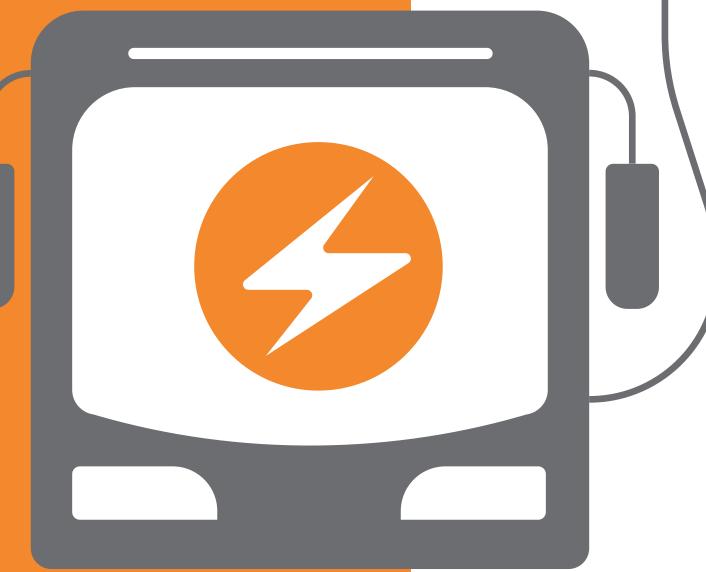
# ELECTRIC BUSES

JMK Research & Analytics

India Market Analysis

Sep 2020





JMK Research & Analytics is a boutique consultancy for all kinds of research and advisory services for Indian and international clients focusing on Renewables, Electric mobility and Battery Storage segments. We employ our interdisciplinary team, strong industry network, vast project experience in the Indian Energy sector to create substantive business value for our clients. Our subscribers include, equipment suppliers, investment agencies, multi-lateral and bilateral agencies, project developers, government authorities.

E: contact@jmkresearch.com
P: +91-7428306655
A: 27/2C, Palam Vihar, Gurgaon, Haryana-India
W: www.jmkresearch.com

## **Authors**

#### Jyoti Gulia

Jyoti Gulia is the Founder of JMK Research & Analytics. She has about 14 years of rich experience in the clean energy segment. Her core expertise includes policy and regulatory advocacy, assessing market trends, financial modelling, and advising companies on their business strategy. She has worked with leading management consulting companies including Bridge To India, Tecnova, Infraline and CRISIL. She holds Masters in Business Administration from FORE School of Management, Delhi and a Bachelors in Engineering from IGIT, Delhi.

#### Akhil Koshy Thayillam

Akhil is an EV sector enthusiast having completed MBA in Energy and Environment from Symbiosis International University (SIIB). He holds a Bachelors degree in Mechanical Engineering from University of Mumbai.

Design Kritmala.com

#### Copyright (c) JMK Research & Analytics 2020

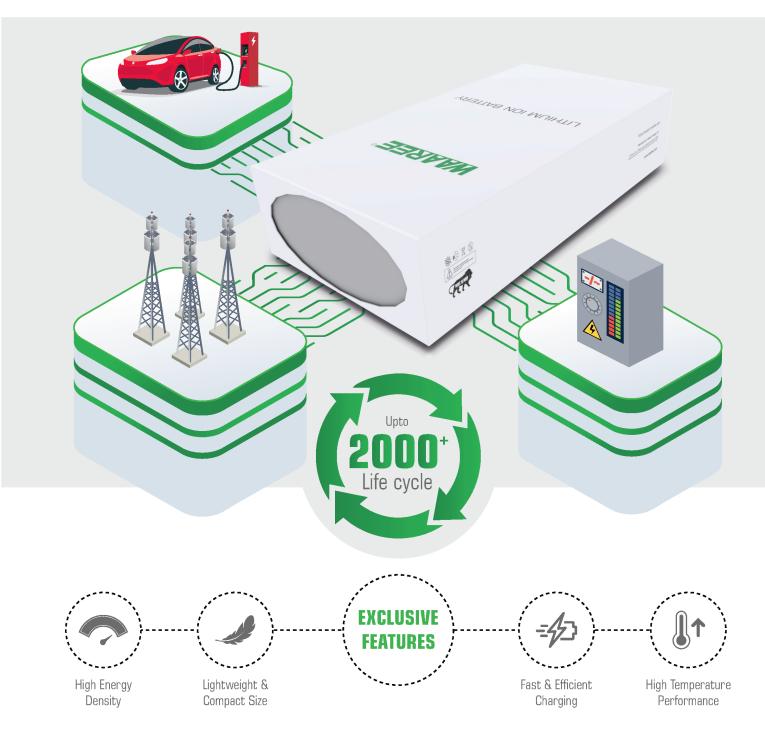
Unless otherwise indicated, the material in this publication may be used freely, shared or reprinted, as long as JMK Research & Analytics is acknowledged as the source.

