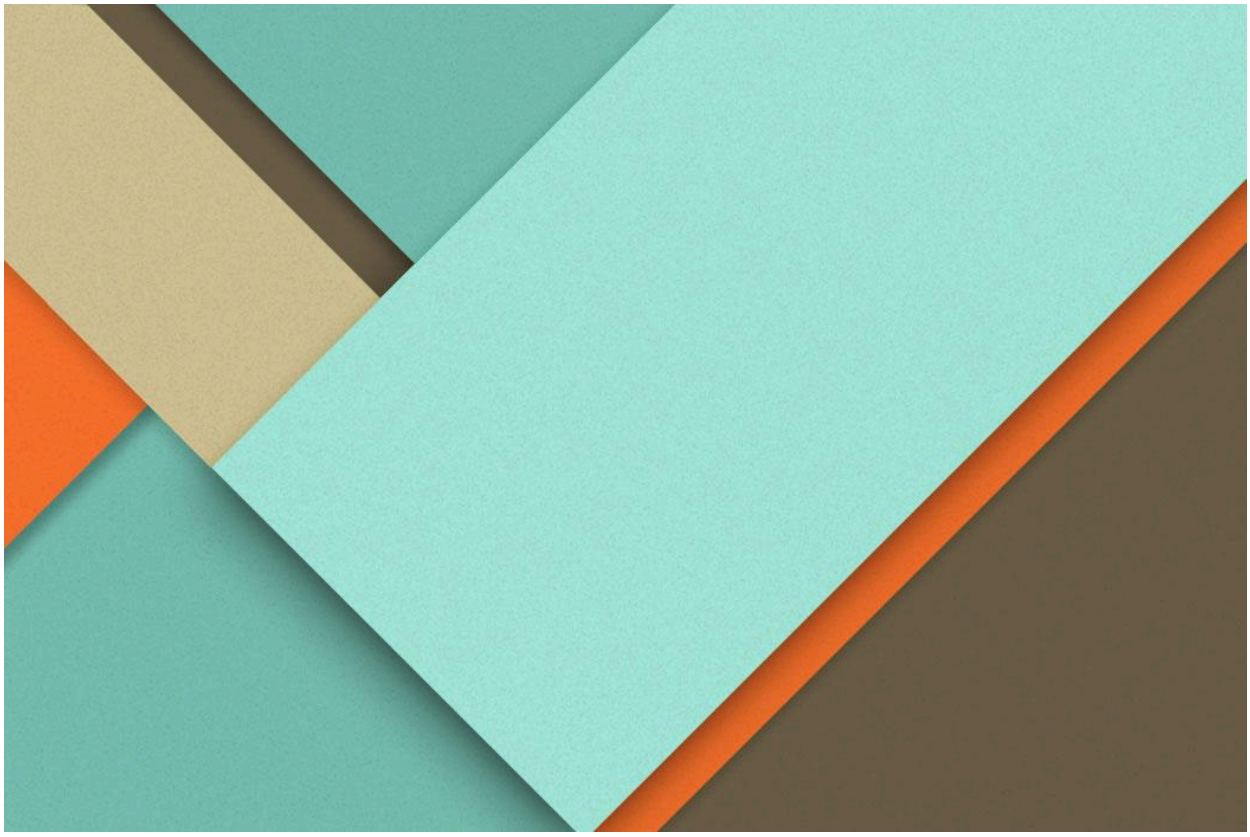


Electric Vehicle Market Penetration & Growth Trend in India

PYTHON+SQL INTEGRATED PROJECT

Arif Muhammed

Problem Statement

AtliQ Motors is an automotive giant from the USA specializing in electric vehicles (EVs). In the last 5 years, their market share rose to 25% in the electric and hybrid vehicles segment in North America. As a part of their expansion plans, they wanted to launch their bestselling models in India, where their market share is less than 2%. Bruce Haryali, the chief of AtliQ Motors India, wanted to do a detailed market study of the existing EV/Hybrid market in India before proceeding further.

Objective

The objective of this project is to conduct a comprehensive analysis of the Indian electric vehicle (EV) market using SQL. AtliQ Motors, a leading EV manufacturer in North America, is exploring opportunities to expand into India, where its market share is currently less than 2%.

the goal is to:

- Understand EV adoption trends across Indian states and brands
- Identify top-performing manufacturers and high-penetration regions
- Analyze growth patterns using metrics like EV penetration rate and CAGR
- Derive actionable business insights to support AtliQ's India launch strategy
- The project involves writing SQL queries on a PostgreSQL database, performing comparative analysis, and visualizing insights using Python (pandas, matplotlib/seaborn

About Dataset

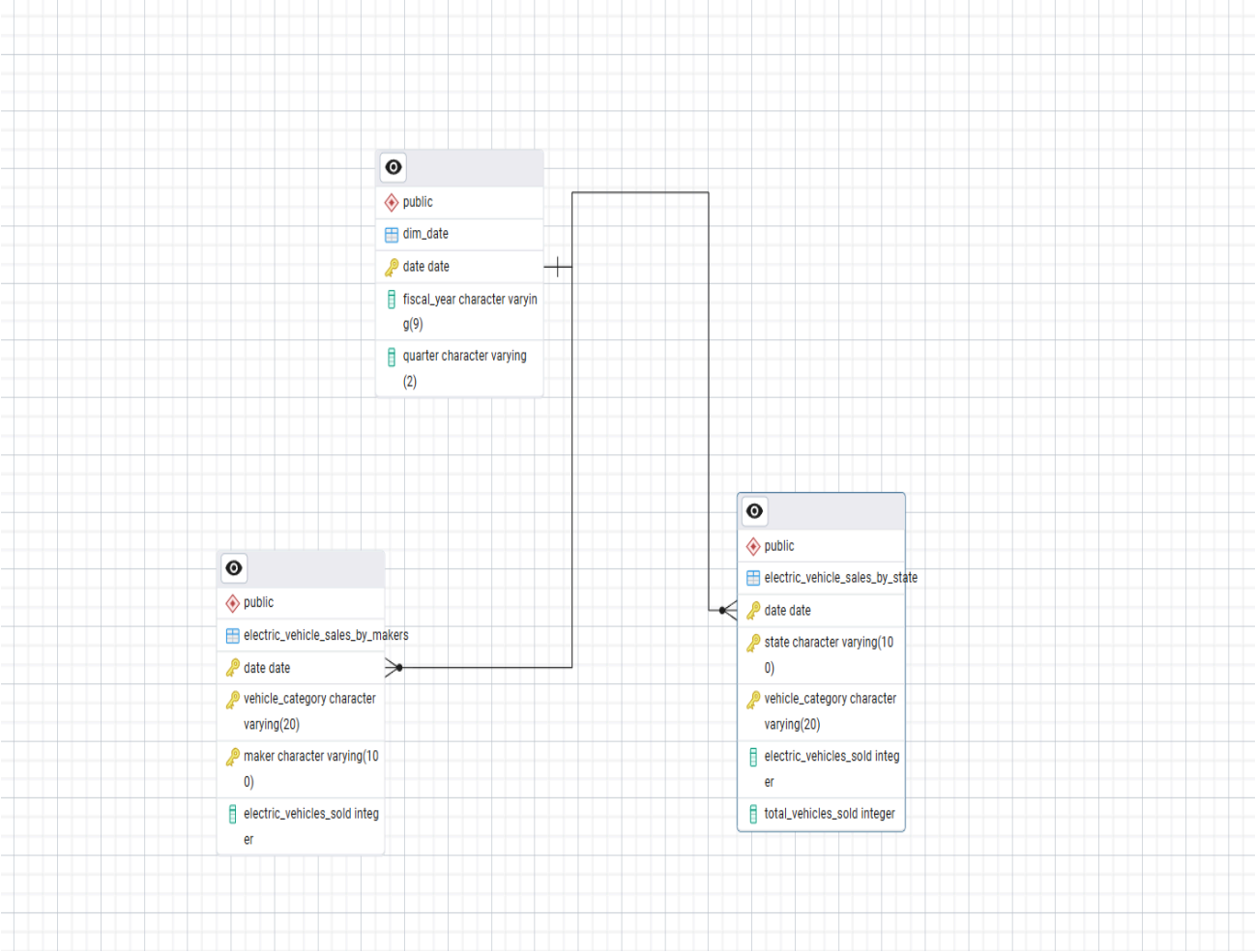
The project uses three CSV files containing EV sales data across India, loaded into a PostgreSQL database for analysis:

- **dim_date**: Time dimension with date, fiscal_year, and quarter – used for time-based grouping.
- **electric_vehicle_sales_by_state**: Monthly EV and total vehicle sales by state and vehicle_category – used to analyze regional trends and EV penetration.
- **electric_vehicle_sales_by_makers**: EV sales by maker, date, and vehicle_category – used to assess brand performance and market share.

