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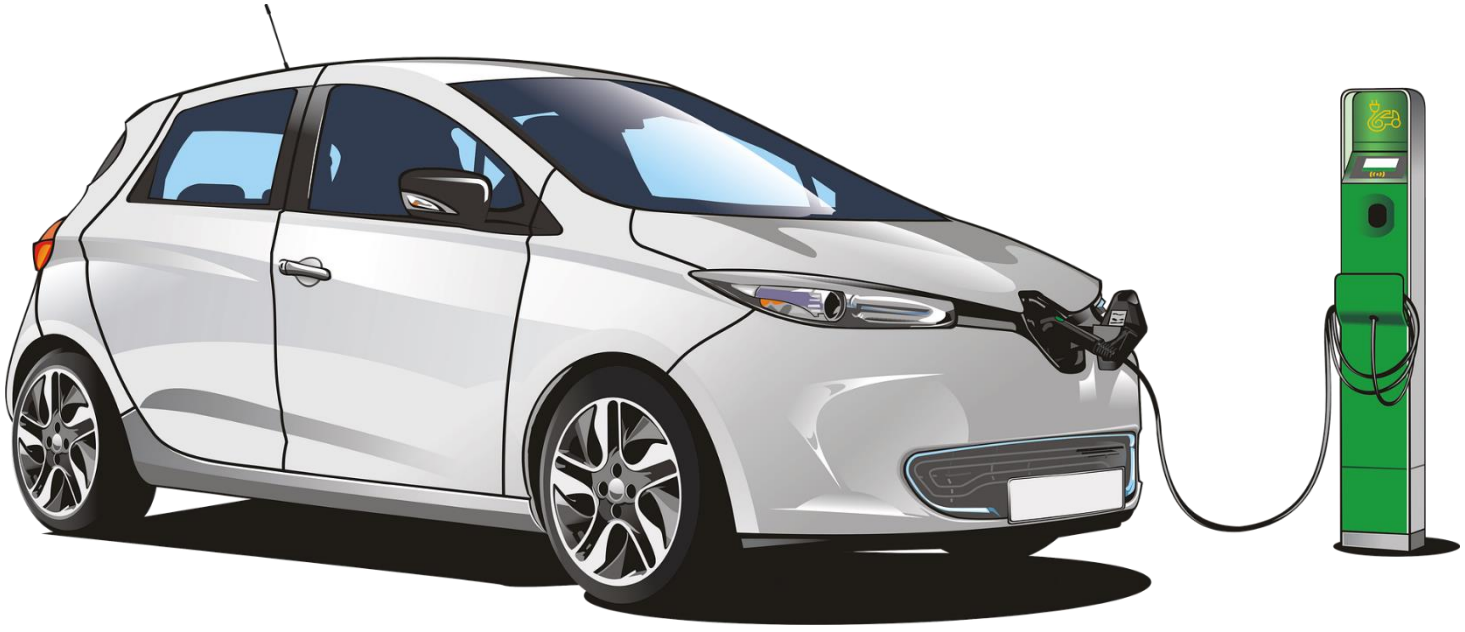


CARBON EMISSIONS SAVINGS IN TAMIL NADU'S ROAD TRANSPORT THROUGH ELECTRIFICATION

I. EXECUTIVE SUMMARY

Dubbed the 'Detroit of India', the state of Tamil Nadu has always been a frontrunner in the automobile space, be it in terms of charting record sales, adapting to new technologies, welcoming industries to its land or attracting the right investments. Being among the top 10 automotive manufacturing hubs in the world, the state produces 50% of all cars that are exported from India. Maintaining this position requires the state to adapt to global market trends. Recognizing that an e-mobility revolution would make the traditional auto manufacturing industry redundant, Tamil Nadu was among the first few states in India to announce an Electric Vehicle policy in 2019, with a futuristic vision of attracting investments and boosting EV manufacturing. The supply side incentives offered in the policy successfully drew the interest of manufacturers, stakeholders and investors. As of 2022, 35% of all investments that have happened in the e-mobility space in India, have been in Tamil Nadu. Over the next five years as well, while the EV segment in India is likely to see investments worth Rs.94,000 crore[i]. Tamil Nadu is once again ahead of the curve, reportedly accounting for 34% share[ii] in the total planned investments.

