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Connecting Aspirations

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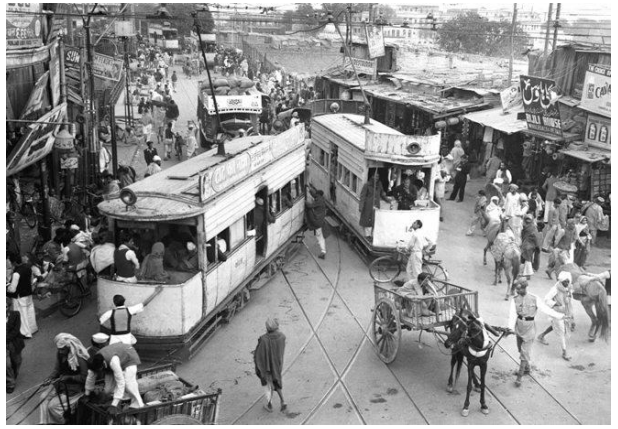
TATA Motors Electric Bus

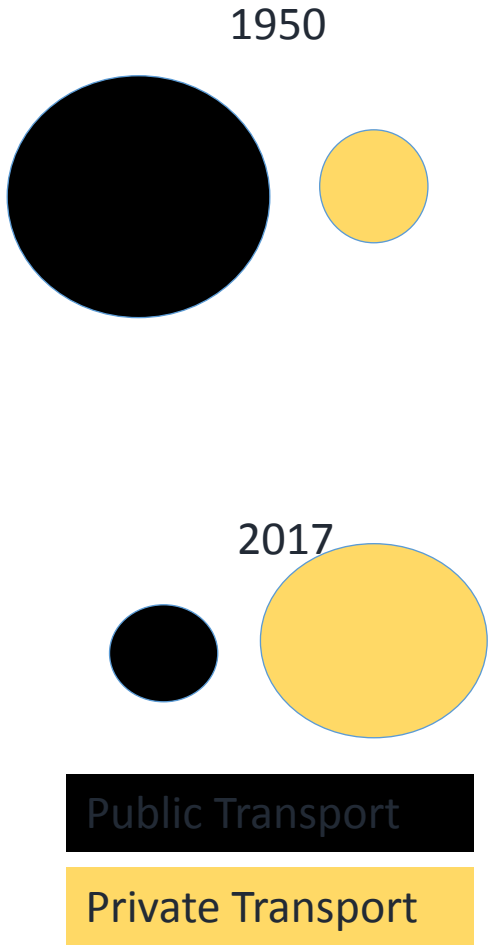
Date: 23rd Sept 2019

City Public Transport - Challenges and way forward

Challenges in Metro and similar cities

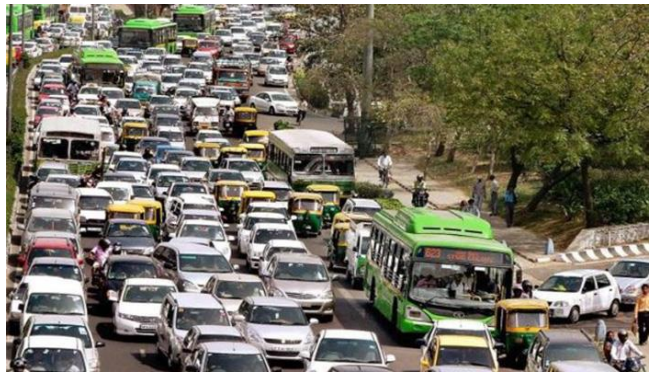
- Shortage of buses – gap of 4000 buses
- Pollution > 300 PM
- Congestion – Avg speed 10 kmph





Way Forward

- Zero Emission buses
- Connected -to improve efficiency and enable modal shift
- Economical – to enable movement of masses



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Tata Motors: Technology Perfected over a Decade

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Platform development Hybrids Electric

Electric Traction System Tested on Bench

Diesel Hybrid Electric Prototype

4 CNG Hybrid Showcased in Common Wealth Games

CNG Series Hybrid Electric Showcased in Kortrijk 2011

10 CNG Series Hybrid buses Delivered to EMT

Front Engine Parallel Hybrid Showcased in Auto Expo

Series Hybrid Bus for Indian Market showcased in Auto Expo -2016

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

1.4 Million Km Of Hybrid Electric Bus

More than 100,000 Km Running

★ Awarded Tender for supply of 10 CNG series Hybrid Electric Bus to EMT Madrid

★ Awarded Tender for supply of 25 Diesel series Hybrid Electric Bus to MMRDA.

