India - Electric Buses

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PUBLIC TRANSPORT RIDERSHIP IN URBAN INDIA IS ON THE DECLINE

WILL INTRODUCTION OF ELECTRIC BUSES CONTRIBUTE TO REVERSAL OF THE TREND?

Quantity & quality of PT, Economics, Air quality & GHG

WHAT ARE THE CHALLENGES FACED BY PTA'S IN INTRODUCING ELECTRIC BUSES?

Technology choice

Procurement Model

Infrastructure

Others

FAME EXPERIENCES

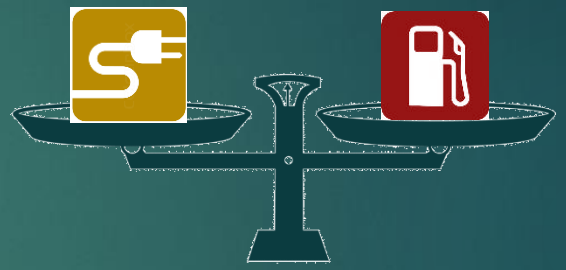
EV Players


Volvo
VDL
Mercedes Benz
Iveco
Scania, Van Hool, Heuliez, Irizar, Solaris, Belkommunmash, Volgabus-Vladimir, Karsan-Bozankaya
Proterra
New Flyer
Add Nova Bus (Volvo), Gillig, Greenpower, MCI
Marco Polo for Latin America
Turkish Manufacturers
Kwauthong Motor (Thailand)
Toyota, Japan
Optare
Ashok Leyland
TATA
JBM
Goldstone
Deccan
KPIT
Anhui Ankai Automobile
BYD
Daimler
Jiangsu Alpha
Jingzhou Xinwei
Nanjing Jiayuan EV
Shandong Yi Xing Electric Automobile.
Shenzhen Wuzhoulong Motors Group
Yutong

1. Economics – Diesel Vs EV

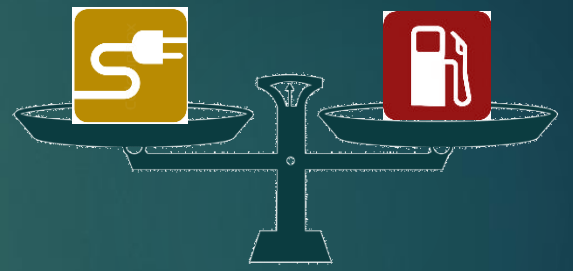
1. EV – Diesel Parity

- ***Expectations***
  - TCO = Equivalent Current Diesel / CNG Bus
  - 1/10th of Diesel Maintenance Costs
  - Route Flexibility
  - Passenger Capacity



EV – Diesel Parity

- ***Findings***
  - Higher Acquisition costs as long as there is no demand aggregation on the supply side
  - Maintenance Costs impacted by Spare part costs. Diesel Buses – matured market and hence cost of spares is lesser than EVs
  - Actual frequency of maintenance and longevity of parts to be a finding in the coming days
  - Investments on High tension lines and Substations as against established Diesel Bunks.



Operation Cost: Diesel v/s Electric Bus

Cost Components	12 Mtr AC Buses	
	Diesel (65L)	Electric (157L)
	Rs./KM	
Energy Expense	31	10
Manpower cost	10	10
Maintenance cost	11	6
Interest	4	8
Depreciation/Amortization/ Repayment	10	22
Insurance and misc	1	1
ROI (@9%)	2	4
Total	**68**	**61**

Electric Buses could save:

- More than 65% of Energy Cost
- More than 40% of Maintenance cost.