Data Cleaning Steps

- No NULL values found in critical columns
- No duplicate rows detected in either fact table
- Vehicle categories are consistent: only `2-Wheeler` and `4-Wheeler`
- No negative sales figures found
- Data is clean and ready for analysis

ER - Diagram

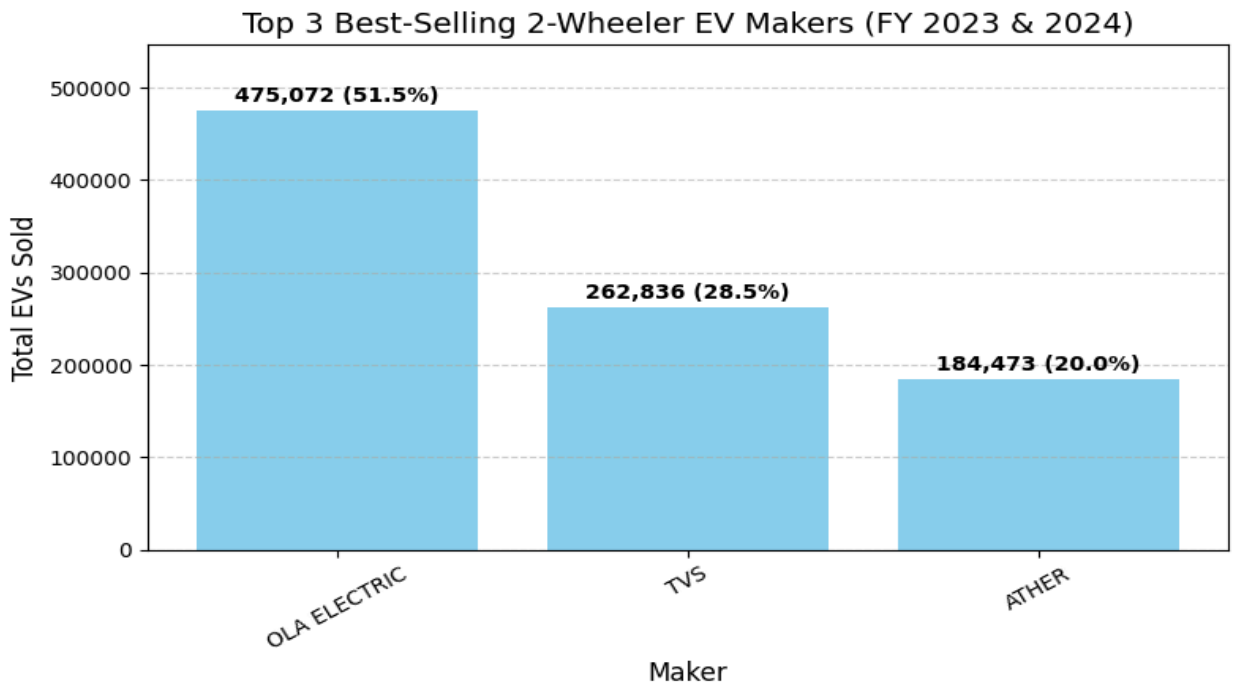

public
dim_date
date date
fiscal_year character varying(9)
quarter character varying(2)
public
electric_vehicle_sales_by_makers
date date
vehicle_category character varying(20)
maker character varying(100)
electric_vehicles_sold integer
public
electric_vehicle_sales_by_state
date date
state character varying(100)
vehicle_category character varying(20)
electric_vehicles_sold integer
total_vehicles_sold integer

Core SQL Analysis

1)List the top 3 makers for the fiscal years 2023 and 2024 in terms of the number of 2-wheelers sold.

```
    m.maker,
    SUM(m.electric_vehicles_sold) AS total_ev_sold
FROM
    electric_vehicle_sales_by_makers m
JOIN
    dim_date d ON m.date = d.date
WHERE
    m.vehicle_category = '2-Wheelers'
    AND d.fiscal_year IN ('2023', '2024')
GROUP BY
    m.maker
ORDER BY
    total_ev_sold DESC
LIMIT 3;
```

	maker character varying (100)	total_ev_sold bigint
1	OLA ELECTRIC	475072
2	TVS	262836
3	ATHER	184473



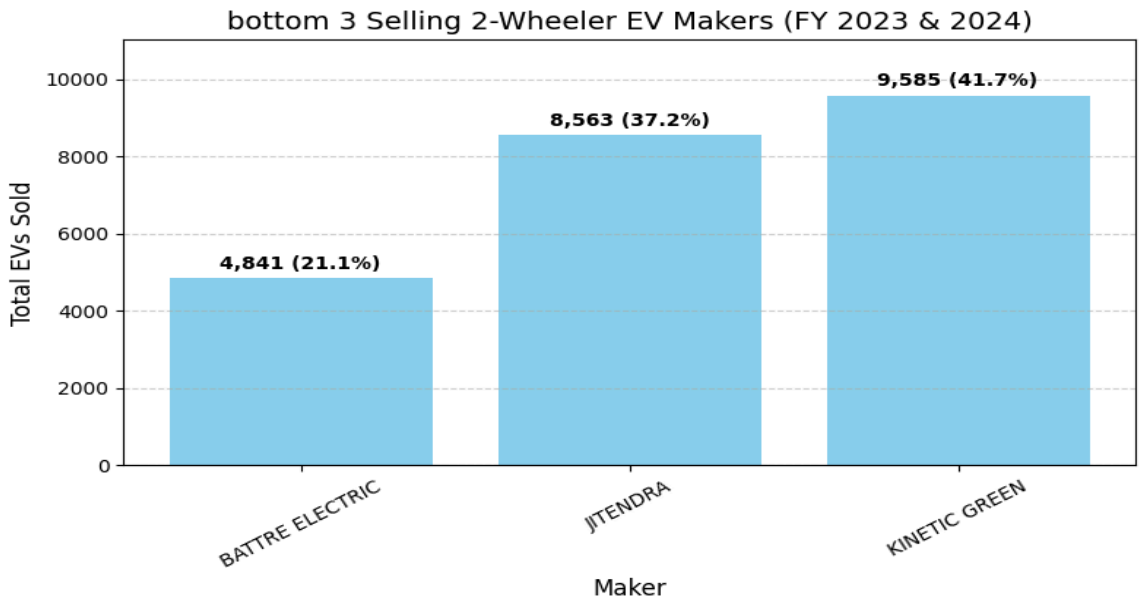
Insight

- ola electric,TVs,Ather are top 3 best selling 2-wheelers
- ola dominate with over half of total sales

2) List the bottom 3 makers for the fiscal years 2023 and 2024 in terms of the number of 2-wheelers sold.

```sql
select
   m.maker,
   sum(m.electric_vehicles_sold) as total_ev_sold
from
  electric_vehicle_sales_by_makers m
join
   dim_date d on m.date = d.date
where
   m.vehicle_category = '2-Wheelers'
   and d.fiscal_year in ('2023','2024')
group by
   m.maker
order by
   total_ev_sold Asc
limit 3;
```

	maker character varying (100)	total_ev_sold bigint
1	BATTRE ELECTRIC	4841
2	JITENDRA	8563
3	KINETIC GREEN	9585



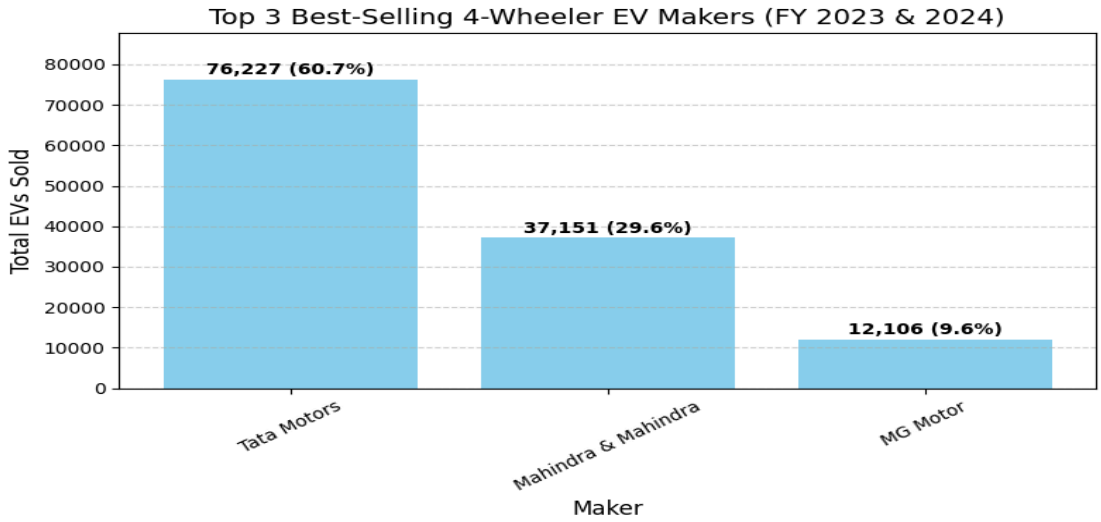
Insight

- Battre electric,jitendra,kinetic green are bottom 3 selling 2-wheelers
- Battre electric with just 4841 unit clearly falling behind

3) List the top 3 makers for the fiscal years 2023 and 2024 in terms of the number of 4-wheelers sold.

```sql
SELECT
    m.maker,
    SUM(m.electric_vehicles_sold) AS total_ev_sold
FROM
    electric_vehicle_sales_by_makers m
JOIN
    dim_date d ON m.date = d.date
WHERE
    m.vehicle_category = '4-Wheelers'
    AND d.fiscal_year IN ('2023', '2024')
GROUP BY
    m.maker
ORDER BY
    total_ev_sold DESC
LIMIT 3;
```

	maker character varying (100)	total_ev_sold bigint
1	Tata Motors	76227
2	Mahindra & Mahindra	37151
3	MG Motor	12106



Insight

1. Tata Motors Dominates the Market

With 76,227 EVs sold, Tata Motors holds a massive 60.7% market share.

This makes it the clear market leader in the 4-wheeler EV segment for FY 2023 & 2024.

2. Mahindra & Mahindra Is a Distant Second

Sold 37,151 EVs, which is 29.6% of the total.

While far behind Tata, it has a strong presence and is a key player in the segment.

