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Assessing the Environmental Benefits from Switching Auto-rickshaws in Chennai to Electric

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Auto-rickshaws are three wheelers used for passenger transport, often classified as Intermediate Public Transport (IPT). Auto-rickshaws have their popularity because they provide affordable and convenient mobility in the absence of public transport or as a complement to public transport for last mile connectivity. They provide both shared and individual services. The shared auto-rickshaws ply on a fixed route and the individual auto-rickshaw in a designated area. This sector also directly employs thousands as drivers. Their small size and manoeuverability makes them ideal modes for congested urban spaces in India.

At present, of the 5.4 million vehicles on road in Chennai, more than 95.6% are non-transport vehicles, including cars, two wheelers and other personal modes. Rest 0.24 million are transport vehicles for passengers and goods (Tamil Nadu State Transport Authority, 2018). Auto-rickshaw is categorized under the transport category of the Regional transport office. In Chennai, Auto-rickshaws constitute 40% of all transport vehicles and 58% of passenger transport vehicles (refer to Figure 2). The share of auto-rickshaws has increased from practically zero in 1970 to over 6% in 2008 (refer to Figure 1). At present this share can be estimated to be considerably higher as the number of auto-rickshaws in Chennai has tripled since 2008.

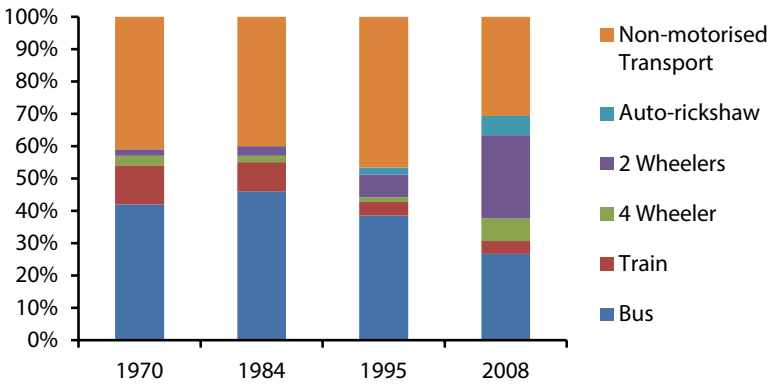


Figure 1: Trip Distribution by Travel Mode

Source: Chennai Comprehensive Transport Study (2009)

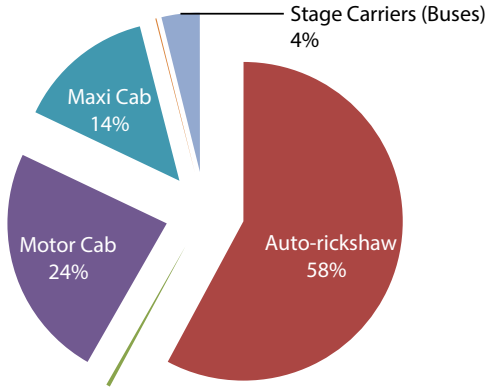


Figure 2: Commercial Passenger Transport Vehicles in Chennai

Source: Tamil Nadu Transport Department (Tamil Nadu State Transport Authority, 2018)

The auto-rickshaws in Chennai mainly run on Liquefied Petroleum Gas (LPG) and Petrol as their primary fuels. The LPG auto-rickshaws came in after 2009 when the State Transport Authority directed all petrol and diesel auto-rickshaws to install LPG kits. The city transport department has not given new permits to any petrol or diesel auto-rickshaws since then. As of 2018, Chennai had a total of 82, 889 auto-rickshaws and an estimated 57, 729 of them were fitted with LPG kits. This research brief paper will assess the potential environmental benefits from electrification of the three-wheeler fleet.

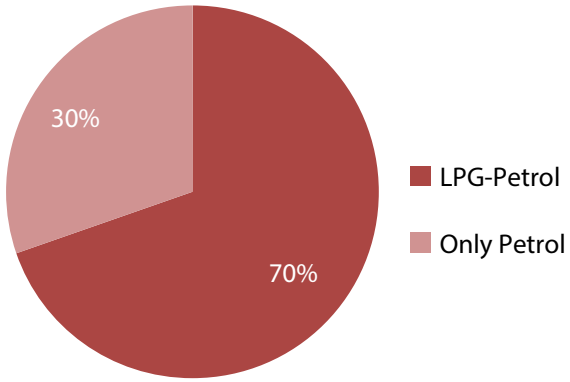


Figure 3: Vehicular Position of Auto rickshaws in Chennai as on 01 April 2018

Source: Tamil Nadu Transport Department (Tamil Nadu State Transport Authority, 2018)