2. Technology

- Overnight/Fast/swap/flash?
- Passenger Capacity
- Energy efficiency
- Range and flexicity in routes and schedules
- Grid impacts

Technology Options

Overnight Charging

- Alternate Current Charging
- No Dwell times during day
- Depot Charging

Opportunity Charging

- Direct Current Charging
- Charge between shifts
- Daytime + Night Charging

Battery Swapping

- Quick Battery Interchange Stations
- Swap after trips
- Eliminates Range Anxiety

Flash Charging

- Ultra-fast Charging
- Terminal Charging
- Eliminates Range Anxiety

TECHNICAL

1. Onboard Chargers
2. NMC Battery (3000 cycles)
3. ON-bus Thermal Management

1. Offboard Chargers
2. NMC Battery
3. ON-bus Thermal Management

1. Batteries charged at Station
2. NMC Battery
3. OFF-bus Thermal Management

1. Offboard Chargers
2. LTO Battery (>20000 cycles)
3. ON-bus Thermal Management

Technology Options

Overnight Charging	Opportunity Charging	Battery Swapping	Flash Charging
Alternate Current Charging	Direct Current Charging	Quick Battery Interchange Stations	Ultra-fast Charging
No Dwell times during day	Charge between shifts	Swap after trips	Terminal Charging
Depot Charging	Daytime + Night Charging	Eliminates Range Anxiety	Eliminates Range Anxiety

OPERATIONAL

Overnight Charging	Opportunity Charging	Battery Swapping	Flash Charging
1. Limited Range per day	1. Range extend during dwell	1. Unlimited Range per day	1. Unlimited Range per day
2. More batteries per bus	2. More batteries per bus	2. One battery per bus	2. One battery per bus
3. Higher Unladen weight	3. Higher Unladen weight	3. Lower Unladen weight	3. Lower Unladen weight
4. Route flexibility	4. Route constrained	4. Route constrained around station	4. Route constrained around station

Comparison of Different Type of E-bus Charging Technology

Parameters	Swap	Overnight + Opportunity	Overnight dedicated without Opportunity
Passenger Capacity	25+Driver, 25 standees = 50	29+Driver, 21 standees= 50	21+D, 21 standees = 42
Fuel Economy	Higher due to lower battery weight	Medium	Lower due to higher battery weight
Scheduling Flexibility	Constrained	Relatively Constrained	High Flexibility
Safety issues	Driver anxiety High voltage lines packed in chassis increases safety	High voltage lines packed in chassis increases safety	Additional Batteries on ROOFTOP. Leading to: Bus stability issues due to higher Centre of Gravity (Perception)
Battery Weight	X	4X	5X
Battery upgradability	High	Low	Low
Range	30 km + Contingency of 15 km	140 km in overnight plus 80-100 km opp. charging	200 km plus
Charging Time per bus	5 minutes for swap	2 hrs 20 min (overnight), 80 min (day)	4-5 hrs

3. Business Models

- Gross cost
- Outright purchase

Business Models

GCC

- Electric Mobility as a Service
- Opex
- OEMs design customized solutions and provide service (OEM, E service, Operator)
- A mix of Depot Charging, Fast Charging, Battery Swapping and Flash Charging

OWN

- Procure, Own, and Operate Electric Buses
- Procure, Own, and Operate Chargers
- Maintenance from OEM
- Warranty from OEM

Business Models : Ups and Downs

GCC

- Updating technology and risk of technology obsolescence with OEM
- Assets with OEM, hence no upfront capex for CTU on bus and charger side
- Important to have expertise in running a GCC before

OWN

- Which Technology to go for?
- No experience in running EVs before! Risk to public?
- Battery replacement costs? Battery prices drop? Battery prices go up from scarcity?
- Sunk cost when Technology becomes obsolete?