Diesel Series Hybrid Electric showcased in FIAA 2010

ACE Electric Showcased in Auto Expo 2010

IRIS EV & Magic EV showcased in Auto Expo 2014

Ultra Electric 9m Showcased in Auto Expo 2016

In 2018, We have developed widest range of electric buses (5 different models)

Advance Preparation by Tata Motors

- **Head start in testing & validation for 9m/12m**
- **8 Prototypes successfully demonstrated**

Electric Bus – Summary of Trials in India

Trial City	Shimla	Chandigarh	Guwahati	Nagpur	Manali
Vehicle	9m Bus	9m Bus	9m Bus	12m Bus	9m Bus
Ambient Temperature (deg C)	Max / Min -34 /19	Max / Min – 41/26	Max / Min – 35/24	Max / Min – 50.8/30	Max/ Min -34/27
Month of Testing	March	June	November	May	August
Testing Duration	5 day	10 days	7 days	5 days	3 days
Total Distance Travelled	840 kms	1715	440	540 kms	312
Consumption (kWhr/km)	0.53	0.55	0.6	0.75	0.55
					

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We have orders of 250+ electric buses from various cities across India and the number is growing

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City	No. of buses required		Bus length	Floor height	Bus Type
	AC	Non-AC			
Indore	40	-	9m	900 mm	9 x 9 AC
Kolkata	80	-	40 -9m; 40 -12m	900 mm	9 x 9 &12 AC
Lucknow	40	-	9m	900 mm	9 x 9 AC
Guwahati	-	15	9m	900 mm	9 x 9 Non-AC
Jammu/Srinagar	-	40	9m	900 mm	9 x 9 Non-AC
Jaipur	40	-	9m	650 mm	6 x 9 AC

Features of our Electric buses with proven advanced technology

- These are built on existing proven platforms of **Starbus Ultra**
- TATA Motors has designed the buses in house with critical EV aggregates sourced from internationally known best in class **suppliers, from USA, Germany and China.**
- The entire vehicle architecture and Software strategy designed, tested and validated in house.
- Best Energy consumption performance due to direct drive and system optimization **– 20% better energy consumption as compared to competition buses.** This allows to use most optimum size of battery to use the desired range.
- **Li-ion batteries with NMC are best suited for Electric Vehicles as they have good specific energy and power density**.
- Li-ion batteries with NMC are best suited for **fast charging** (**120Kwh pack can be fully charged in 2 hrs.)**
- **Batteries on roof top to prevent breakdowns due to water logging**.
- Batteries are liquid cooled to keep temperature within an optimum range to ensure longer life and better performance in tropical conditions as in India.
- Most of the models have been Type Approved and registered under FAME scheme.
- Annual Maintenance Contract, extended warranty, finance etc. is available if required.
- **Extensive trials have been done** in Himachal, Chandigarh, Assam and Maharashtra to establish performance in different geographies of the country.

E-Buses can run on all routes and get charged during shift break at mid-day

Full charge ~ 2hours

60 km top-up ~ 1hr

1 Start of day

(All buses start at respective depots with full charges)

2 Daily Operation

(Vehicle operated on designated route till shift-end)

3 Shift changeover

(Vehicles come back to depot for shift change, top-up charging to be carried out)

4 End of Day

(All batteries recharged at respective depot)

Routes will be optimized to enable 5 minute service levels and e-Bus utilization

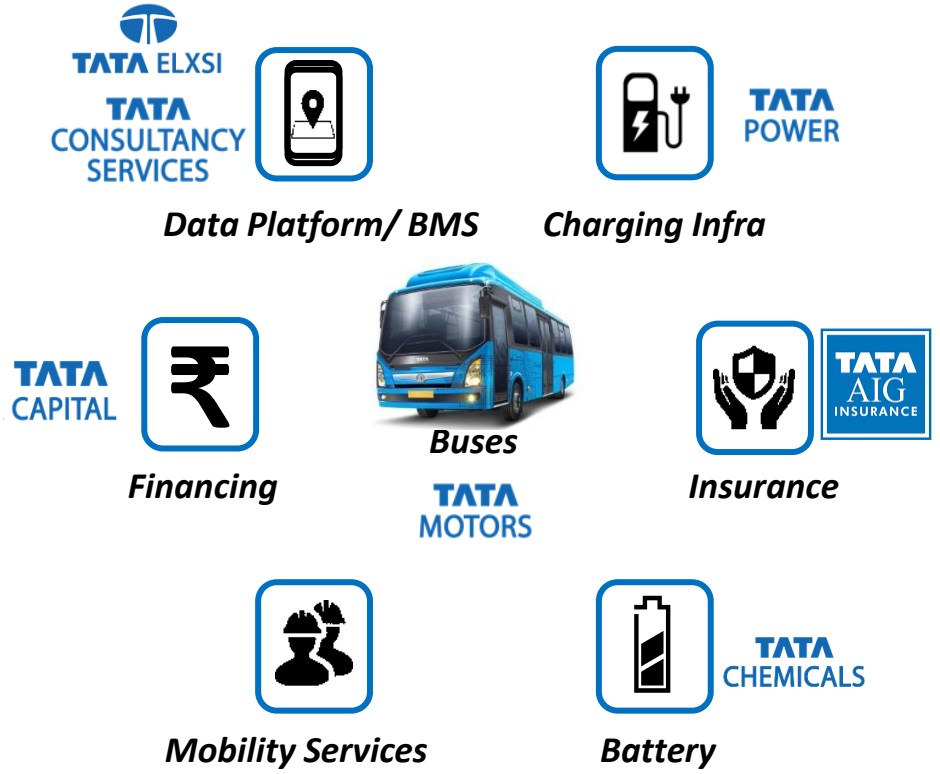
1. Average number; different for every route