The state already boasts of having automobile retail sales beyond the national average in several categories. In EVs particularly, the state has seen a large number of registration in the financial year 2021-2022, standing third[iii] in the country, according to data sourced from Vahan. In rural Tamil Nadu especially, there has been a large appetite for electric vehicles, with 78%[iv] of the two-wheeler sales reported from towns and cities with less than 10 lakh population. Overall, two wheelers comprise 90% of EV sales[v] in Tamil Nadu, the highest in the nation. Given the appetite to switch to cleaner means of transportation as opposed to diesel or petrol vehicles, the ground is fertile for the state government to further promote EV adoption among consumers.

Currently the state does not have a fixed target on the percentage of Electric Vehicles they would want to see deployed on its streets. However, a significant conversion of its vehicles from ICE to electric will have various benefits, key among them would be the reduction in carbon emissions.

This study estimates how much carbon emissions could be avoided based on 2 target scenarios.

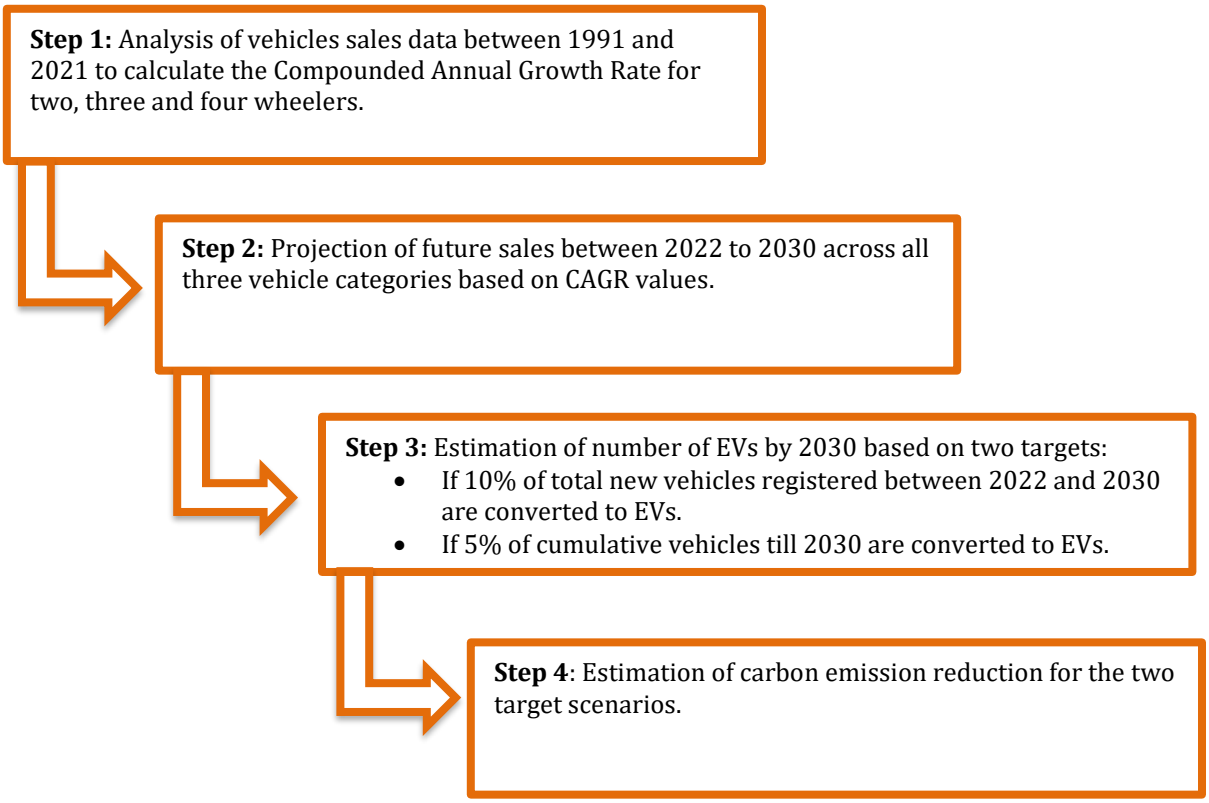
- **Scenario 1:** If 5% of all sales till 2030 are converted to electric, Tamil Nadu can save 36.53 million tonnes of carbon emissions

- **Scenario 2:** If 10% of newly registered vehicles between 2022 -2030 are converted to electric, Tamil Nadu can save 38.76 million tonnes of carbon emissions.