3. MG Motor Has a Smaller Share

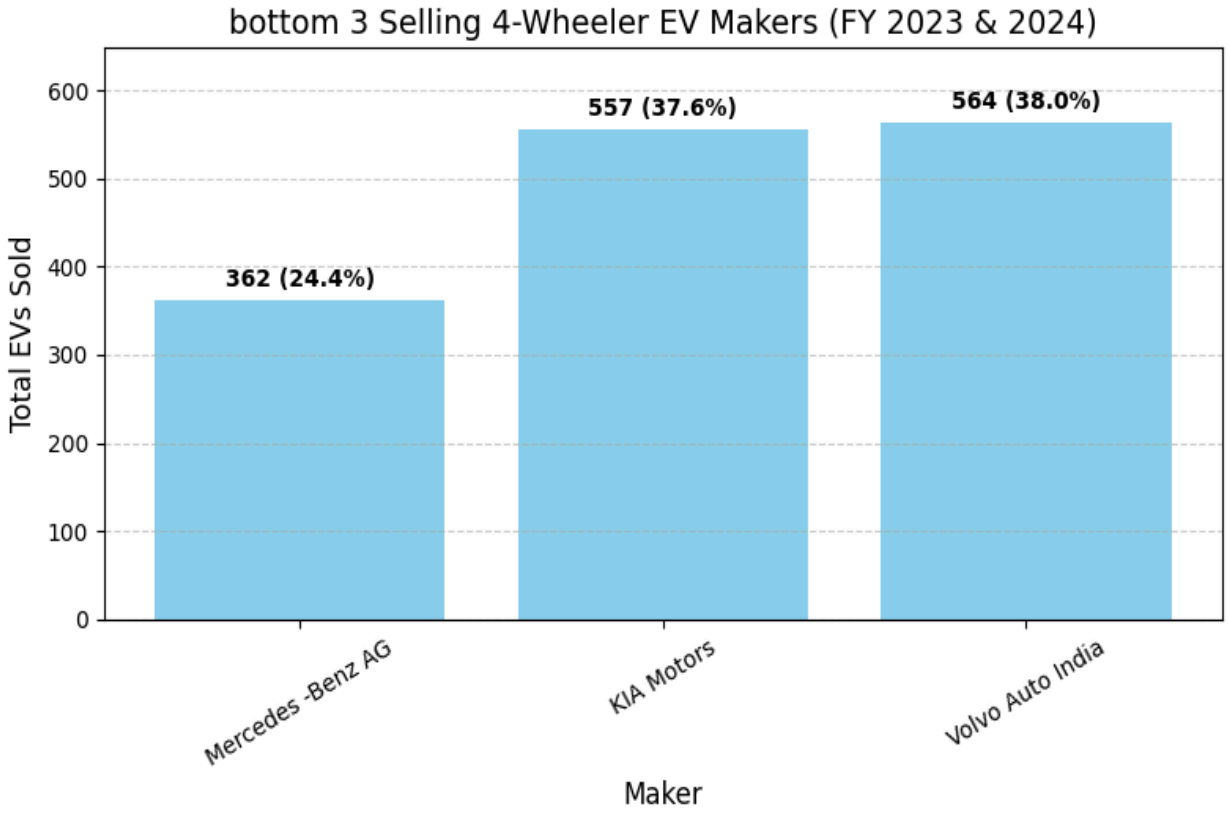
Sold 12,106 EVs, making up only 9.6% of the market.

4) List the bottom 3 makers for the fiscal years 2023 and 2024 in terms of the number of 4-wheelers sold

```sql
WITH ev_totals AS (
    SELECT
        m.maker,
        SUM(m.electric_vehicles_sold) OVER (PARTITION BY m.maker) AS total_ev_sold,
        ROW_NUMBER() OVER (PARTITION BY m.maker ORDER BY m.maker) AS row_num
    FROM
        electric_vehicle_sales_by_makers m
    JOIN
        dim_date d ON m.date = d.date
    WHERE
        m.vehicle_category = '4-Wheelers'
        AND d.fiscal_year IN ('2023','2024')
),
deduplicated AS (
    SELECT DISTINCT maker, total_ev_sold
    FROM ev_totals
)

SELECT *
FROM deduplicated
ORDER BY total_ev_sold ASC
LIMIT 3;
```

	maker character varying (100)	total_ev_sold bigint
1	Mercedes -Benz AG	362
2	KIA Motors	557
3	Volvo Auto India	564



Insight

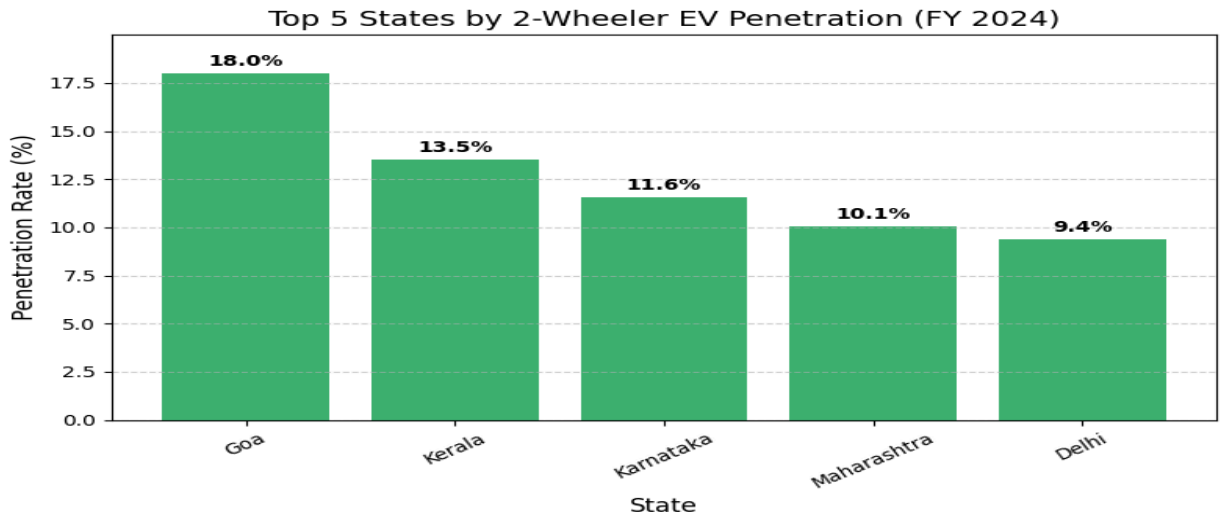
Mercedes-Benz AG had the lowest 4-wheeler EV sales with just 362 units (24.4%) in FY 2023 & 2024,

followed by KIA Motors (557 units, 37.6%) and Volvo Auto India (564 units, 38.0%), indicating minimal market presence compared to leading players.

5) Identify the top 5 states with the highest penetration rate in 2-wheeler EV sales in FY 2024.

```sql
SELECT
    s.state,
    s.vehicle_category AS two_wheelers,
    SUM(s.electric_vehicles_sold)
    ::float / NULLIF(SUM(s.total_vehicles_sold), 0)
    * 100 AS penetration_rate
FROM
    electric_vehicle_sales_by_state s
JOIN
    dim_date d ON s.date = d.date
WHERE
    d.fiscal_year = '2024'
    AND s.vehicle_category = '2-Wheelers'
GROUP BY
    s.state, s.vehicle_category
ORDER BY
    penetration_rate DESC
LIMIT 5;
```

	state character varying (100)	two_wheelers character varying (20)	penetration_rate double precision
1	Goa	2-Wheelers	17.992263768649845
2	Kerala	2-Wheelers	13.524902534418349
3	Karnataka	2-Wheelers	11.573278573365307
4	Maharashtra	2-Wheelers	10.072506951081882
5	Delhi	2-Wheelers	9.40086570685409



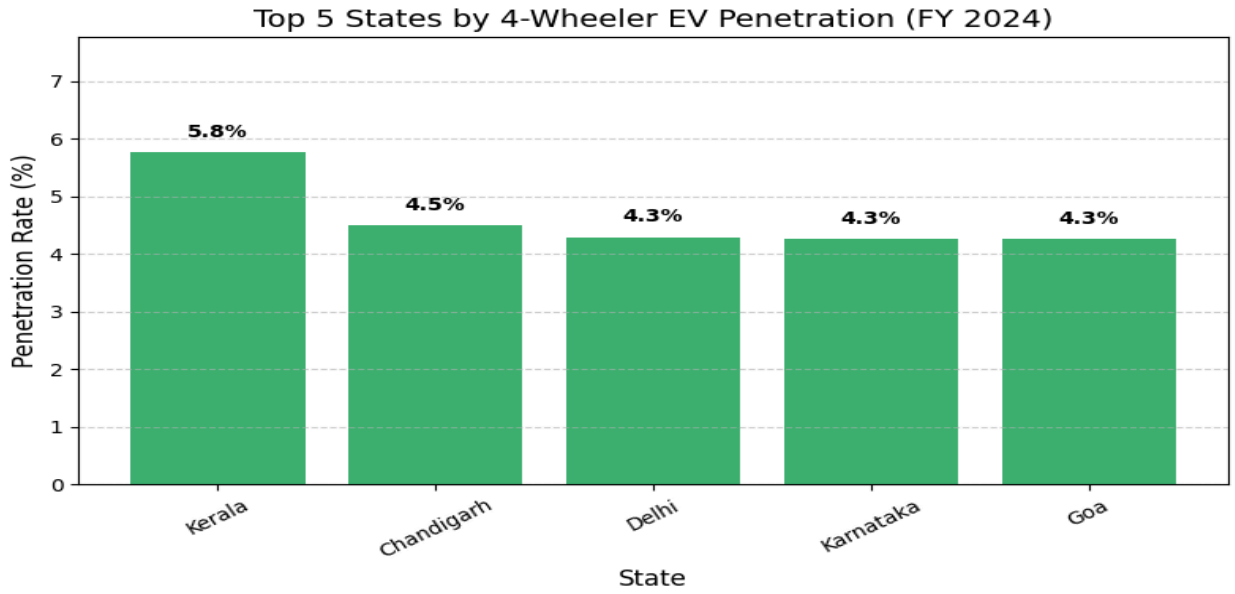
Insight

- Goa leads the nation in 2-wheeler EV adoption with an impressive 18% penetration rate in FY 2024.
- It is followed by Kerala (13.5%), Karnataka (11.6%), Maharashtra (10.1%), and Delhi (9.4%), indicating strong EV - policy implementation and consumer shift in these states.