Tata Group is taking the lead in electrifying transportation in India

Tata Group has laid out a strong vision to shape EV adoption in India

- Achieve **1 million Tata EVs** on the road by FY25
- **Proactively build the EV market** in India & drive **breakthrough adoption**
- Provide unique value proposition of our EV offerings through a **Tata e-Mobility ecosystem**

Tata Group companies are working together to create an EV ecosystem

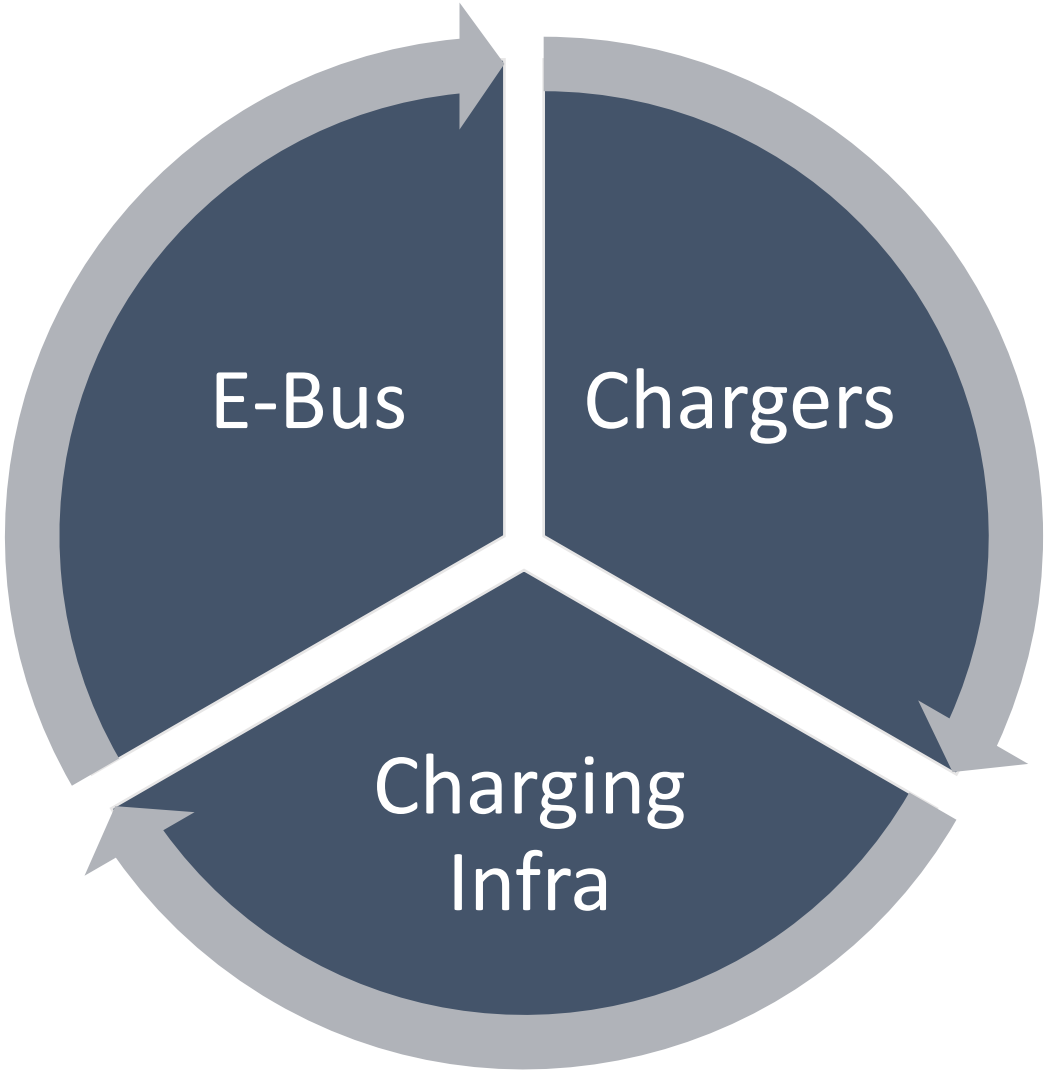


Key Achievements in Electric Buses

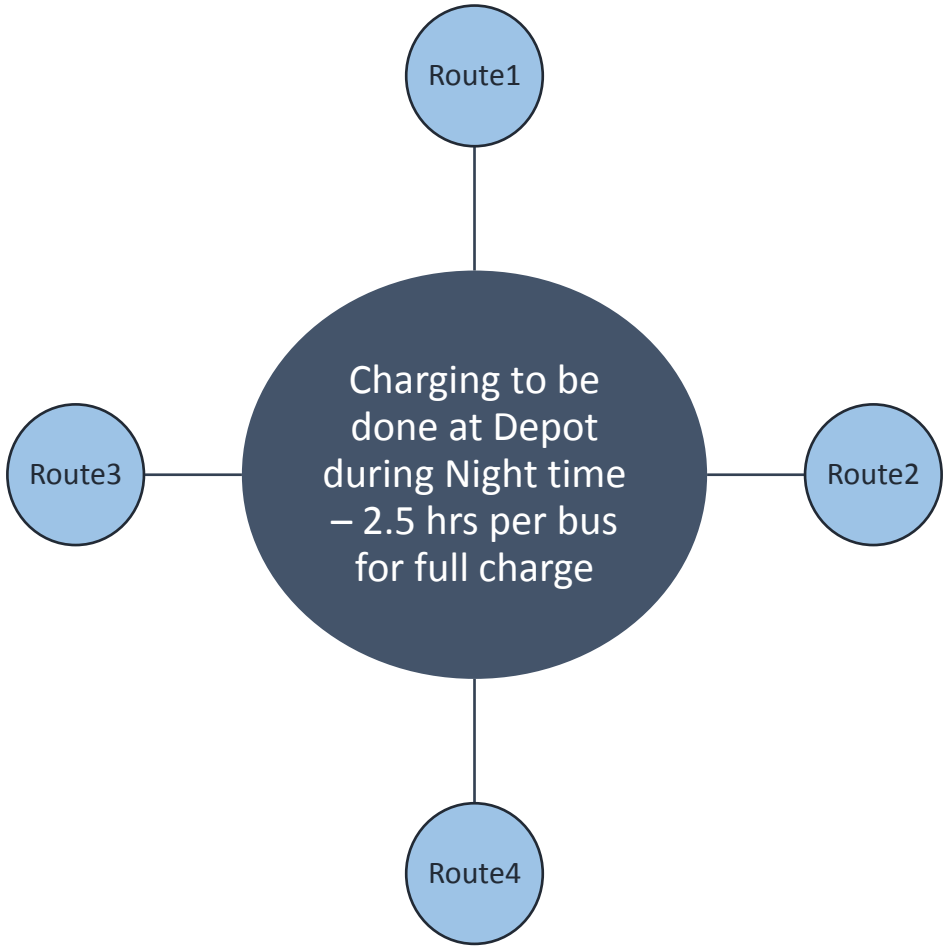
- Supplying majority of electric buses in India – won 250+ buses via tenders
- Supplied Electric Buses to 5 cities across India
- We received **"ICV People Mover of the year"** and **"CV of the year"** award for Ultra 9m Electric Bus at Apollo CV Awards
- Tata Motors received "Best solution Provider for Electric Vehicles" at Smart, Livable and Resilient City Conclave, Pune

Electric Bus Ecosystem

Requirement



Considering Depot/Dedicated Space as Charging hub



Installation of charging systems at the depot would be part of the service

DC Charger specifications

Power: 120 kW

Concurrent charging: 2 vehicles

Charger solution offered

Installation offered with AMC, including warranty period

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TML can provide chargers and buses along with setting-up charging infrastructure for 11 KV input

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Infra requirement

# Fast Chargers proposed (120 KW)	**TML's Scope- TML will provide Chargers after studying the routes – approx. 1 charger for 2 buses**
Civil / Electrical Infra set-up required from Tata? **Note: 11KV line supply will be in scope of client**	Depot is expected to have 11 KV Line which is required for charging of buses
Substation for 33 KVA to 11 KVA	**Assumed to be available**
HT Cables	**Can be Part of TML/User scope (optional)**
RMU – Ring Main Unit	
Metering (CT, PT)	
Sub-Transformer (11 KV / 415 V)	
LT Cabling	**Can be part of Part of TML scope (optional)**
Feeder Pillars	
Civil structure (Transformer platform)	**Assumed to be available**
Statutory approvals	**Assumed to be available**
Parking	**Assumed to be available**

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TML has the widest range of pure Electric buses