This report outlines the methodology and calculations undertaken to arrive at this estimate.

II. METHODOLOGY

We undertook the below mentioned steps to calculate the reduction in future carbon emissions by 2030 based on two targets for electrification of two, three and four wheelers.



III. CALCULATIONS AND RESULTS

Step 1: Analysis of vehicle sales data between 1991 to 2021 to calculate the CAGR for two, three and four wheelers

We collated sales data via the Tamil Nadu transport department[vi] archives and Vahan[vii] to calculate the Compounded Annual Growth Rate (CAGR) in total vehicle sales between the years 1991 and 2021 across three segments - Two-wheelers, Three-wheelers and Four-wheelers. As can be seen in Table 1, the CAGR for two-wheelers was found to be 10.014 percent, for three-wheelers it was 6.009 percent and for four-wheelers it was 9.905 percent.

Table 1. Compound Annual Growth Rate (CAGR) Calculations

Year	Vehicle category: 2W	% Growth (Y-OY)	Vehicle category: 3W	% Growth (Y-O-Y)	Vehicle category: 4W	% Growth (Y-O-Y)
1999	3,214,068	-	38,713	-	428,585	-
2000	3,679,525	-	110,247	-	479,315	11.84
2001	4,163,002	13.14	120,219	9.05	512,421	6.91
2002	4,600,565	10.51	127,344	5.93	552,668	7.85
2003	5,073,643	10.28	140,184	10.08	598,850	8.36
2004	5,547,755	9.34	147,356	5.12	638,470	*
2005	6,106,057	10.06	160,207	8.72	690,536	8.15
2006	6,750,328	10.55	148,587	*	761,826	10.32
2007	7,503,426	11.16	153,774	3.49	842,606	10.60
2008	8,260,019	10.08	165,210	7.44	948,311	12.55
2009	9,036,783	9.40	172,170	4.21	1,056,858	11.45
2010	9,969,598	10.32	181,610	5.48	1,206,647	14.17
2011	11,207,338	12.42	223,394	*	1,376,533	14.08
2012	12,659,928	12.96	230,641	*	1,530,923	11.22
2013	14,150,373	11.77	240,039	4.07	1,700,116	11.05
2014	15,595,140	10.21	245,479	*	1,878,577	10.50

2015	16,991,527	8.95	232,112	*	2,039,507	8.57
2016	18,400,635	8.29	259,756	11.91	2,207,102	8.22
2017	19,987,302	8.62	272,848	5.04	2,393,751	8.46
2018	21,586,210	8.00	282,587	3.57	2,591,825	8.27
2019	23,346,216	8.15	302,859	7.17	2,794,953	7.84
2020	24,918,384	*	319,097	5.36	2,981,036	*
2021	26,126,329	*	631,356	*	3,405,758	*
Average growth CAGR		10.22		6.44		10.02

*Blank cells represent elimination of the higher & lower (negative) deviation values in sales for data consistency

CAGR projections have been made based on smoothened 20-yr sales data, rather than the last 10 years. A comparison between the two datasets shows deviations in magnitude and directions of trends, indicative of strong short-term downward pressures over the last decade. Downward trends in vehicle sales, in part, reflect the impacts of reforms in automotive emission norms through the implementation of BS4 and BS6 norms. Sales figures in 2020 and 2021 were also suppressed due to the effect of the Covid-19 pandemic and the lockdowns enforced in those years. These short-term impacts have resulted in strong downward biases in the 10-year trends, particularly in 2W and 4W sales figures. Additionally, as the vehicle scrappage policy comes into effect, replacement of retired vehicles is likely to be a significant factor influencing sales trends in years to come. The choice of longer-term data was made keeping the need for consistency, granularity and the duration of projection in mind. Longer term data provides a clearer trend and helps temper the effect of short-term shocks on sales, enabling a more comprehensive projection of sales trends until 2030.