Pilot Project for electrification of Public Transport-11 cities

- In October, 2017, the Government of India invited Expression of Interest (EoI) from State Government Departments/Undertakings, Municipal Corporations, Public authorities etc for innovative proposals for multi-modal public transport based on purely electric powertrain.
- In response to this EOI, Department of Heavy Industry received 47 proposals from 44 cities across 21 states having requirement of 3144 E-buses, 2430 E-Four Wheeler Taxies and 21545, E-Three Wheeler Autos with the total financial support of 4054.6 crores sought from Government of India.
- Following were the selection parameters for this EoI:
  - Population of City (Million Plus as per 2011 Census) and Special Category States also considered for grant through a special window.
  - Average PM 2.5 of the city as per 2016 data
  - No. of vehicles registered in the city (for million plus cities)
  - Ranking in Swachhata Abhiyan
  - Smart Cities

Following cities were selected for funding under the present Expression of Interest as the pilot project for Multi-Modal Electric Public Transport under FAME India scheme :

Ahmedabad
(40 buses, 20 taxis & 20 three wheelers)

Bangalore
(40 buses, 100 taxis & 500 three wheelers)

Indore
(40 buses, 50 taxis & 200 three wheelers)

Mumbai
(40 buses)

Jaipur
(40 buses)

Hyderabad
(40 buses)

Jammu
(15 buses)

Kolkata
(40 buses & 200 taxis)

Lucknow
(40 buses)

Guwahati
(15 buses)

Delhi
(40 buses)

- The Government announced Rs 437 crore subsidy to these 11 cities under FAME India, for launching electric buses, taxis and three-wheelers.

Cities with Gross Cross Contract Model

No.	Criteria	Ahmedabad (AJL)	Jaipur (JCTCL)	Mumbai (BEST)	Bangalore (BMTC)	Hyderabad
1	Number of Buses	40 (+ 25% variation) Midi AC	40 (+ 25% variation) Midi AC and Non AC	20 Midi AC and 20 Midi Non-AC (+25% variation)	150 (Midi and large buses)	40 OR 60 (Midi / large)
2	Bus operations requirement range.	220 km per day with opportunity for charging in between (200 km operations + 10% contingency)	220 km per day with opportunity for charging in between (200 km operations + 10% contingency)	Three Options : - 170-200 km with charging time of 3 hrs - 80 km - charging time 2 hrs - 50 km with battery swapping (5 min.) or fast charging (20 min)	200 km per day with opportunity for charging in breaks.	Two opportunities for charging not more than 30 minutes each (250 km app)
3	Guaranteed Km	6000 km per month (72000 km pa)	4500 km per month (54000 km pa)	4000 km per month (48000 km pa)	6000 km per month (72000 km pa)	Range less 50 km.
4	Agreement Period	7 + 2 years.	8 + 2 years.	7 years	7+3 years	12 years
5	No. Consortium Members permittd	Maximum 2 (OEM and Bus Operator)	Maximum 2 (OEM and Bus Operator)	Max 3 (OEM or Operator)	Not mentioned.	Three
6	Tender	Ashok Leyland	Tata Motors Ltd	Goldstone	Goldstone	Goldstone