## Disclaimer

The presentation of the materials contained in this report is of a general nature and is not intended to address the requirements of any particular individual segment or entity. JMK Research & Analytics does not guarantee the accuracy or completeness of information nor does it accept responsibility for the consequence of its use.

# HIGH PERFORMANCE LITHIUM ION





## OUR LITHIUM ION BATTERIES ARE MANUFACTURED WITH UTMOST CARE & PASSES THROUGH 30+ QUALITY TESTS BEFORE REACHING YOU



Combustion test



Acupuncture test



Thermal shock test



Drop test



Temperature cycling test





## CONTENTS

- 1. Executive Summary | 6
- 2. Market Overview | 7
- 3. TCO Analysis of Diesel v/s Electric buses | 8
- 4. Modes of E-bus procurement | 9
  - Outright purchase model
  - Gross Cost Contract model
- 5. Policy Scenario 10
  - Central Policies
    - National Urban Transportation Policy (NUTP)
    - NEMMP 2020
    - FAME 1
    - FAME 2
  - · State policies
- 6. Tender analysis | 14
  - FAME-I
  - FAME-2
- 7. Market Size | 18
- 8. Investments | 20
- 9. Charging Infrastructure | 22
  - Charging technology
  - Challenges
- 10. Key players | 24
- 11. Conclusion | 25