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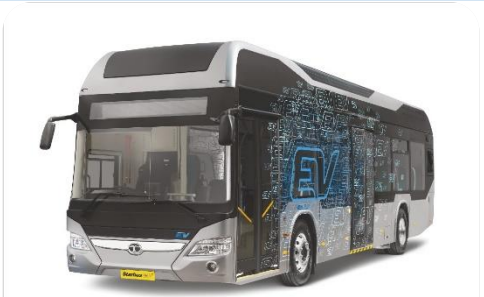
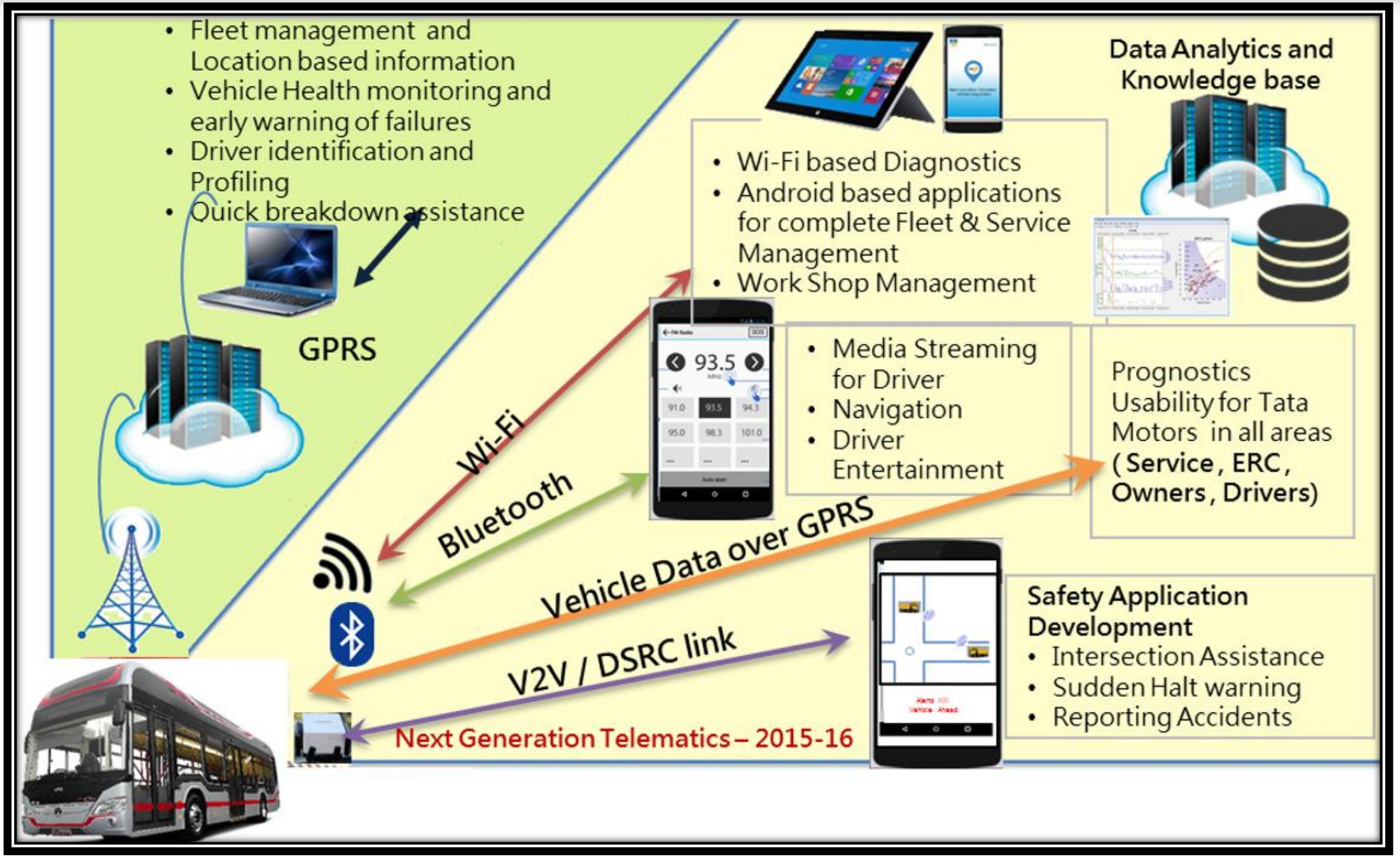
Floor Height	7metre	9 to 9.5metre	12 metre
900mm			
650mm			
400mm			

Length

SMART FEATURES: Connected Vehicle



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Summary Certain parameters

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Parameters / Models	4/12m Low Floor Full Electric	9/12m Full Electric	Ultra Electric 6/9m	Ultra Electric 9/9m	7m Electric Bus (Planned)
Length	12 m	12 m	9 m	9m	Upto 7 m
Floor Height	400 mm	900 mm	650 mm	900mm	900mm
Lead on Single Charge *(Depends on drive and traffic conditions)	*100 - 150 km (Extendable)	*100 - 150 km	*150 - 170 km	*150 - 170 km	*100 - 150 km
Charging Time	Normal: 4-6 Hr Fast Charging: 2 Hr	Normal: 4-6 Hr Fast Charging: 2 Hr	Normal: 4-6 Hr Fast Charging: 2 Hr	Normal: 4-6 Hr Fast Charging: 2 Hr	Normal: 4-6 Hr Fast Charging: 2 Hr
Charging Infrastructure Reqd.	60 -120 KW charger	60 -120 KW charger	60 -120 KW charger	60 -120 KW charger	60 -120 KW charger
Power Consumption	0.9 to 1.2 KW/Hr	0.9 to 1.2 KW/Hr	0.7 to 0.9 KW/Hr	0.7 to 0.9 KW/Hr	0.5 to 0.7 KW/Hr
Scope of warranties	Standard - 2 Years , Batteries & Motors- 4 Years (AMC as an option can be provided for the life cycle of the bus)				
Seating Capacity	31+1D & Standees	40 + 1D & Standees	26 +1D & Standees	31 + 1D & Standees	>15 + 1D & Standees