Methodology

This paper will estimate savings in terms of greenhouse gas (GHG) emissions and in terms of pollutants like Carbon Monoxide (CO), Hydrocarbon (HC), Nitrous Oxides (NOx) and Particulate Matters (PM). The emissions in the transport sector is dependent on the level of travel activity (A), the modal structure (S), the fuel intensity of the mode (I), and the fuel's carbon content which emission factor (F), in grams per litre of fuel consumed. The relationship between these parameters is represented mathematically by "ASIF" equation (Lee Schipper, 2009).

Emissions= Activity (A)×Modal Share (S)×Energy Intensity (I)×Emission Factor (F)

Estimated Current Emissions from Auto-rickshaw in Chennai

This section briefly summarizes the estimated 2017–18 vehicular emissions in terms of PM, HC, NOx and CO; and 2017–18 GHG emissions in terms of CO_2 equivalent units for auto-rickshaws in Chennai.

	Carbon Monoxide	Hydrocarbons	Nitrous Oxides	Particulate Matter
Total per day emissions in Metric Tons (MT)	14.66	7.42	1.47	0.74

	Fuel Consumed (in thousand Litres)	GHG Emissions (in MT)
LPG	339.52	556.81
Petrol	131.53	302.52

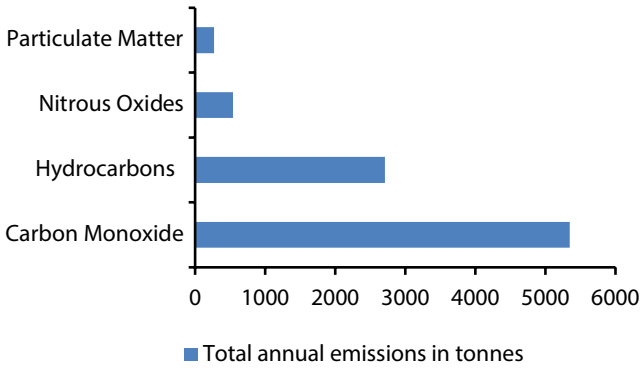


Figure 4: Estimated Annual Emissions from Auto-rickshaws in Chennai (2017-18)

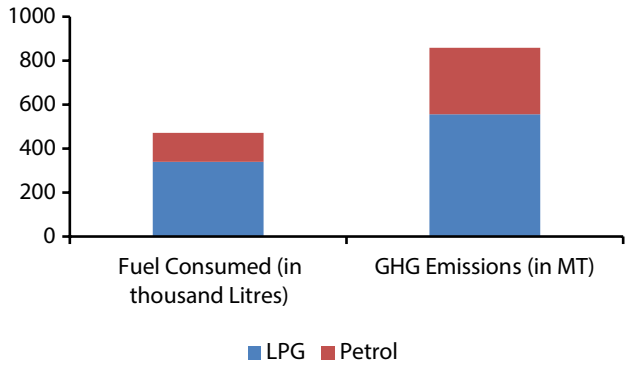


Figure 5: Estimated Fuel Consumed and its GHG impact (2017-18)

Estimated Environmental Benefits

Due to large transportation demand for last mile connectivity, Chennai's auto-rickshaw population has exponentially grown in numbers (refer to Figure 6). The compound annual growth rate since 2008-09 to 2017-18, is 14.8%. Additionally, the Tamil Nadu EV policy states that an Open Permit System will apply to the e-auto permits to be issued. Further, the policy has also waived off permit fees and road tax for e-autos till 2022.