Step 2: Projection of future sales between 2022 to 2030 across all three vehicle categories based on CAGR values.

Based on the CAGR values calculated from past vehicle sales, we projected future sales between 2022 to 2030 across all three vehicle categories. We used rounded off growth rates of 10.22%, 6.44% and 10% for two-wheelers, three-wheelers and four wheelers respectively.

As can be seen in Table 2, the projection for registered vehicles across categories between 2022 to 2030 is:

- Two wheelers: 33,925,871
- Three wheelers: 435,164
- Four wheelers: 4,296,734
- Total projected sales: 38,657,770

Step 3: Estimation of number of EVs by 2030 based on two targets:

We have considered two target scenarios:

1. **10% of total new vehicles registered between 2022 to 2030 are electric.**

As can be seen in table 2, this amounts to 3,865,777 electric vehicles on road across two, three and four wheelers.

2. **5% of all vehicles until 2030 are electric.**

As can be seen in table 2, this amounts to 3,593,662 electric vehicles on road across two, three and four wheelers.

Notes:

- In the sales projection for vehicles by 2030, we have not taken into account the impact of the scrappage policy that may be launched by the Tamil Nadu government. Scrappage incentives may lead to increase in sales of electric vehicles.

- These sales projections represent sales of commercial three and four wheelers as well. However, the state reserves the right to approve number of permits, and that decision from the state may also impact overall ICE and electric vehicle sales.

- The sales of electric vehicles are also impacted by changes in battery costs, availability of financial support from states and banks, as well as improvement in overall charging infrastructure and e-mobility ecosystem. Those variables have not been considered while making these projections.

Table 2. Estimation of vehicle sales between 2022 to 2030 & numbers of EV on road on the basis of assumption

Sales projections as per the average CAGR for each vehicle segment	**At a CAGR**	**10.22%**	**6.44%**	**10%**	**Total**
	Segments	**2W**	**3W**	**4W**	**From 1991 till 2021 we have 30,163,443**
	2022	28,796,439.82	672,015.33	3,747,014.95	33,215,470.1
	2023	31,739,435.97	715,293.11	4,122,465.85	36,577,194.94
	2024	34,983,206.33	761,357.99	4,535,536.93	40,280,101.25
	2025	38,558,490.02	810,389.44	4,989,997.73	44,358,877.19
	2026	42,499,167.70	862,578.52	5,489,995.50	48,851,741.72
	2027	46,842,582.64	918,128.58	6,040,093.05	53,800,804.27
	2028	51,629,894.58	977,256.06	6,645,310.37	59,252,461.02
	2029	56,906,469.81	1,040,191.35	7,311,170.47	65,257,831.63
	2030	**62,722,311.02**	**1,107,179.68**	**8,043,749.75**	**71,873,240.25**
Total Vehicles registered between 2022 to 2030		33,925,871.20	435,164.35	4,296,734.80	38,657,770.35
A benchmark target of avg 10 % new vehicle registered to be electric		3,392,587.12	43,516.43	429,673.48	3,865,777.03
Target to have 5% of total vehicles (cumulative-Till date of 2030) to be electric		3,136,115.55	55,358.98	402,187.49	3,593,662.02

Step 4: Estimation of carbon emission reduction based on two EV target scenarios

Our calculations show that if 10% of new registered vehicles between 2022 to 2030 are converted to electric, Tamil Nadu can save 38.76 million tonnes of carbon emissions.

Similarly, if 5% of cumulative sales by 2030 are converted to electric, Tamil Nadu can save 36.53 million tonnes of carbon emissions. This is shown in Table 3 and 4 respectively.