6) Identify the top 5 states with the highest penetration rate in 4-wheeler EV sales in FY 2024

```sql
SELECT
    s.state,
    s.vehicle_category AS two_wheelers,
    SUM(s.electric_vehicles_sold)
    ::float / NULLIF(SUM(s.total_vehicles_sold), 0)
    * 100 AS penetration_rate
FROM
    electric_vehicle_sales_by_state s
JOIN
    dim_date d ON s.date = d.date
WHERE
    d.fiscal_year = '2024'
    AND s.vehicle_category = '4-Wheelers'
GROUP BY
    s.state, s.vehicle_category
ORDER BY
    penetration_rate DESC
LIMIT 5;
```

	state character varying (100)	two_wheelers character varying (20)	penetration_rate double precision
1	Kerala	4-Wheelers	5.7584454897724635
2	Chandigarh	4-Wheelers	4.503112445366651
3	Delhi	4-Wheelers	4.29075722169741
4	Karnataka	4-Wheelers	4.261120173647761
5	Goa	4-Wheelers	4.2543533878022615



Insight

- Kerala leads the nation in 4-wheeler EV adoption with an 5.8% penetration rate in FY 2024.
- It is followed by Chandigarh (4.5%), Delhi (4.3 %), Karnataka (4.3%), and Goa (4.3%),
- indicating strong EV policy implementation and consumer shift in these states.

7) List the states with negative penetration (decline) in 4-Wheelers EV sales from 2022 to 2024?

```sql
WITH penetration_2022 AS (
    SELECT
        s.state,
        ROUND((SUM(s.electric_vehicles_sold)::FLOAT / NULLIF(SUM(s.total_vehicles_sold), 0)
        * 100)::NUMERIC, 2) AS penetration_2022
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE d.fiscal_year = '2022'
      AND s.vehicle_category = '4-Wheelers'
    GROUP BY s.state
),

penetration_2024 AS (
    SELECT
        s.state,
        ROUND((SUM(s.electric_vehicles_sold)::FLOAT / NULLIF(SUM(s.total_vehicles_sold), 0)
        * 100)::NUMERIC, 2) AS penetration_2024
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE d.fiscal_year = '2024'
      AND s.vehicle_category = '4-Wheelers'
    GROUP BY s.state
)

SELECT
    p22.state,
    p22.penetration_2022,
    p24.penetration_2024,
    (p24.penetration_2024 - p22.penetration_2022) AS change
FROM penetration_2022 p22
JOIN penetration_2024 p24 ON p22.state = p24.state
WHERE (p24.penetration_2024 - p22.penetration_2022) < 0
ORDER BY change ASC;
```

	state character varying (100)	penetration_2022 numeric	penetration_2024 numeric	change numeric
1	Andaman & Nicobar Island	1.88	0.84	-1.04

- Andaman & Nicobar Islands is the only state where EV adoption for 4-Wheelers actually declined from FY 2022 to FY 2024

8)List the states with negative penetration (decline) in 2-Wheelers EV sales from 2022 to 2024?

```sql
WITH penetration_2022 AS (
    SELECT
        s.state,
        ROUND((SUM(s.electric_vehicles_sold)::FLOAT / NULLIF(SUM(s.total_vehicles_sold), 0)
        * 100)::NUMERIC, 2) AS penetration_2022
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE d.fiscal_year = '2022'
      AND s.vehicle_category = '2-Wheelers'
    GROUP BY s.state
),

penetration_2024 AS (
    SELECT
        s.state,
        ROUND((SUM(s.electric_vehicles_sold)::FLOAT / NULLIF(SUM(s.total_vehicles_sold), 0)
        * 100)::NUMERIC, 2) AS penetration_2024
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE d.fiscal_year = '2024'
      AND s.vehicle_category = '2-Wheelers'
    GROUP BY s.state
)

SELECT
    p22.state,
    p22.penetration_2022,
    p24.penetration_2024,
    (p24.penetration_2024 - p22.penetration_2022) AS change
FROM penetration_2022 p22
JOIN penetration_2024 p24 ON p22.state = p24.state
WHERE (p24.penetration_2024 - p22.penetration_2022) < 0
ORDER BY change ASC;
```

	state character varying (100)	penetration_2022 numeric	penetration_2024 numeric	change numeric
1	Ladakh	4.48	4.06	-0.42

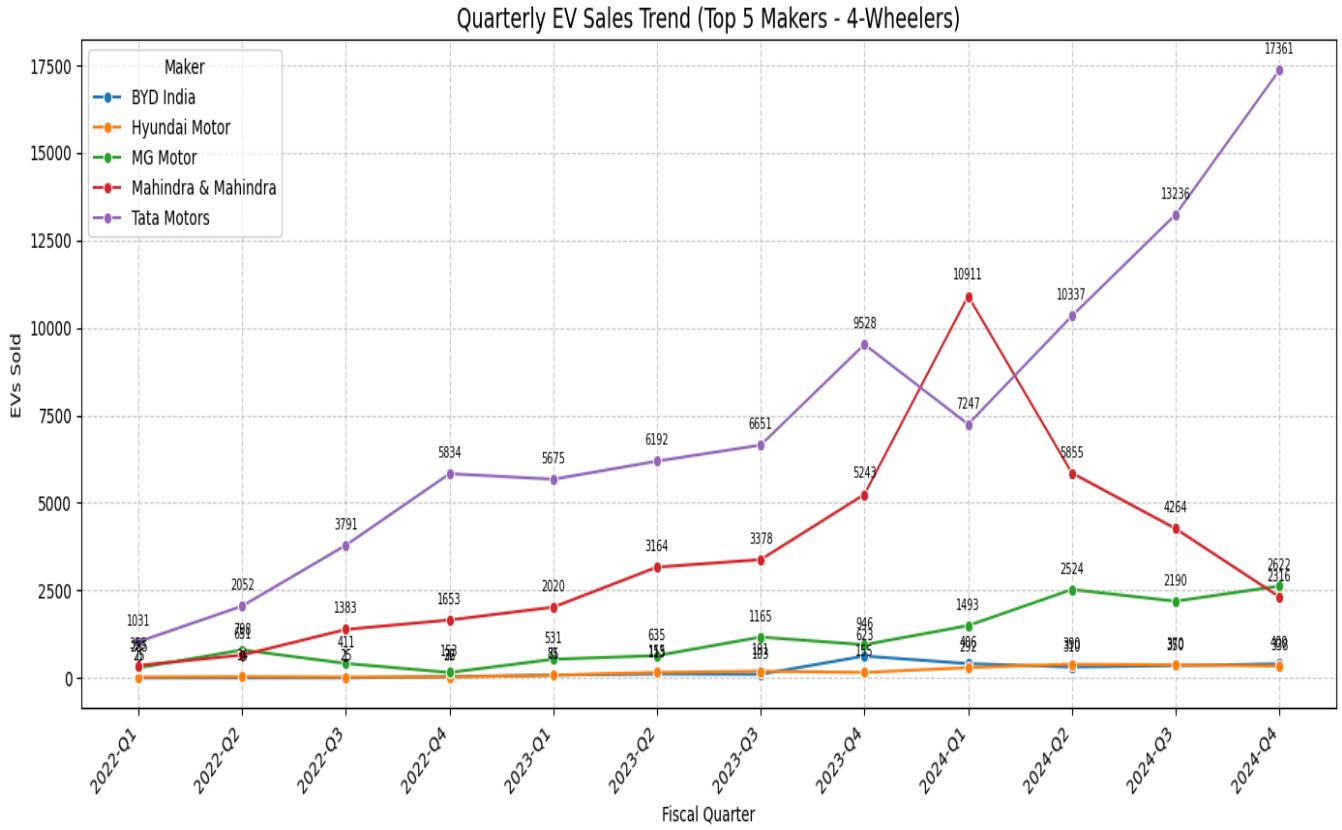
- Ladakh is the only state (in your data) where 2-Wheeler EV penetration decreased from FY 2022 to FY 2024 — a drop of 0.42 percentage points.

9)What are the quarterly trends based on sales volume for the top 5 EV makers (4-wheelers) from 2022 to 2024?

```
WITH top_5_makers AS (
    SELECT
        m.maker
    FROM
        electric_vehicle_sales_by_makers m
    JOIN
        dim_date d ON m.date = d.date
    WHERE
        m.vehicle_category = '4-Wheelers'
        AND d.fiscal_year IN ('2022', '2023', '2024')
    GROUP BY
        m.maker
    ORDER BY
        SUM(m.electric_vehicles_sold) DESC
    LIMIT 5
),
quarterly_trends AS (
    SELECT
        m.maker,d.fiscal_year,d.quarter,
        SUM(m.electric_vehicles_sold) AS quarterly_ev_sales
    FROM
        electric_vehicle_sales_by_makers m
    JOIN
        dim_date d ON m.date = d.date
    WHERE
        m.vehicle_category = '4-Wheelers'
        AND d.fiscal_year IN ('2022', '2023', '2024')
    GROUP BY
        m.maker, d.fiscal_year, d.quarter
)
SELECT
    qt.maker,qt.fiscal_year,qt.quarter,qt.quarterly_ev_sales
FROM
    quarterly_trends qt
JOIN
    top_5_makers t5 ON qt.maker = t5.maker
ORDER BY
    qt.maker, qt.fiscal_year, qt.quarter;
```

	maker character varying (100)	fiscal_year character varying (9)	quarter character varying (2)	quarterly_ev_sales bigint
1	BYD India	2022	Q1	0
2	BYD India	2022	Q2	0
3	BYD India	2022	Q3	1
4	BYD India	2022	Q4	32
5	BYD India	2023	Q1	81
6	BYD India	2023	Q2	113
7	BYD India	2023	Q3	103
8	BYD India	2023	Q4	623
9	BYD India	2024	Q1	406
10	BYD India	2024	Q2	310
11	BYD India	2024	Q3	350
12	BYD India	2024	Q4	400
13	Hyundai Motor	2022	Q1	25
14	Hyundai Motor	2022	Q2	34
15	Hyundai Motor	2022	Q3	25
16	Hyundai Motor	2022	Q4	26
17	Hyundai Motor	2023	Q1	75
18	Hyundai Motor	2023	Q2	155
19	Hyundai Motor	2023	Q3	191
20	Hyundai Motor	2023	Q4	155
21	Hyundai Motor	2024	Q1	292