Cities with Direct Purchase Contract Model

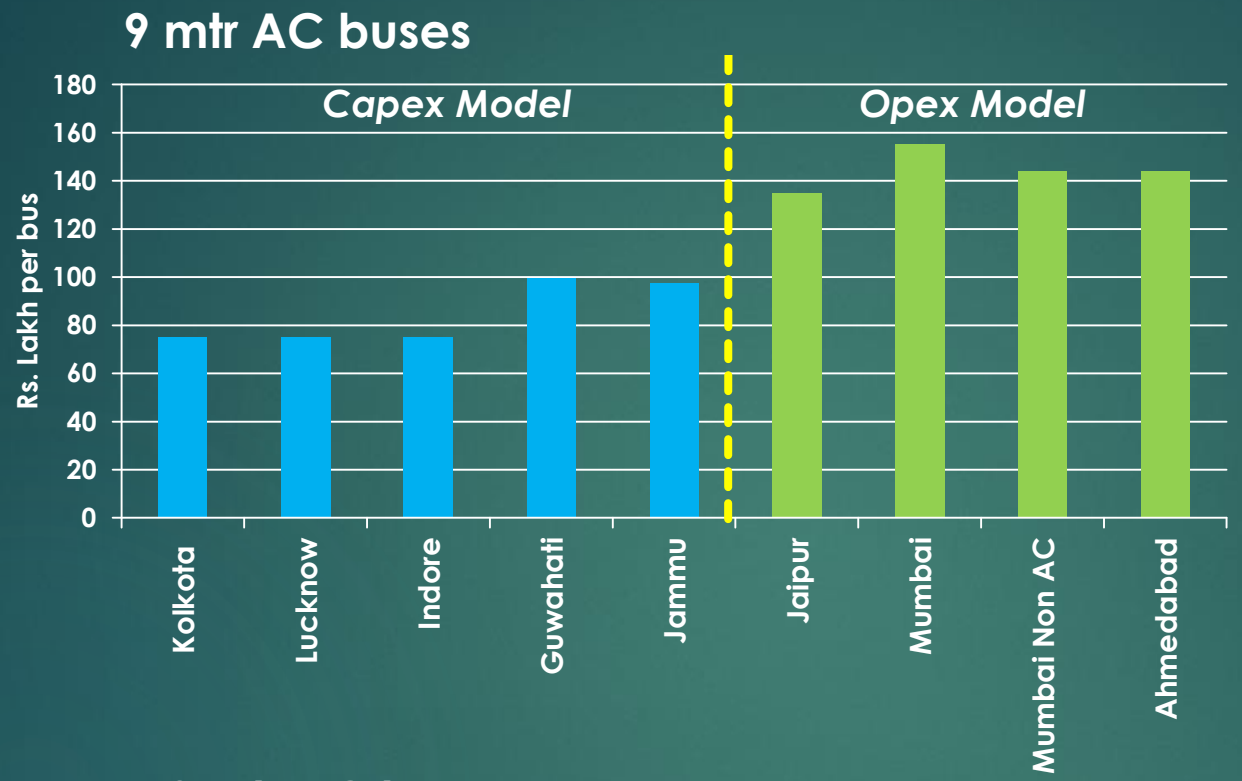
- In case of cities with direct purchase contract, Tata Motors Limited bagged purchase orders in all of these cities namely Kolkata, Lucknow, Guwahati, Indore and Jammu.
- Aggressive bidding was witnessed in the procurement process in these cities.
- Normally, the cost of an electric bus is above the Rs. 1 crore mark.
- The lowest bid in all of these cities was below this mark.

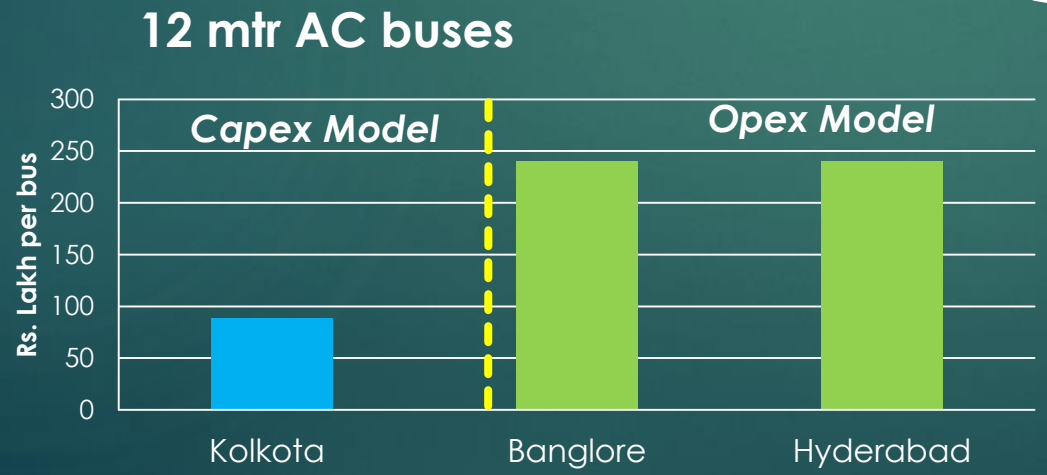
City	Authority	Contract Type	Tender awarded to	Type of bus	No. of buses	Warranty (in years)	Assured kms per day	Range offered on fully charged battery (in km)	Charger	Cost of Buses (in lakh Rs.)
Kolkata	West Bengal Transport Corporation Limited	Direct Purchase	Tata Motors Limited	9m AC	20	5	-	150	30 slow charging and 10 fast charging facilities	77
				12m AC	20	5	-	150		88
Lucknow	Lucknow City Transport Services Limited	Direct Purchase	Tata Motors Limited	9m AC	40	10	-	170 to 200	The decision on number of Chargers to be provided is left to the Contractor.	85
Guwahati	Assam State Transport Corporation	Direct Purchase	Tata Motors Limited	9m AC	15	5	-	>180	2 Fast chargers on the route	99
Indore	Atal Indore City Transport Services Limited	Direct Purchase	Tata Motors Limited	9m AC	40	5	-	180	2 Fast chargers on the route	85
Jammu	Jammu and Kashmir State Road Corporation	Direct Purchase	Tata Motors Limited	9m AC	15	-	-	-	-	99