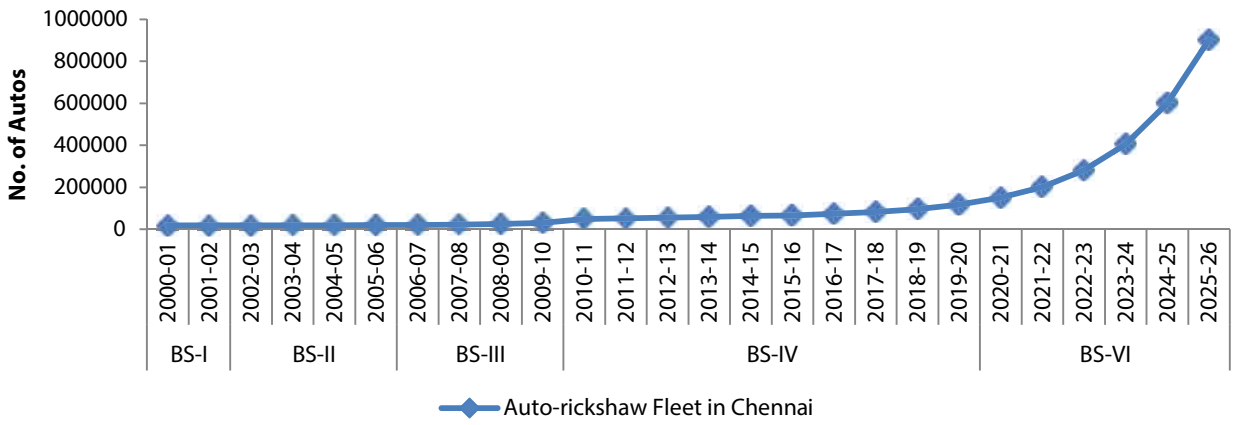
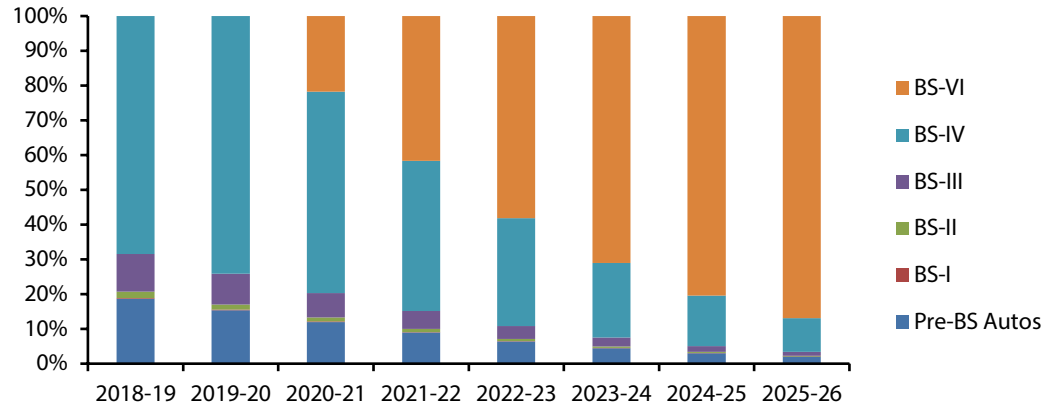
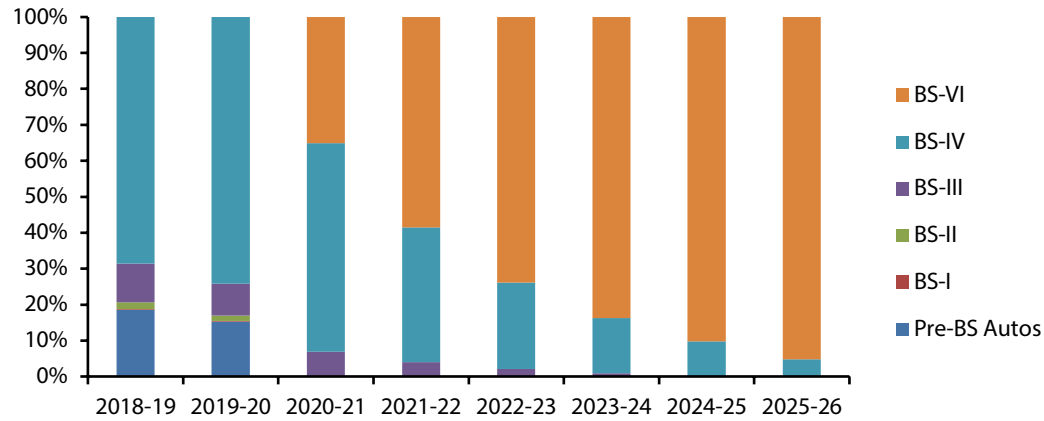
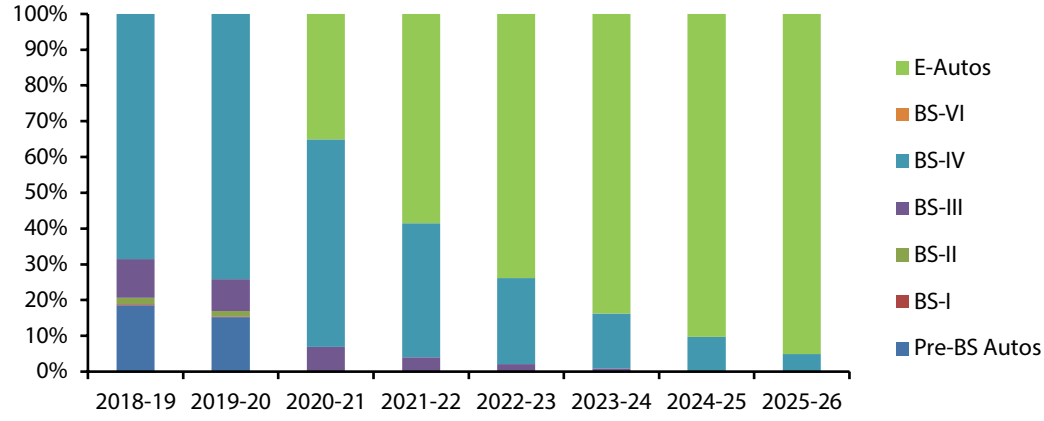