Total rows: 60 | Query complete 00:00:00.077



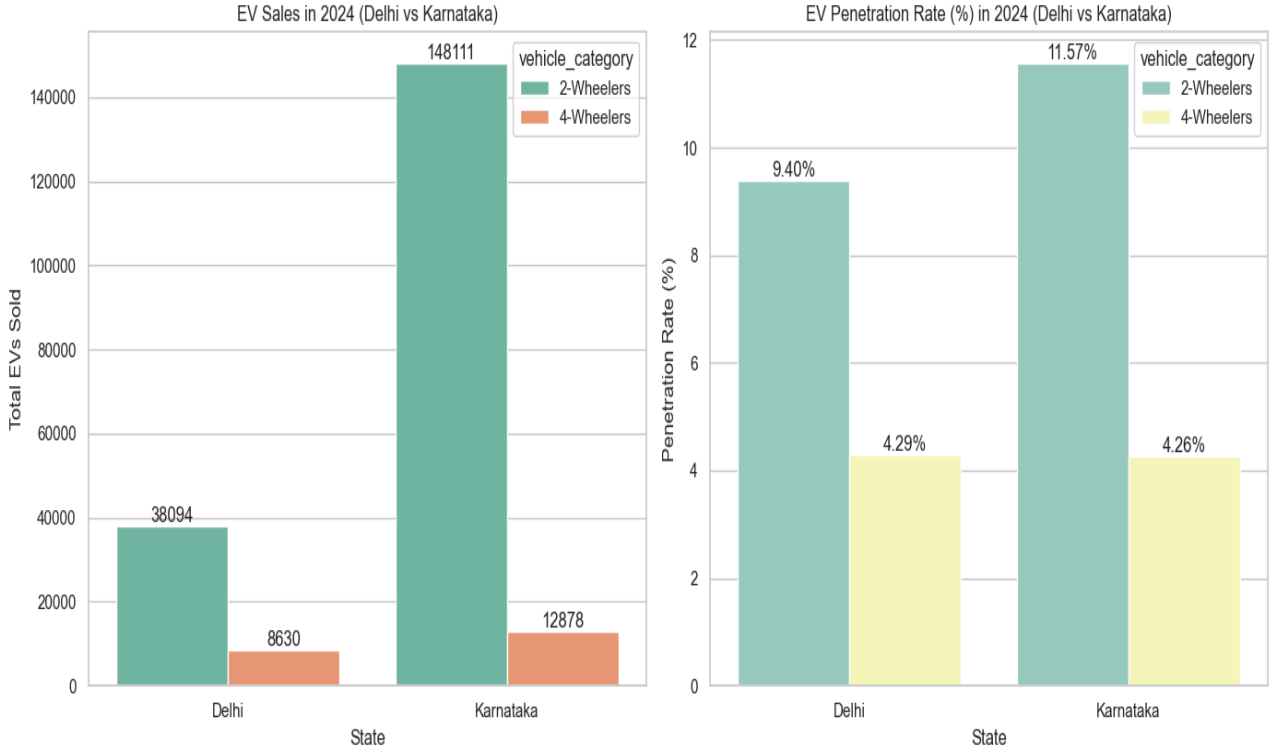
Insight

- Tata Motors dominates the market with massive growth, followed by Mahindra & Mahindra.
- MG Motor is emerging as a strong third.
- Hyundai and BYD show little momentum — possibly limited models or marketing in India.

10)How do the EV sales and penetration rates in Delhi compare to Karnataka for 2024?

```sql
SELECT
    s.state,
    s.vehicle_category,
    SUM(s.electric_vehicles_sold) AS total_ev_sales,
    SUM(s.total_vehicles_sold) AS total_vehicle_sales,
    ROUND((SUM(s.electric_vehicles_sold)
    ::FLOAT / NULLIF(SUM(s.total_vehicles_sold), 0) * 100)::NUMERIC, 2)
    AS penetration_rate
FROM
    electric_vehicle_sales_by_state s
JOIN
    dim_date d ON s.date = d.date
WHERE
    d.fiscal_year = '2024'
    AND s.state IN ('Delhi', 'Karnataka')
GROUP BY
    s.state, s.vehicle_category
ORDER BY
    s.state, s.vehicle_category;
```

	state character varying (100)	vehicle_category character varying (20)	total_ev_sales bigint	total_vehicle_sales bigint	penetration_rate numeric
1	Delhi	2-Wheelers	38094	405218	9.40
2	Delhi	4-Wheelers	8630	201130	4.29
3	Karnataka	2-Wheelers	148111	1279767	11.57
4	Karnataka	4-Wheelers	12878	302221	4.26



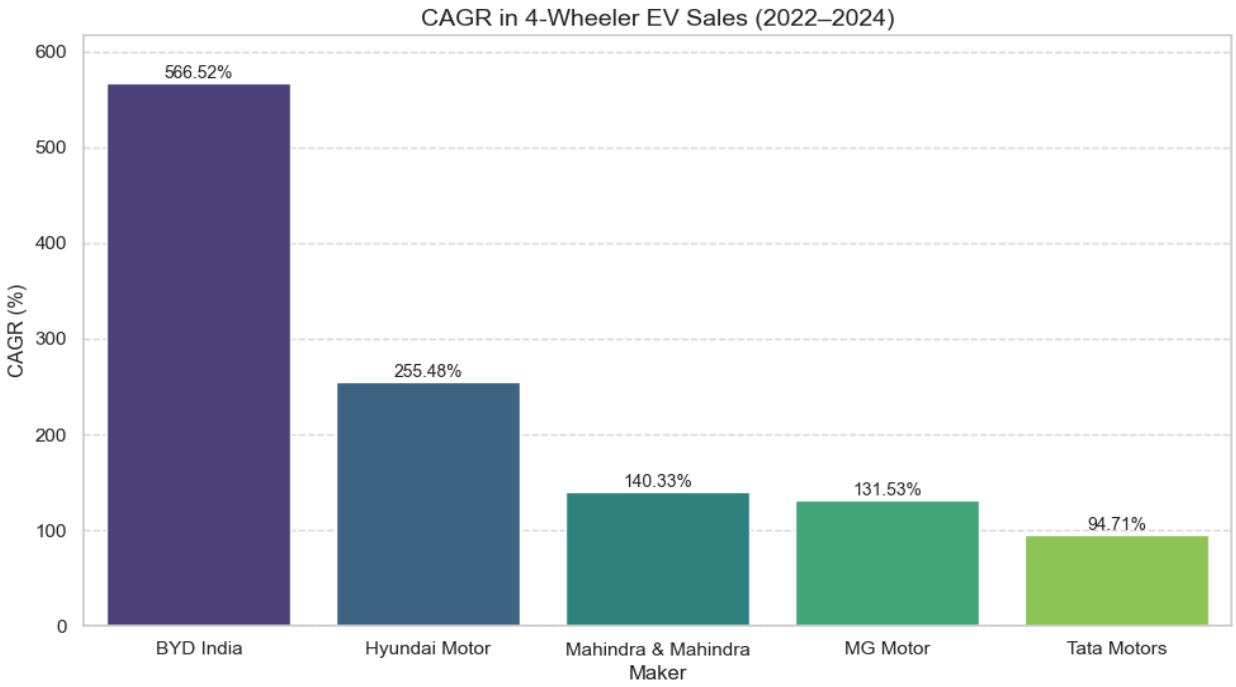
Insight

- Karnataka is leading in both sales volume and penetration for 2-wheelers, indicating a more mature or rapidly growing EV ecosystem in this segment.
- Delhi has comparable penetration in 4-wheelers, despite lower total sales—likely due to a smaller base of total vehicle registrations.
- The data suggests that Delhi may benefit from targeted 2-wheeler EV adoption policies to catch up with Karnataka.

11) List down the compounded annual growth rate (CAGR) in 4-wheeler units for the top 5 makers from 2022 to 2024.

```sql
WITH sales_by_year AS (
    SELECT
        m.maker,
        d.fiscal_year,
        SUM(m.electric_vehicles_sold) AS total_sales
    FROM electric_vehicle_sales_by_makers m
    JOIN dim_date d ON m.date = d.date
    WHERE
        m.vehicle_category = '4-Wheelers'
        AND d.fiscal_year IN ('2022', '2024')
    GROUP BY m.maker, d.fiscal_year
),
pivoted_sales AS (
    SELECT
        maker,
        MAX(CASE WHEN fiscal_year = '2022' THEN total_sales END) AS sales_2022,
        MAX(CASE WHEN fiscal_year = '2024' THEN total_sales END) AS sales_2024
    FROM sales_by_year
    GROUP BY maker
),
filtered AS (
    SELECT *
    FROM pivoted_sales
    WHERE sales_2022 > 0
),
top_5 AS (
    SELECT *
    FROM filtered
    ORDER BY sales_2024 DESC
    LIMIT 5
)
SELECT
    maker,
    sales_2022,
    sales_2024,
    ROUND((POWER(sales_2024::NUMERIC / sales_2022, 1.0 / 2) - 1) * 100, 2) AS cagr_percentage
FROM top_5
ORDER BY cagr_percentage DESC;
```

	maker character varying (100)	sales_2022 bigint	sales_2024 bigint	cagr_percentage numeric
1	BYD India	33	1466	566.52
2	Hyundai Motor	110	1390	255.48
3	Mahindra & Mahindra	4042	23346	140.33
4	MG Motor	1647	8829	131.53
5	Tata Motors	12708	48181	94.71