## **ABBREVIATIONS**

AC	Alternating Current	JV	Joint Venture
AEEE	Alliance for an Energy Efficient Economy	km	Kilometre
AICTSL	Atal Indore City Transport Service Ltd.	kmph	kilometre per hour
APSRTC	Andhra Pradesh State Road Transport Corporation	KW	Kilowatt
ASRTU	Association of State Road Transport Undertakings	kWh	kilowatt-hour
ASTC	Assam State Transport Corporation	LBNL	Lawrence Berkeley National Laboratory
BEST	Brihanmumbai Electricity Supply and Transport	LCTSL	Lucknow City Transport Services Ltd.
BEV	Battery Electric Vehicle	MCA	Model Concession Agreement
ВМТС	Bengaluru Metropolitan Transport Corporation	MW	Megawatt
BRTS	Bus Rapid Transit System	NEMMP	National Electric Mobility Mission Plan
CAGR	Compound Annual Growth Rate	NMMT	Navi Mumbai Municipal Transport
CMVR	Central Motor Vehicles Rules	NUTP	National Urban Transportation Policy
CNG	Compressed Natural Gas	0&M	Operation & Maintenance
DC	Direct Current	OEM	Original Equipment Manufacturer
DHI	Department of Heavy Industries	PEMSPL	PMI Electro Mobility Solutions Pvt. Ltd.
	B !!!!!!		
DMRC	Delhi Metro Rail Corporation	PPP	Public-Private Partnership
DMRC EGM	Delhi Metro Rail Corporation  Essel Green Mobility	PPP R&D	Public-Private Partnership  Research and Development
	·		·
EGM	Essel Green Mobility	R&D	Research and Development
EGM Eol	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &)	R&D RfP	Research and Development  Request for Proposal  Society of Manufacturers of Electric
EGM Eol FAME	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &)  Electric Vehicles	R&D RfP SMEV	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles
EGM Eol FAME FCEV	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle	R&D RfP SMEV SPV	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle
EGM Eol FAME FCEV GCC	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract	R&D RfP SMEV SPV SRTC	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation
EGM Eol FAME FCEV GCC GCF	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract  Green Climate Fund	R&D RfP SMEV SPV SRTC SRTU	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation  State Road Transport Undertaking
EGM Eol FAME FCEV GCC GCF Gol	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract  Green Climate Fund  Government of India	R&D RfP SMEV SPV SRTC SRTU STU	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation  State Road Transport Undertaking  State Transport Undertaking
EGM Eol FAME FCEV GCC GCF Gol GST	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract  Green Climate Fund  Government of India  Goods & Services Tax	R&D RfP SMEV SPV SRTC SRTU STU TCO	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation  State Road Transport Undertaking  State Transport Undertaking  Total Cost of Ownership
EGM Eol FAME FCEV GCC GCF Gol GST HRTC	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract  Green Climate Fund  Government of India  Goods & Services Tax  Himachal Road Transport Corporation  Internal Combustion Engine  Jammu and Kashmir State Road Transport	R&D RfP SMEV SPV SRTC SRTU STU TCO TSRTC	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation  State Road Transport Undertaking  State Transport Undertaking  Total Cost of Ownership  Telangana State Road Transport Corporation
EGM EoI FAME FCEV GCC GCF GoI GST HRTC ICE	Essel Green Mobility  Expression of Interest  Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles  Fuel Cell Electric Vehicle  Gross Cost Contract  Green Climate Fund  Government of India  Goods & Services Tax  Himachal Road Transport Corporation  Internal Combustion Engine	R&D RfP SMEV SPV SRTC SRTU STU TCO TSRTC UITP	Research and Development  Request for Proposal  Society of Manufacturers of Electric Vehicles  Special Purpose Vehicle  State Road Transport Corporation  State Road Transport Undertaking  State Transport Undertaking  Total Cost of Ownership  Telangana State Road Transport Corporation  International Association of Public Transport



## **EXECUTIVE SUMMARY**

Access to efficient multi-modal public mobility system is deeply intertwined with the socio-economic development of any region. Contributing to this, public road transportation especially public buses in India play a very important role as a large part of the society rely on public transportation.

According to Association of State Road
Transport Undertakings (ASRTU), India has one
of the lowest bus to people ratio of less than
1.5:1000. There are approximately 1.6 million
public and private buses in India and another
1 million are required to cater to the transport
needs of the general public. Out of the total,
only 0.2 million buses are owned by SRTUs.
Most of these SRTUs (State Road Transport
Undertakings) in India are facing diminishing
financial returns and incurring heavy losses.
Had it not for timely Government support, the
rising fuel costs over the years with minimal or
no hike in passenger fares would have led the
SRTUs to bankruptcy.

Therefore, there is a tremendous underlying opportunity for a more effective delivery of road transport service in India. The advent of electric buses (e-bus) will pave the way for future of efficient mass public transport system. Apart from being cleaner and greener, the major advantage of an e-bus is its extremely low operational and maintenance (O&M) expenditure per unit km. The Total Cost of Ownership (TCO) of e-buses is 10-20% lesser than that of diesel buses.

In September 2017, the first commercial e-bus operations began in India in Himachal Pradesh. Since then, the e-bus market has evolved substantially. By March 2020, about 1,031 e-buses were sold across different states and transport undertakings.

As per JMK Research estimates, additional 1850 buses are likely to be sold in FY2021 and around 4640 units in FY2022.