- Hence, there is an extremely tight competition amongst the OEMs to establish market dominance in the electric vehicle market especially in the bus segment.

Source: UITP, 2018 & DHI

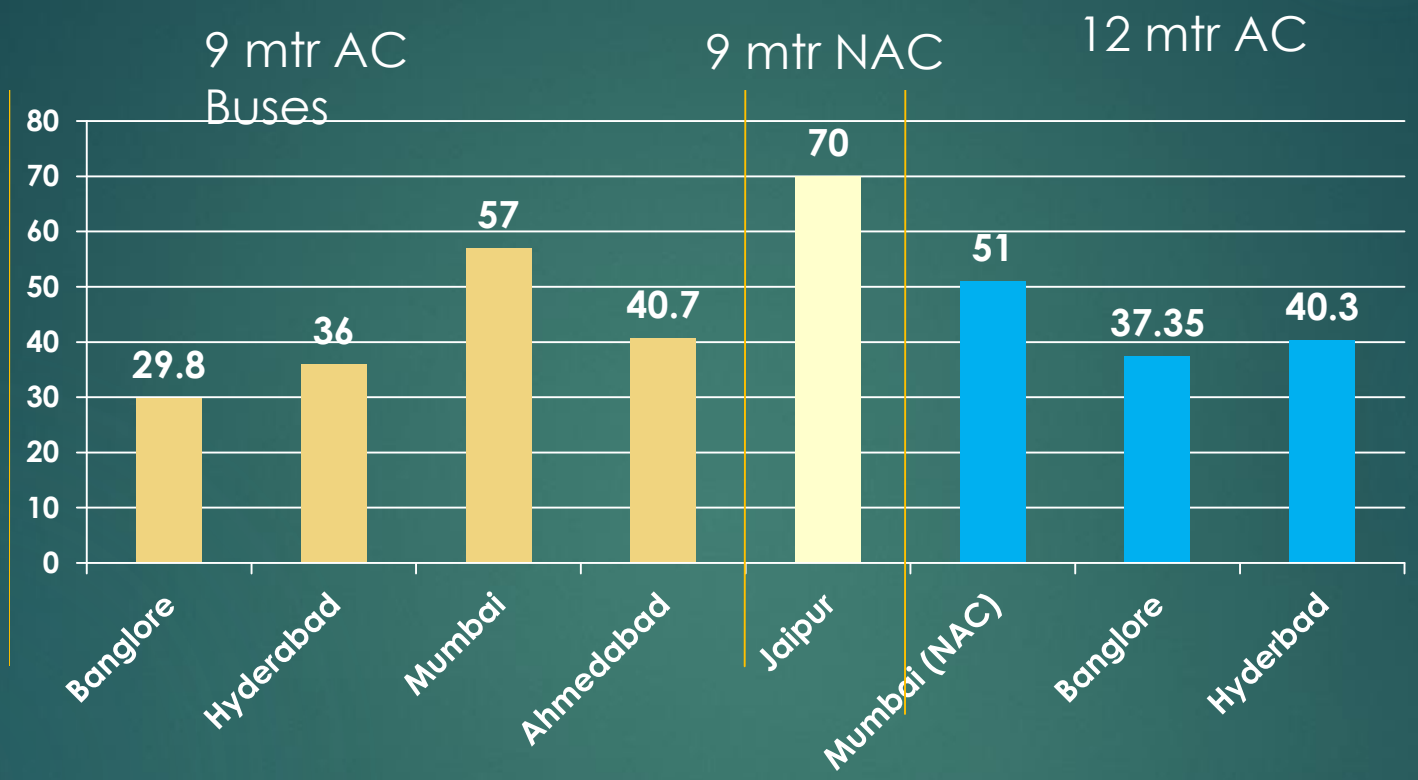
FAME India – Lessons





- Manufacturers willing to become operators
- Experienced Cities seem to prefer Opex Model
- OEM loaded high risk premiums on operations
- Steep Procurement timeline seem to have affected pricing
- Absence of uniformity in Specifications and bus type

FAME India – OPEX PRICES



Summary of the procurement process

- Summing up everything, Tata Motors Limited bagged tenders for 190 buses, Goldstone-BYD for 290 buses and Ashok Leyland for 40 buses.
- Also, it can be seen that cities with considerable experience in intracity bus operations have opted for Gross Cost Contract.
- Also, it is seen in case of cities with gross cost contract that there is huge variation between price quoted by the Goldstone-BYD, Tata Motors Limited and Ashok Leyland.
- Tata Motors and Ashok Leyland have higher bid prices compared to Goldstone-BYD.
- During stakeholder interview with TATA motors, it was found that they perceive high risk as they are primarily manufacturers by nature and have very little or no experience as an operator.
- Also, electric buses are a relatively very new concept for Indian market.
- Whereas, if we see the case of Goldstone-BYD, BYD is a Chinese company with very high experience with electric buses worldwide.
- Hence, they seem to be very well versed with the economics associated with electric bus operations and which is why their bid prices are very less compared to its competitors.

4. Others

- Others
  - Battery sourcing and availability
  - FAME did not finalise the technology or procurement model – focus on "Electric" not bus service
  - Niti Ayog – Model Contract Draft
    - Escrow Account
    - Need to focus on financial sustainability of authorities