Table 3: Carbon emissions reduction for 10% of new registered vehicles to be electric

Vehicle segment	**Average Number of kms covered by the vehicle in India in its life time**	**CO_2 Emission factor in gm/km**	**Number of vehicles targeted to be electric 10% of new vehicles (2030-2022)**	**CO_2 estimated**
2w	80,000	39.04	3,392,587.12	10,595,728,092,472.20
3w	2,25,000	113.5	43,516.43	1,111,300,957,497.08
4w	3,50,000	179.94	429,673.48	27,060,406,111,192.40
Total CO_2 estimated in gm				38,767,435,161,161.60
Total CO_2 estimated in million tonnes				**38.76**

Notes:

- The average number of kilometres covered by any vehicle segment represents the distance that can be covered at optimum engine capacity, i.e. before the engine's efficiency reduces to the point that it starts polluting.
- The value of grams of carbon released per kilometre is in line with the values used by NITI Aayog's e-amrit portal.

Table 4: Carbon emission reduction if 5% of total vehicles till 2030 are electric

Vehicle segment	Average Number of kms covered by a vehicle in India in its life time	**CO_2 Emission factor in gm/km**	**Number of vehicles targeted to be electric 5% of total 2030**	CO_2 estimated
2w	80000	39.04	3,136,115.55	9,794,716,089,120.70
3w	225000	113.5	55,358.98	1,413,730,048,645.54
4w	350000	179.94	402,187.49	25,329,365,787,437.00
Total CO_2 estimated in gm				36,537,811,925,203.30
Total CO_2 estimated in million tonnes				**36.53**

Notes:

- The average number of kilometres covered by any vehicle segment represents the distance that can be covered at optimum engine capacity, i.e. before the engine's efficiency reduces to the point that it starts polluting.
- The value of grams of carbon released per kilometre is in line with the values used by NITI Aayog's e-amrit portal.

The below table shows that if no vehicles are converted to electric, the total new ICE vehicles on road would emit close to 387 million tonnes of carbon.

Table 5: Carbon emissions from total new ICE vehicles by 2030

Vehicle segment	**Average Number of kms covered by a vehicle in India in its life time**	**CO_2 Emission factor in gm/km**	**Total Number of vehicles**	**CO_2 estimated**
2w	80000	39.04	33,925,871.20	105,957,280,924,722.00
3w	225000	113.5	435,164.35	11,113,009,574,970.80
4w	350000	179.94	4,296,734.80	270,604,061,111,924.00
Total CO_2 estimated in gm				387,674,351,611,616.00
Total CO_2 estimated in million tonnes				**387.67**

Table 6: Comparison of carbon emissions savings

Total emissions for new ICE vehicles (million tonnes)	**If 10% new vehicles registered between 2022-2030 are electric, the carbon emissions are (million tonnes)**	**Percentage saved wrt to total emission**	**If 5% of all vehicles registered till-2030 are electric, the carbon emissions are (million tonnes)**	**Percentage saved wrt to total emission**
387.67	38.76	10.0	36.65	9.45

IV. Conclusion

The state of Tamil Nadu has already, at several platforms, indicated that it is dedicatedly working towards addressing the harmful effects of environmental pollution and the resultant damage caused to our climate. Accelerating the adoption of electric vehicles is an important step in this direction which will lead to both financial and social benefits. The burning of fossil fuels by traditional combustion engines contributes to the emission of carbon dioxide which in turn leads to global warming. In our study, we have found that even a 5-10% conversion to EV use, could prevent a significant amount of carbon emission.

In addition to lower maintenance and running costs, fully electric vehicles have zero tailpipe emissions. According to NITI Aayog, even with electricity production taken into account, petrol or diesel vehicles emit almost three times more carbon dioxide than the average electric vehicle. From an energy efficiency perspective, which the Tamil Nadu Climate Action plan focuses upon as well, electric vehicles can convert around 60% of the electrical energy from the grid to power its wheels. A petrol or diesel vehicle however converts only 17-21% of the fuel stored to energy required to power movement. Given India's ambition to achieve 40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by the year 2030, the time has come to accelerate the adoption of electric vehicles. Tamil Nadu, which has been vocal in its concern for the environment and results of climate change, once again has the opportunity today to lead this revolution and show the country a roadmap toward switching to e-mobility.

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Details of all calculations