The ebus market growth is fuelled by more than US\$1 Bn worth of investment deals forged in the past few years with investors of varied business backgrounds. To keep up with the pace of e-bus induction and deployment onto the public roads, the charging systems and allied-infrastructure must also be enhanced and/or developed systematically to overcome local-specific challenges.

Henceforth, this report shall briefly touch upon the significant developments in the Indian e-bus market, policies, tender analysis, charging infrastructure and so on.





## **MARKET OVERVIEW**

The electric bus market in India has gained strong momentum over the recent years. Big OEMs such as Tata Motors, Olectra Greentech in partnership with China's BYD, Ashok Leyland etc. are confident that the overall market environment supported by robust regulatory framework, would stimulate the growth of e-bus sales. Driven by the Government subsidy under FAME schemes along with low operation and maintenance of e-buses, a growing number of STUs and city bus agencies are willing to deploy them for public transport.

Rise in general awareness about air pollution, climate change and most importantly the increasing diesel prices over the years (from around Rs.60 per litre in July 2016 to close to Rs.80 per litre in June 2020) are some of the reasons that incentivize most state and city transport authorities to increasingly accommodate clean public transport solutions in their regional development plans.

During the early days of e-buses in India, STUs (State Transport Undertakings) and city transport corporations conducted trials to study their feasibility in actual road conditions. Bengaluru's BMTC was the first transport authority to operate e-buses in India albeit under trial in 2014. Following this initiative, the transport authorities across several states/cities such as Himachal Pradesh, Tamil Nadu, Chandigarh, Assam, Maharashtra, and Delhi also conducted e-bus trials in an effort to induct them in their bus fleet.

The Himachal Road Transport Corporation (HRTC) purchased 25 Goldstone eBuzz K7

The first commercial operation of an e-bus in India began in September 2017 in Himachal Pradesh.

zero-emission electric buses from Goldstone-BYD (presently, known as Olectra-BYD). A few months following HRTC's move, the Brihanmumbai Electricity Supply and Transport (BEST) of Mumbai was next to induct a fleet of e-buses towards the end of 2017. The Goldstone-BYD supplied a total of 6 buses to BEST and were deployed in Mumbai suburban sectors.

Until FY18, only 31 e-buses were sold in India and all these buses were manufactured by Goldstone-BYD. This number grew multiple fold in next two years and by FY20 additional 1000 e-buses were procured by multiple transport authorities from a range of OEMs/suppliers.

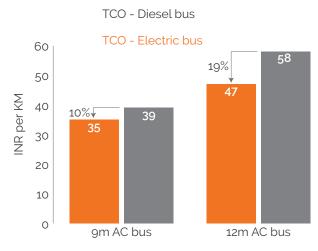




## TCO ANALYSIS: DIESEL vs E-BUSES

The upfront costs of electric buses are more than the diesel counterparts across all length-based categories. However, a comparison of the Total Cost of Ownership (TCO) between diesel and electric buses reveal that the electric buses makes more economic sense.

#### TCO: Diesel bus and E- bus (9 m and 12 m)



Source: UITP, LBNL

Assuming the average driving range of 200 km per day for AC buses, the estimated TCO for 9m and 12m AC diesel buses are Rs. 39 per km and Rs. 58 per km respectively; As for AC electric buses with a battery cost per unit capacity assumed as \$200 per kWh (excluding import tariff), buses of 9m category have an estimated TCO of Rs. 35 per km, whereas, for 12m bus, it is about Rs. 47 per km.

The wide gap in TCO of diesel and e-buses of 9m and 12m length is primarily due to the fact that although the capex of electric 12m bus is substantially higher than that of 9m bus, the difference between the opex charges per km for 9m and 12m variants are disproportionately smaller.

If life-cycle health and environmental costs are also taken into consideration, the net cost incurred over the lifetime of diesel buses would be significantly higher than that of electric buses. Therefore, holistic cost implication of electric buses in comparison with diesel buses is very less.