    - Viability Gap

Viability Gap Funding Scheme - Gujarat

- Scheme open to 8 cities with Municipal Corporations and to Class A Municipalities with population of lakh plus.
- Operations cost part funded for a period of 7 years (bus life) and no capital cost will be funded
- Approval based on Feasibility Report
- VGF to meet maximum of 33% of operation cost, or actual viability gap, whichever is lower.
- Approved cities to avail benefit only up to a maximum limit of operated km. Also minimum number of km to be operated.
- Performance parameters for being eligible for release of funds
  - Fleet utilization % (95%)
  - The city / town must adopt inflation linked fare revision
  - Proper Performance Appraisal System
- Scheme tentatively called "Augmented Urban Mobility (AUM)" Scheme

Electric Buses : Financing

What next?

- Scale?
- City targets
- Top 35 cities (20-30000 buses in 5-7 years)

Summing up

- Inadequate knowledge, information, experience about electric bus technology, operations, management is pushing prices higher
- While FAME makes a good beginning in terms of in introducing electric buses in India, scaling up in terms of number of cities and bus fleet in each city is necessary (say 35 cities; 40-50000 buses in 5-7 years!)
- Technology choices in terms of charging concepts and their suitability need careful consideration. Application, impact on capacity, cost, localization potential need consideration
- Local manufacturing base need to be widened
- Given various risks, opex model appears preferable over capex model. Associated capacity development to be taken up including model contracts document
- Towards Standardisation, UBS – II need to be updated to include electric buses
- Market development on the supplier side need policy encouragement – OEM, Energy supplier, Energy service provider, bus operator..

Thank you

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