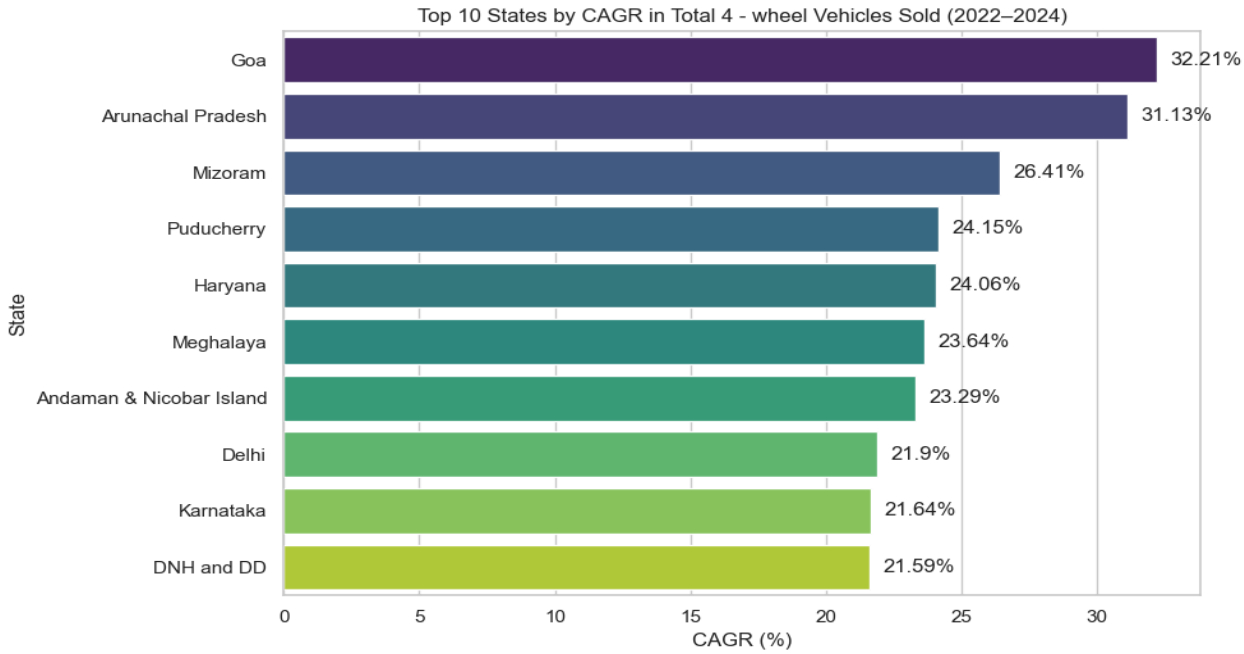
Insight

- BYD India leads in CAGR due to low initial sales base, showing rapid growth.
- Tata Motors, while having the largest sales volume, has a lower CAGR due to an already strong base.
- Other top makers like Hyundai, Mahindra, and MG Motor show consistent expansion from 2022 to 2024.

12) List down the top 10 states that had the highest compounded annual growth rate (CAGR) from 2022 to 2024 in total 4- wheel vehicles sold.

```sql
WITH yearly_sales AS (
    SELECT
        s.state,
        d.fiscal_year,
        SUM(s.total_vehicles_sold) AS total_sales
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE
        d.fiscal_year IN ('2022', '2024')
        AND s.vehicle_category = '4-Wheelers'
    GROUP BY s.state, d.fiscal_year
),
pivoted AS (
    SELECT
        state,
        MAX(CASE WHEN fiscal_year = '2022' THEN total_sales END) AS sales_2022,
        MAX(CASE WHEN fiscal_year = '2024' THEN total_sales END) AS sales_2024
    FROM yearly_sales
    GROUP BY state
),
filtered AS (
    SELECT *
    FROM pivoted
    WHERE sales_2022 > 0
)
SELECT
    state,
    sales_2022,
    sales_2024,
    ROUND((POWER(sales_2024::NUMERIC / sales_2022, 1.0 / 2) - 1) * 100, 2) AS cagr_percentage
FROM filtered
ORDER BY cagr_percentage DESC
LIMIT 10;
```

	state character varying (100)	sales_2022 bigint	sales_2024 bigint	cagr_percentage numeric
1	Goa	13865	24234	32.21
2	Arunachal Pradesh	7688	13219	31.13
3	Mizoram	3371	5387	26.41
4	Puducherry	7508	11573	24.15
5	Haryana	174990	269304	24.06
6	Meghalaya	9254	14146	23.64
7	Andaman & Nicobar Island	1169	1777	23.29
8	Delhi	135345	201130	21.90
9	Karnataka	204252	302221	21.64
10	DNH and DD	3725	5507	21.59



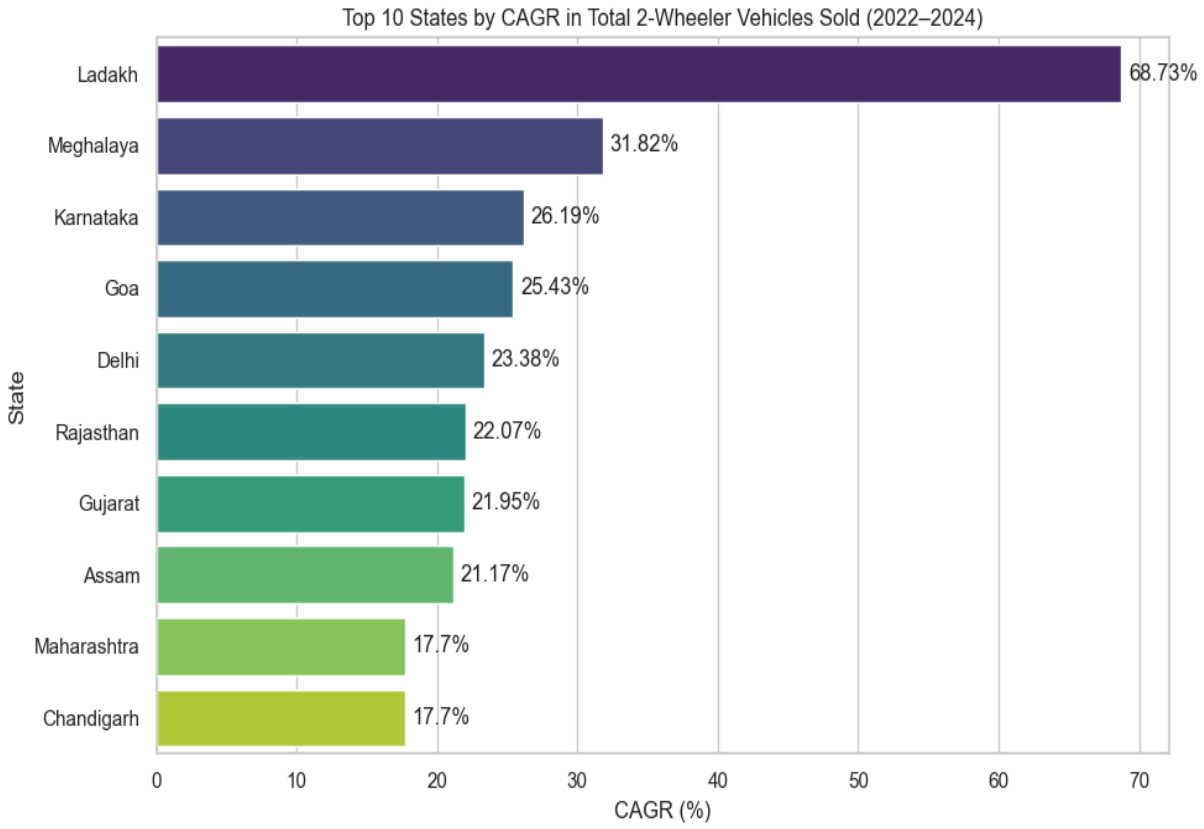
Insight

- Goa and Arunachal Pradesh lead the country in 4-wheeler sales growth, with CAGR of 32.21% and 31.13% respectively.
- Smaller regions like Mizoram and Puducherry also show strong adoption trends, surpassing larger markets.
- Delhi and Karnataka, while major markets, show relatively moderate growth (~21–22%), likely due to their already high base volumes.
- The consistent growth across smaller states and UTs suggests emerging markets are rapidly embracing 4-wheeler EVs.

13) List down the top 10 states that had the highest compounded annual growth rate (CAGR) from 2022 to 2024 in total 2 - wheel vehicles sold.

```sql
WITH yearly_sales AS (
    SELECT
        s.state,
        d.fiscal_year,
        SUM(s.total_vehicles_sold) AS total_sales
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE
        d.fiscal_year IN ('2022', '2024')
        AND s.vehicle_category = '2-Wheelers'
    GROUP BY s.state, d.fiscal_year
),
pivoted AS (
    SELECT
        state,
        MAX(CASE WHEN fiscal_year = '2022' THEN total_sales END) AS sales_2022,
        MAX(CASE WHEN fiscal_year = '2024' THEN total_sales END) AS sales_2024
    FROM yearly_sales
    GROUP BY state
),
filtered AS (
    SELECT *
    FROM pivoted
    WHERE sales_2022 > 0
)
SELECT
    state,
    sales_2022,
    sales_2024,
    ROUND((POWER(sales_2024::NUMERIC / sales_2022, 1.0 / 2) - 1) * 100, 2) AS cagr_percentage
FROM filtered
ORDER BY cagr_percentage DESC
LIMIT 10;
```

	state character varying (100)	sales_2022 bigint	sales_2024 bigint	cagr_percentage numeric
1	Ladakh	268	763	68.73
2	Meghalaya	12939	22482	31.82
3	Karnataka	803642	1279767	26.19
4	Goa	34507	54290	25.43
5	Delhi	266195	405218	23.38
6	Rajasthan	734752	1094945	22.07
7	Gujarat	831276	1236242	21.95
8	Assam	311051	456726	21.17
9	Maharashtra	1311960	1817343	17.70
10	Chandigarh	16238	22496	17.70