## **MODES OF E-BUS PROCUREMENT**

The two broad classification of e-bus procurement models that have been approved by Department of Heavy Industries (DHI) as a FAME criterion are **Outright Purchase Model** and **Gross Cost Contract (GCC) model**. STU and city bus agencies show preference to a specific mode of e-bus tender predominantly on the basis of the availability of upfront capital, other lifecycle costs, inclination towards contracting outsourced staff for e-bus O&M activities, expertise level of in-house staff for e-bus operations

## **Outright Purchase Model**

In this type of contract model, which is synonymous to public monopoly model, the state government owns the buses and is responsible for planning and operation of e-bus services. It is a capital-intensive model. Under FAME-I, DHI granted 60% subsidy and the remaining 40% was availed from the SRTCs. Although outright purchase contract involves high capex, significant savings is accrued through reduced opex or recurring costs in comparison with ICE-buses. As the whole O&M services is under

the management of the bus agencies as is the tradition, states, initially, saw preference of outright purchase model over GCC model. However, due to lack of expertise in e-bus technologies, STUs or city bus agencies face higher risk of operational failures.

## **Gross Cost Contract (GCC) model**

GCC mode of procurement is also known as OPEX model. As per this Public Private Partnership (PPP) model, the contracted operator or the supplier manages the O&M aspects of e-bus service. The supplier is remunerated on the basis of a fixed cost per km. Under FAME 1 scheme, DHI provides subsidy upto 60% of capital cost of e-bus over 3 years in 3 installments of 20% each in each fiscal. For subsidy under FAME 2, DHI funds upto 40% of the estimated cost of the bus. GCC model has far more benefits than outright purchase model. GCC facilitates substantial easement in financial expenses, quality O&M service from specialist outsourced staff. In addition to this, the bus agency is able to focus more on the vehicle passenger services.

	Pros	Cons
Outright Purchase Model	<ul> <li>The bus agency holds 100% autonomy over fleet operation and thus, minimal conflict of managerial interests</li> <li>Retention of existing staff jobs</li> </ul>	<ul> <li>Huge upfront investment required</li> <li>Requirement for adequate O&amp;M staff training and related expenses</li> </ul>
Gross Cost Contract (GCC) Model	<ul> <li>Financial and operational risks are shared between the bus agency and supplier</li> <li>Improved passenger/customer service delivery</li> </ul>	<ul> <li>Fixed price per km irrespective of ridership for the entire contract period</li> <li>Requires stringent operator performance monitoring by the transport authority</li> </ul>





## **POLICY SCENARIO**

## **Central Policies**

## National Urban Transportation Policy (NUTP)

First framed in 2006 and then revised in 2014, NUTP aims at bringing about comprehensive improvements in urban transport services and infrastructure by planning for the people rather than vehicles by providing sustainable mobility and accessibility to all citizens to jobs, education, social services and recreation at affordable cost and within reasonable time.

Among the many approaches guiding to achieve the policy objectives, it also includes the measure of "use of clean fuel and clean vehicle technology", promoted by way of incentivization and additional financial support for R&D, commercialization and implementation of clean technologies, clean fuel and renewable sources of energy, from the central government

#### **NEMMP 2020**

Unveiled in 2013, the national-level guidance document providing vision and roadmap for faster adoption and manufacturing of EVs (full range of hybrid & electric vehicles) in India. The target of the National Electric Mobility Mission Plan (NEMMP) is to achieve 6-7 million units of hybrid & electric vehicle sales in India by 2020.

As per the government estimates then, out of the total potential investment of INR 20,000 – 23,500 crores for achieving desired EV sales, about INR 1100 – 1300 crores will be required for supporting growth of hybrid and electric bus sales by 2020.