Our e-Bus mobility solutions offers several advantages, while addressing the typical challenges in acquiring e-Buses

Advantages of e-Buses

- Zero Tailpipe emissions – improves air quality
- 40-50% lower fuel costs compared to diesel buses
- Reduces diesel cost burden (~52% of overall cost)
- Lower maintenance downtime and costs compared to diesel buses

Additional advantages through an end-to-end mobility solution

- One stop solution – no coordination hassles between suppliers to integrate different parts of the e-mobility ecosystem
- Savings from day 1 – lower net cost / km to NMC
- Greater control of vehicle operations – ensure service delivery to employees
- Potential to drive greater ridership and better user satisfaction
- Potential to optimize vehicle routes and operating costs, increase efficiency through digital solutions including fleet management and monitoring, Bus Stop Monitoring and Management.
- Potential for additional revenue from monetization of vehicle data

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Electric bus success stories

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Tata Motors Starts the Supply of 40 Electric Buses to AICTSL

The Ultra Electric buses are air-conditioned, have modern interiors and comfortable seats for 31 passengers.

News18.com | Updated:March 9, 2019, 3:30 PM IST

Tata Motors to supply 80 electric buses to West Bengal Transport Corporation

Of the total e-buses to be supplied to WBTC, 40 are Ultra Electric 9/9m AC and the rest are 9/12m AC. The company has already provided 20 Ultra Electric 9/9m AC buses to the corporation, while the remaining 20 are scheduled to be delivered by March 31, 2019. The 40 9/12m AC e-buses will be furnished in a phased manner.

Tata Motors starts supply of 40 electric buses for Lucknow city transport

Tata Motors said on Sunday that it will be supplying 40 air conditioned electric buses to the Lucknow City Transport Services Ltd (LCTSL) in a phased manner within the next four months.

IANS | Updated: February 11, 2019, 12:06 IST

40 electric buses soon to hit J&K Roads

Jammu, Mar 5 (UNI) Giving a major boost to the government's vision to electrification in transport sector, as many as 40 electric buses would soon hit the roads of Jammu and Kashmir.

"The Jammu and Kashmir State Road Transport Corporation is soon going to introduce 40 electric buses in both Jammu and Srinagar regions likely from the month of May," official sources here said.

They said that air and noise pollution free, electric buses will run on separate routes in both Jammu and Srinagar regions and added, "these lower floor buses will be added to the State Road Transport Corporation next month but will be made functional in May."

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E-Bus Inauguration Pics in several states

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WBTC inspection Pics at various stages

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Lucknow inspection Pics at various stages. Jammu customers were also shown Electric buses

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Key Points related to charger installation:

- Approx 66 chargers are installed at various depots of Kolkata (Nonapkur, Salt lake depot, Kasba Depot, Howrah Depot)

- 1 chargers each is also installed in Lucknow Alambagh Depot and Indore. More chargers will be installed within 31st March at various locations in India

Electric Buses supplied till June 2019 under FAME 1

Cities	9 m	12 m
Kolkatta	40	40 Nos Expected in July
Lucknow	40	
Indore	40	
Jammu	20	
Kashmir	20	
Guwahati	15	
Total	175 Nos	

TATA Buses have covered more than 5 Lakh kms of operation.

Alternate technology- HYBRID

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Starbus Hybrid

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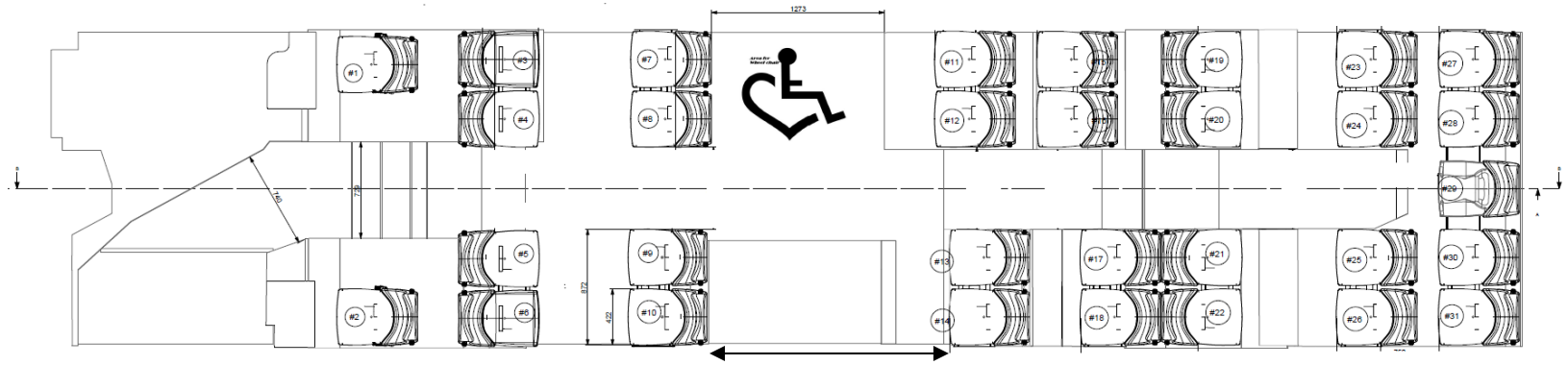
- ✓Power Train - Series Electric Hybrid with 5 Litre Diesel Engine
- ✓Transmission – Automatic
- ✓Suspension – Electronically Controlled Air Suspension At Front & Rear
- ✓Brakes – Electronic Braking system with disc brake in front & Rear
- ✓Passenger Capacity – 31+1 Seats (Can be used as Tarmac Coach)
- ✓Floor height – 400 mm Full low floor
- ✓Max Speed – 80 Km/ hr.
- ✓Budgetary Price – 2.5* Cr for Diesel & 2.75* Cr for CNG