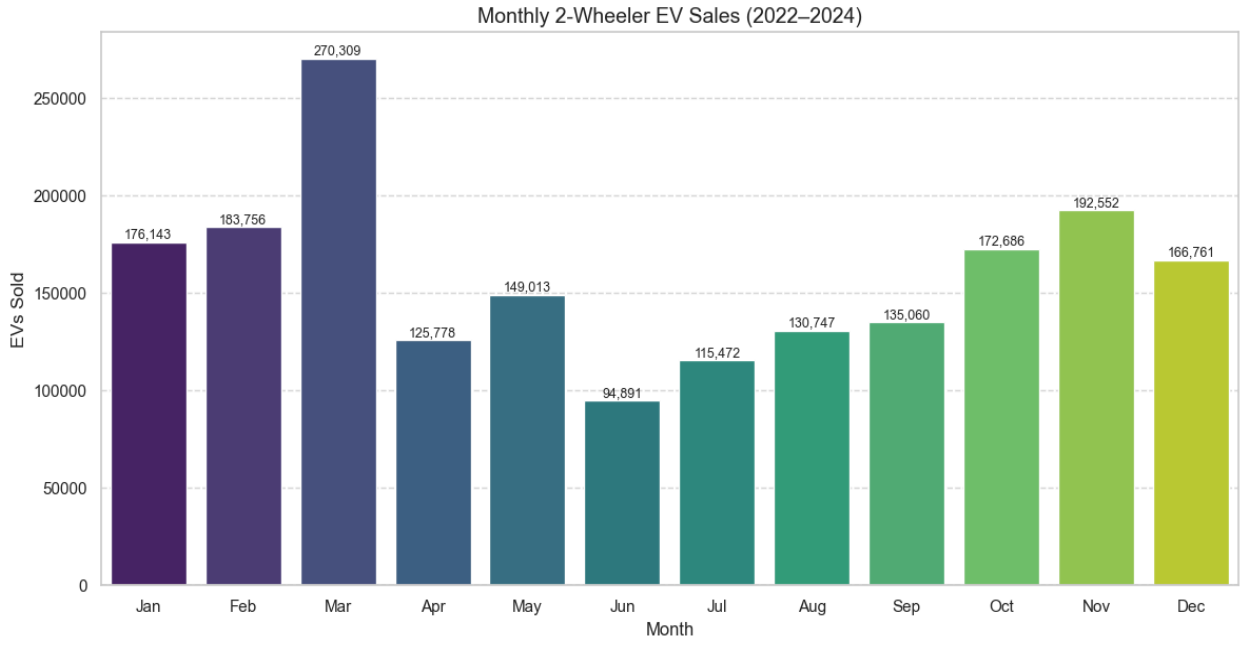
Insight

- Ladakh tops the chart with an impressive CAGR of 68.73%, indicating rapid EV adoption from a low base.
- Meghalaya and Karnataka follow with strong growth at 31.82% and 26.19%, showing both emerging and established markets expanding.
- High population states like Delhi, Rajasthan, and Maharashtra show steady growth (~17–23%), reflecting ongoing transition momentum.
- Goa and Chandigarh also demonstrate significant uptick in 2-wheeler EV sales despite their smaller geographic footprint.
- The overall trend shows that both smaller and larger states are increasingly embracing electric mobility.

14) What are the peak and low season months for 2 wheel EV sales based on the data from 2022 to 2024?

```sql
SELECT
    EXTRACT(MONTH FROM s.date) AS month,
    SUM(s.electric_vehicles_sold) AS total_2w_sales
FROM
    electric_vehicle_sales_by_state s
JOIN
    dim_date d ON s.date = d.date
WHERE
    d.fiscal_year IN ('2022', '2023', '2024')
    AND s.vehicle_category = '2-Wheelers'
GROUP BY
    month
ORDER BY
    month;
```

	month numeric	total_2w_sales bigint
1	1	176143
2	2	183756
3	3	270309
4	4	125778
5	5	149013
6	6	94891
7	7	115472
8	8	130747
9	9	135060
10	10	172686
11	11	192552
12	12	166761



Insight

Peak Season Months March had the highest 2-wheeler EV sales across all months, reaching 270,309 units.

This is likely due to year-end incentives, tax benefits, or government scheme deadlines.

November and February also performed well with 192,552 and 183,756 sales respectively, suggesting strong demand during the festive and financial quarters.

Low Season Months June recorded the lowest sales with only 94,891 units sold.

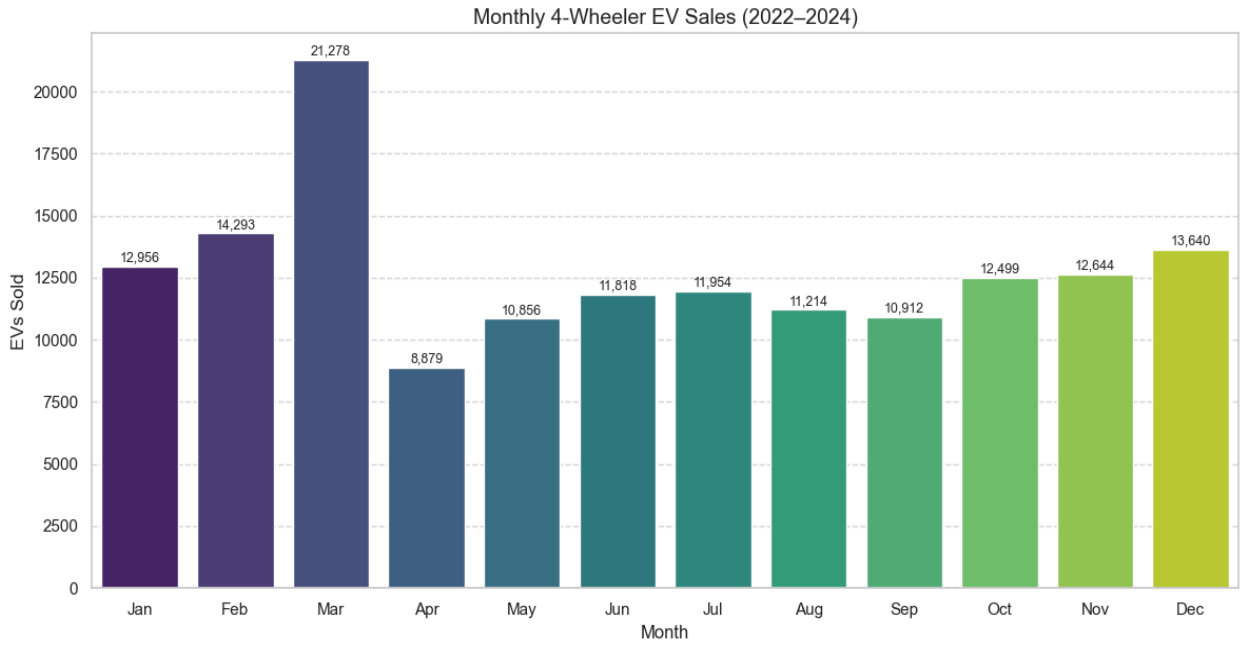
This drop may correlate with monsoon onset, agricultural season focus, or lower purchasing activity.

July and April were also relatively low-performing months, indicating a post-year-end dip.

15) What are the peak and low season months for 4 wheel EV sales based on the data from 2022 to 2024?

```sql
SELECT
    EXTRACT(MONTH FROM s.date) AS month,
    SUM(s.electric_vehicles_sold) AS total_4w_sales
FROM
    electric_vehicle_sales_by_state s
JOIN
    dim_date d ON s.date = d.date
WHERE
    d.fiscal_year IN ('2022', '2023', '2024')
    AND s.vehicle_category = '4-Wheelers'
GROUP BY
    month
ORDER BY
    month;
```

	month numeric	total_4w_sales bigint
1	1	12956
2	2	14293
3	3	21278
4	4	8879
5	5	10856
6	6	11818
7	7	11954
8	8	11214
9	9	10912
10	10	12499
11	11	12644
12	12	13640



Insight

March is the peak month

With 21,278 units sold, March sees the highest EV sales, likely driven by financial year-end incentives, tax planning, or dealership targets.

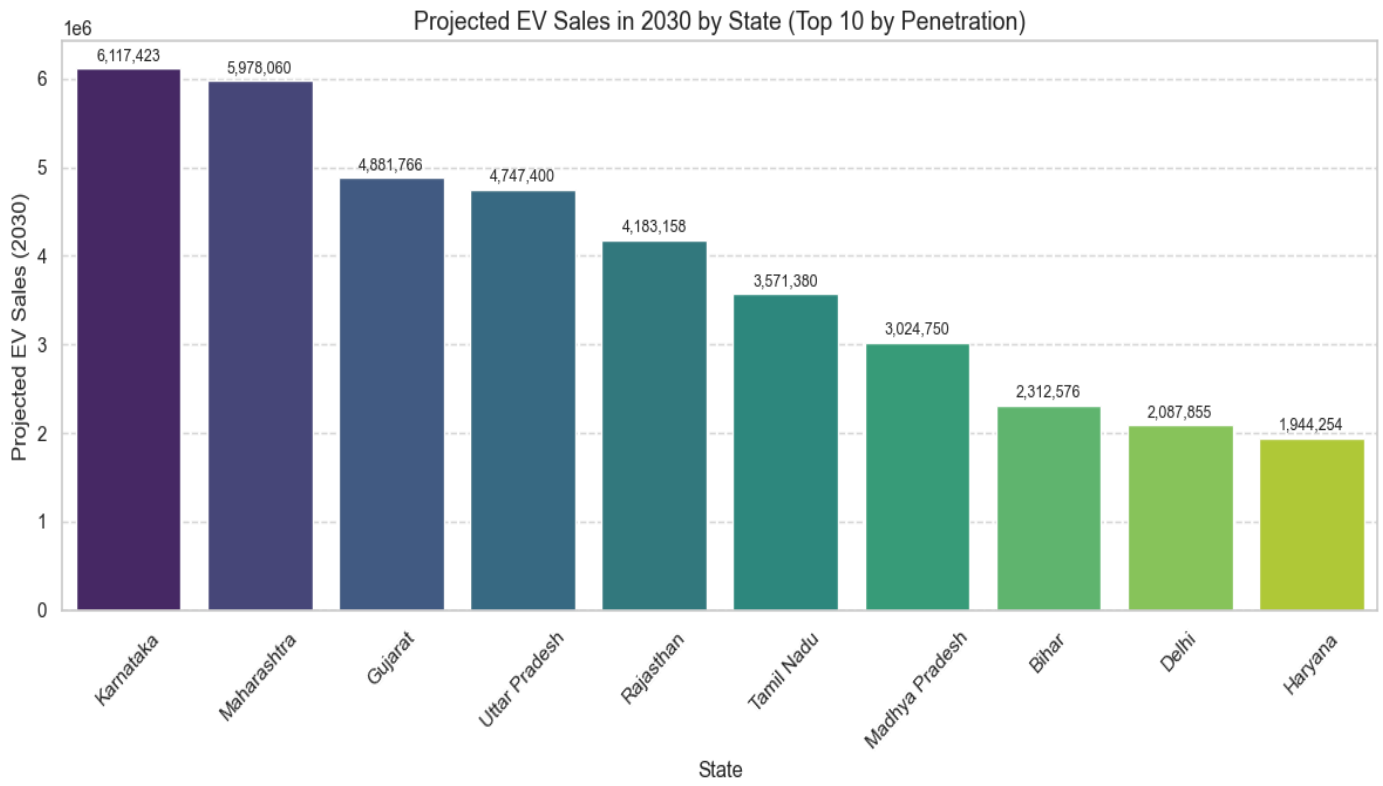
April marks the lowest sales

Only 8,879 units were sold in April, a sharp dip following March. This may be due to consumer fatigue, budget resets, or the start of the new fiscal year.