Figure 6: Estimated Growth of Passenger Three wheeler Fleet in Chennai

For estimating the paper is assuming that the proportional and absolute growth of auto-rickshaw fleet in Chennai will remain the same in all three scenarios. The three scenarios discussed are:

- Business as Usual: No e-autos are purchased. New registration of autos grows at CAGR of 14.8%.
- Scenario A: Mandated scrapping with Incentive. Phase out auto-rickshaws older than 15 years from 2020-21 and incentivize purchase of new LPG BS VI auto-rickshaws.
- Scenario B: Mandated scrapping, no new ICE auto-rickshaw and EV subsidy. Phase out auto-rickshaws older than 15 years from 2020-21, ban registration of new ICE auto-rickshaw and subsidize purchase of new e-autos.

Scenario	Transition
BaU	 **Figure 7:** B-a-U Expected Change in Chennai Auto-rickshaw Fleet (2018-19 to 2025-26)
Scenario A	 **Figure 8:** Scenario A: Expected Change in Chennai Auto-rickshaw Fleet (2018-19 to 2025-26)
Scenario B	 **Figure 9:** Scenario A: Expected Change in Chennai Auto-rickshaw Fleet (2018-19 to 2025-26)

The results of the above mentioned scenario are given below:

Year			2020–21	2021–22	2022–23	2023–24	2024–25	2025–26
Local Impact on Air Pollution (Annual)	CO emissions	BAU	6250.1	6467.9	6861.3	7523.4	8595.8	10298.5
		Scenario A (% reduced)	53%	55%	55%	52%	47%	41%
		Scenario B (% reduced)	61%	63%	66%	70%	75%	92%
	HC & NOx emissions	BAU	4048	4332	4751	5383	6351	7848
		Scenario A (% reduced)	51%	55%	56%	55%	52%	50%
		Scenario B (% reduced)	57%	61%	65%	70%	76%	93%
	PM emissions	BAU	463	606	824	1160	1682	2495
		Scenario A (% reduced)	55%	57%	58%	59%	59%	59%
		Scenario B (% reduced)	55%	66%	75%	83%	89%	97%
GHG Emissions	GHG emissions	BAU	5,50,622	7,30,559	10,11,218	14,48,987	21,31,806	31,96,853
		Scenario B (% reduced)	5%	5%	5%	4%	4%	3%

Conclusion

As per the results, to reduce vehicular emissions emitted from the auto-rickshaw sector the policy interventions need to be strengthened. The bouquet of policy interventions suggested by TERI based on the results are incentivizing scrapping of auto-rickshaws older than 15 years, mandating scrapping and incentivizing purchase of new LPG BS VI auto-rickshaws. The scenarios show that scrapping of older auto-rickshaws will have a significant impact on reducing emissions in the short term. However, the emissions will continue to rise as the auto-rickshaw fleet expands in the long term. Hence, promoting electric auto-rickshaws is essential for minimizing exhaust emissions from auto-rickshaws in the long term. However, the scenarios also show that with the current electricity generation mix in Tamil Nadu, e-autos will have limited impact on mitigating GHG emission.

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