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Hybrid Electric bus operation

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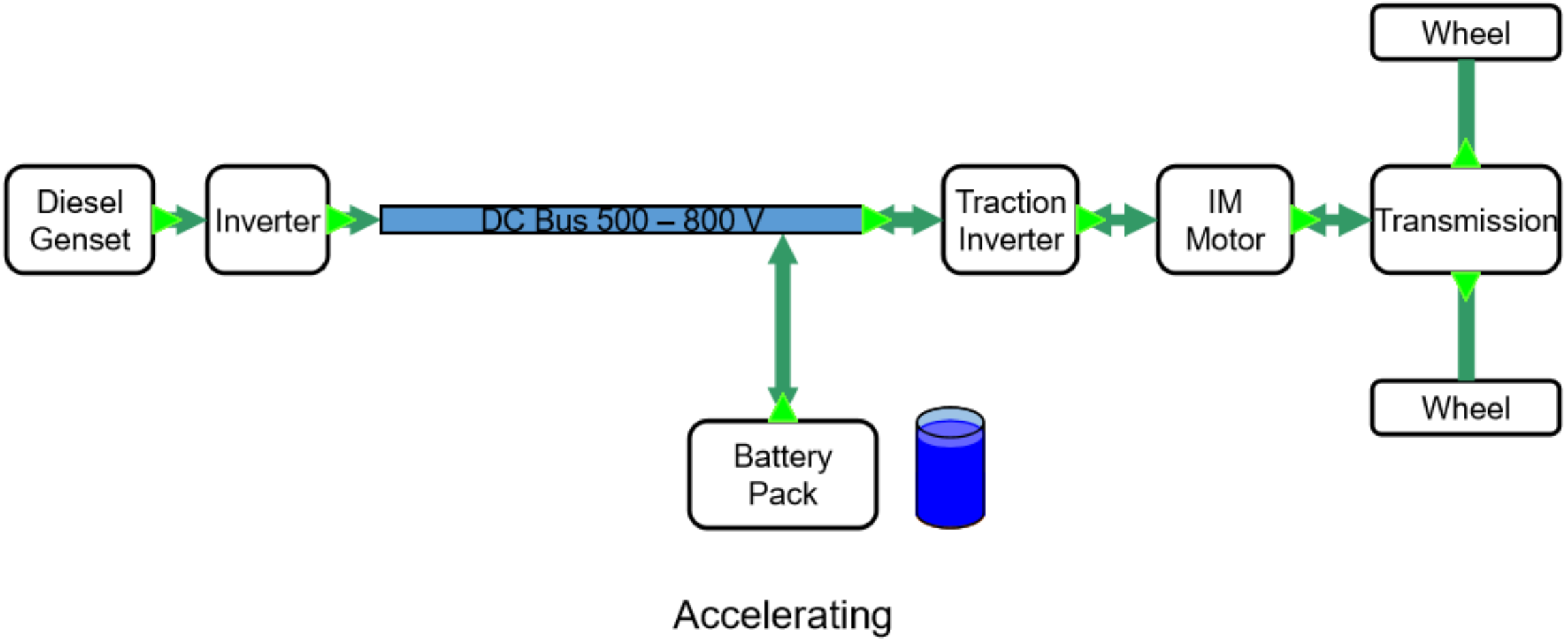