16) What is the projected number of EV sales (including 2-wheelers and 4wheelers) for the top 10 states by penetration rate in 2030, based on the compounded annual growth rate (CAGR) from previous years?

```
WITH total_sales AS (
    SELECT s.state,d.fiscal_year,SUM(s.total_vehicles_sold) AS total_sales
    FROM electric_vehicle_sales_by_state s
    JOIN dim_date d ON s.date = d.date
    WHERE d.fiscal_year IN ('2022', '2024')
    GROUP BY s.state, d.fiscal_year),
pivoted AS (
    SELECT -
        state,
        MAX(CASE WHEN fiscal_year = '2022' THEN total_sales END) AS sales_2022,
        MAX(CASE WHEN fiscal_year = '2024' THEN total_sales END) AS sales_2024
    FROM total_sales
    GROUP BY state
),
filtered AS (
    SELECT *
    FROM pivoted
    WHERE sales_2022 > 0
),
cagr_calc AS (
    SELECT
        state,
        sales_2022,sales_2024,
        ROUND((POWER(sales_2024::NUMERIC / sales_2022, 1.0 / 2) - 1), 6) AS cagr_decimal  -- Decimal format
    FROM filtered
),
projected AS (
    SELECT
        state,
        sales_2024,
        ROUND(cagr_decimal * 100, 2) AS cagr_percentage,
        ROUND(sales_2024 * POWER(1 + cagr_decimal, 6))::BIGINT AS projected_2030_sales
    FROM cagr_calc
)
SELECT *
FROM projected
ORDER BY projected_2030_sales DESC
LIMIT 10;
```

	state character varying (100)	sales_2024 bigint	cagr_percentage numeric	projected_2030_sales bigint
1	Karnataka	1581988	25.28	6117423
2	Maharashtra	2293994	17.31	5978060
3	Gujarat	1590987	20.55	4881766
4	Uttar Pradesh	2932347	8.36	4747400
5	Rajasthan	1300476	21.50	4183158
6	Tamil Nadu	1716940	12.98	3571380
7	Madhya Pradesh	1286182	15.32	3024750
8	Bihar	1132703	12.63	2312576
9	Delhi	606348	22.88	2087855
10	Haryana	732029	17.68	1944254



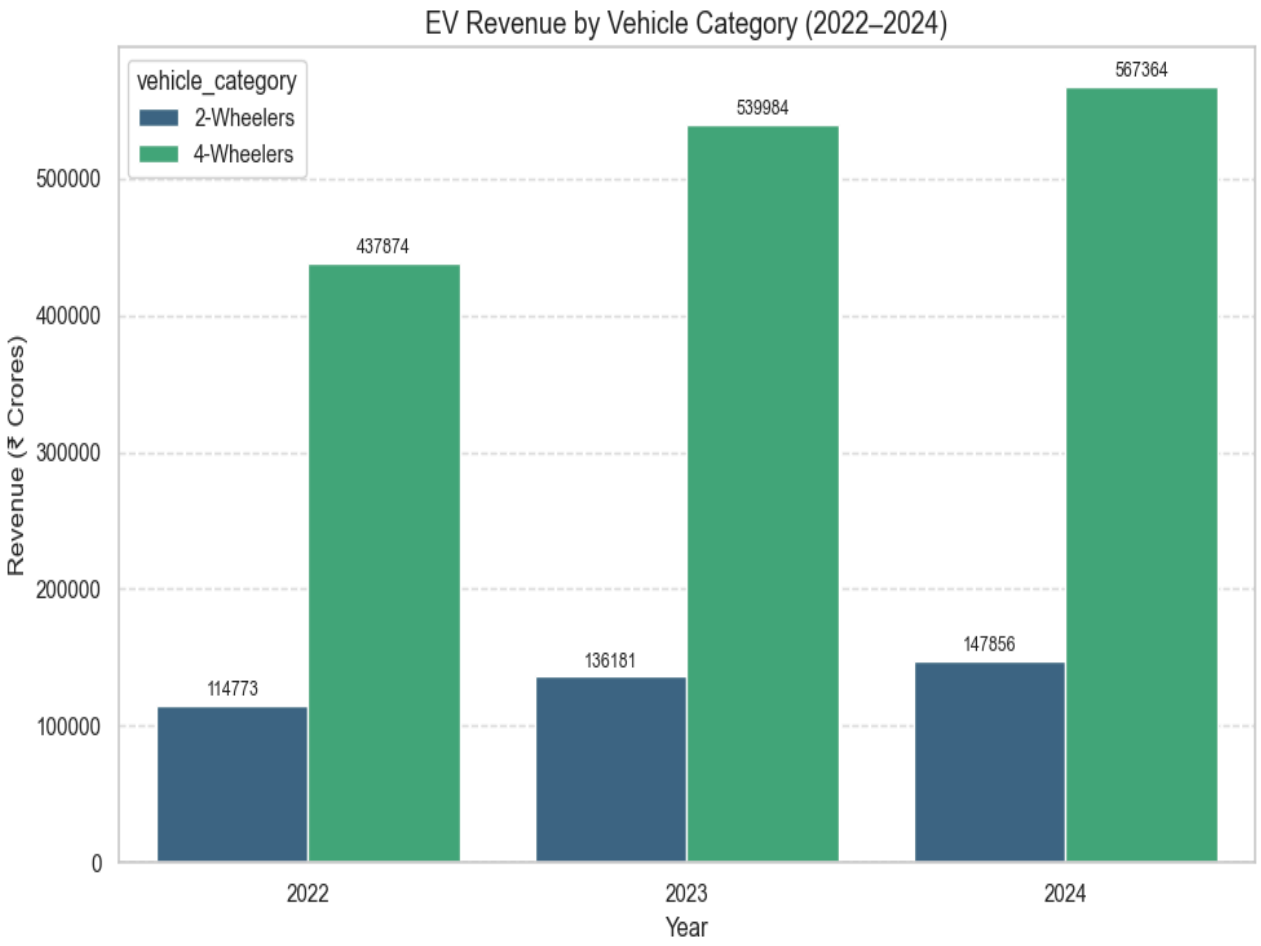
insight

- **Karnataka** leads with **6.1 million** projected EV sales in 2030.
- **Maharashtra** follows closely with **6 million** sales.
- **Gujarat**, **Uttar Pradesh**, and **Rajasthan** show strong EV growth.
- **Delhi** and **Haryana** have lower projections despite being urban centers.
- Western and southern states dominate EV adoption trends.

17) Estimate the revenue growth rate of 4-wheeler and 2-wheelers EVs in India for 2022 vs 2024 and 2023 vs 2024, assuming an average unit price.

Vehicle Category	Average Price (INR)
2-Wheelers	₹85,000
4-Wheelers	₹15,00,000

	vehicle_category character varying (20)	rev_2022 numeric	rev_2023 numeric	rev_2024 numeric	growth_2022_vs_2024 numeric	growth_2023_vs_2024 numeric
1	2-Wheelers	1147726525000	1361809140000	1478559615000	28.83	8.57
2	4-Wheelers	4378738500000	5399842500000	5673645000000	29.57	5.07



Insight

- 4-Wheelers Dominate Revenue Share In all three years (2022 to 2024), 4-wheeler EVs generate significantly more revenue than 2-wheelers.
- This is expected due to the much higher average unit price (₹15,00,000 vs ₹85,000).
- Consistent Revenue Growth 2-Wheelers grew from ₹1.15 lakh Cr in 2022 → ₹1.48 lakh Cr in 2024 (~29% increase).
- 4-Wheelers grew from ₹4.38 lakh Cr in 2022 → ₹5.67 lakh Cr in 2024 (~30% increase).
- This indicates strong, steady growth in both segments, with 4-wheelers showing slightly higher absolute revenue gain.

Recommendations for AtliQ Motors' EV Market Expansion in India

1. Focus on 2-Wheelers and 4-Wheelers:

- These two segments dominate the Indian EV market.
- 2-Wheelers account for the highest sales volume, with strong year-on-year growth.
- 4-Wheelers exhibit rapid CAGR, especially among emerging brands like BYD India and MG Motor.

2. Target High-CAGR States:

- Karnataka, Maharashtra, Gujarat, and Rajasthan have demonstrated high CAGR and total EV sales.
- These states are ideal for initial market entry and dealer network expansion.

3. Align Launch Timing with Peak Sales Months:

- EV sales peak in March, November, and October, indicating strong seasonality.
- Product launches and promotional campaigns should be aligned with these months for maximum traction.

4. Consider Price Sensitivity:

- Low-cost 2-wheelers dominate EV sales despite high volume.

- AtliQ should consider launching an affordable EV lineup to compete effectively.

5. Leverage Future Projections:

- Sales projections for 2030 (based on CAGR) show exponential growth, particularly in urban and Tier-2 cities.

- Early investment in local manufacturing and infrastructure will help capture future market share.

6. Build Strategic Partnerships:

- Collaborate with charging infrastructure providers, fintech companies (for EV financing), and state EV policy units.

- These partnerships can accelerate adoption and improve brand positioning.