Accelerating

Smart Features: Contemporary Styling – Interior & Exterior

Contemporary Styled Bus

Integrated Head Lamp with DRL & LED Position and Side Blinker

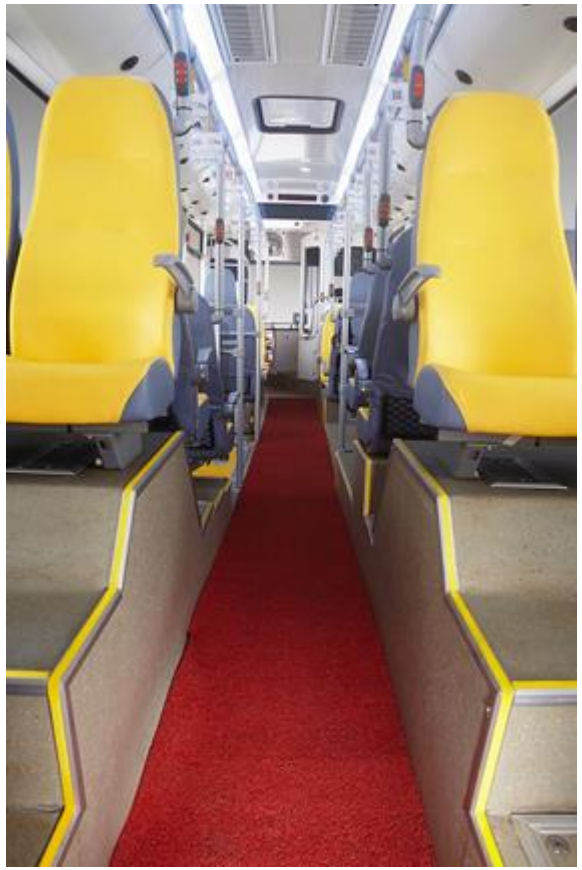
Integrated Tail Lamp with All LED lights

State of the Art Driver Cockpit

Dashboard Swings with Steering Column and VDV based Layout

- Front Inswing Door and Rear Outswing Door for easy ingress and exit for passengers
- Large Panoramic Windows

- Fully Low Floor till Back
- Warm Interiors



Seats for Disabled with Seat Belt and Back Support

Seats for Disabled with Seat Belt and Back Support

Over Hang Seats

USB Charging Integrated with Seats

Tata Motors delivers 25 hybrid buses to MMRDA

COMMERCIAL VEHICLES

By Nilesh Wadhwa 16 Mar 2018

Domestic commercial vehicle major Tata Motors today handed over 25 Starbus Series hybrid (electric-diesel) buses to the Mumbai Metropolitan Regional Development Authority (MMRDA), as part of the state government's effort to adopt lower emission vehicles in public transport. These buses are the electrified version of Tata Motors' Starbus.

The Union minister for Heavy Industries and Public Sector Enterprises, Anant Geete, said: "Our ministry is focused on promoting the FAME Scheme. We had invited all states and cities to take advantage of the subsidy towards adopting electrified vehicles that will reduce pollution in the cities. I am happy that MMRDA has taken a lead in adopting the new technology which will help Mumbai city reduce emission levels."

Electric buses TATA MOTORS perspective

- TML is ready with capacity to build more than 100- 200 buses per month and increase the capacity multiple times once we have sufficient time to ramp up production. Need 6 months to start supplies especially batteries which are imported.

- Power infrastructure has to be planned well in advance before buses are produced. *At some of the locations buses procured under FAME 1 are not in operation as power infrastructure is still not there after more than 2 year's of having placed orders for buses.*

- Routes have to be selected and tweaked if required to improve on efficiency and utilization so that we can get the best out of electrification. Accordingly range of bus should be selected to enable fast charging at intervals instead of having battery capacity which would last for complete day. To choose between carrying people vrs carrying batteries.

Electric buses TATA MOTORS perspective

How to make electric buses in public transport sustainable

We need to find out ways and mean to make electric mobility viable without subsidy if we want it to be sustainable.

- Preference to buses over private transport.
- Improvements through innovation has to be incorporated as a process in working of all stakeholders.
- City buses would give higher benefits over intercity buses as primary purpose is to reduce pollution and congestion in the cities.
- Finances have to be arranged for complete contract period before the project is started. This could be one of the most critical factor for success of PPP model of operation in future of public transport. Guaranteed payments have to be ensured.
- Follow guidelines of DHI/ MCA (Niti Aayog) and procurement through GeM portal should be done instead of working on different tender terms and conditions.

Electric buses are now in the range of commercial viability

	New CNG Fleet		New e-Bus Fleet	
New Bus Capex	45 – 50 Lacs / bus	↑	**1.5-2x**	• Higher capital cost, even after accounting for FAME subsidies
Capex/ km (for life of vehicle)	27 – 33%	↑	**1.4-1.8x**	• Additional cost of charging infrastructure included in Capex
Operating costs				
• Fleet Maintenance	35 – 40%	↓	**0.7-0.9 x**	• Fewer moving parts • Fewer consumables (e.g., engine oil)
• Fuel	25 – 27%	↓	**0.35-4x**	• Assuming power cost of INR 5-6 / kWh
• Insurance	2%	↔	**1.5x**	• Third party liability insurance is the same for both types of vehicles
Cost/ km	**100%**	↔	**1-1.1x**	

Cost per km

Additional Benefits

- ✓ Environmentally friendly – no tailpipe emissions
- ✓ Higher ease of maintenance
- ✓ Lower CNG subsidies for Delhi government
- ✓ Additional features to improve customer experience & cost – e.g., vehicle connectivity

THANK YOU