#### FAME 1

As an initiative under NEMMP, the Department of Heavy Industries (DHI) formulated FAME scheme to support market development and manufacturing ecosystem of EVs. It has four focus areas: technology development, demand creation, pilot projects and charging infrastructure. The original scheme did not include demand incentive allocation for e-buses until it was partially modified in September 2017, which brought a new incentive structure for 'fully electric buses' (CMVR category – M2 &M3). The two levels of incentives offered were length-agnostic and

Incentive Level 1	60% of purchase cost or
(Min. Localization	Rs. 85 Lakh
level - 15%)	(whichever is lower)
Incentive Level 2	60% of purchase cost or
(Min. Localization	Rs. 1 Crore
level - 35%)	(whichever is lower)

was only on the basis of minimum level of localization achieved.

Subsequently, DHI received proposals for 3,144 e-buses by STUs in India. Of which, Government sanctioned extension of financial support for 390 e-buses across 11 cities in December 2017.

By the end of the first phase of FAME on 31st March 2019, DHI sanctioned a total of 425 electric and hybrid buses to various cities in the country with a total cost of about INR 300 crores.





#### FAME 2

In March 2019, out of the proposed EV fund support of INR 8596 crores (via demand incentives), e-bus segment was allocated INR 3545 crores. A maximum of 7,090 buses is planned to be supported through phase-II of the scheme.

Approx. battery size	250 kWh
Total incentive @ INR 20,000 per kWh	INR 50 Lakhs
Max. ex-factory price to avail incentive	INR 2 crores
Max. number of buses to be supported	7090
Total fund support from DHI	INR 3545 cr.

\*INR 20,000 per kWh of uniform maximum demand incentive proposed for buses.

In June 2019, DHI invited Expression of Interest (EoI) from million-plus cities, smart cities, State/UT capitals and cities from special category states for submission of proposal for deployment of E-Buses on operational cost model basis. DHI planned to sanction a total of 5,000 buses for deployment with FAME 2 support across 40 cities. The maximum demand incentive that could be availed under

Standard Bus (length > 10m to 12m)	55 Lakhs
Midi Bus (length > 8m to 10m)	45 Lakhs
Mini Bus (length > 6m to 8m)	35 Lakhs

FAME 2 would be determined on the basis of bus length, the parameter that was absent in FAME 1.

In contrast to having two choices under FAME 1 for selection of mode of e-bus deployment i.e Capex and Opex model, Opex mode/ wet lease model of deployment by the transport undertaking is mandated in order to be eligible for FAME 2 subsidy. The bidding model to be adopted by operators/ suppliers for bus deployment would be solely Gross Cost Contract (GCC) based bidding.

Further, NITI Aayog-formulated Model
Concession Agreement (MCA) also known
as Supply-Cum-Operation and Maintenance
Agreement which must be adopted by the
selected city. According to this agreement,
the concessionaire/ operator/ supplier
is responsible to meet the financial
requirements for procurement of buses,
operation & maintenance of buses and
allied-infrastructure whereas the transport
corporation shall incur operational cost on per
km basis.

Subsquently, DHI received an overwhelming response of 86 proposals from 26 States/UTs for the deployment of 14988 e-buses. Upon evaluation of all proposals, 5,595 electrical buses had been sanctioned by DHI to various State/ City Transport Undertakings under FAME-II; Out of this, 5095 electric buses to 64 state/ City Transport Undertaking for intracity transport, 400 electric buses for inter-city operation and 100 electric buses for last mile connectivity to Delhi Metro Rail Corporation (DMRC) were allocated. To support the total approved buses, government incentive of about Rs. 2800 crores would be extended.





## **State Polices**

State	Targets	Incentives/Concessions/Other Initiatives
Andhra Pradesh  (Policy announced in 2018 and applicable upto 2023)	<ul> <li>Convert 100% of APSRTC bus fleet of over 11,000 buses into e-buses (BEVs/FCEVs) by 2029</li> <li>First phase of 100% conversion of bus fleet in top 4 cities by 2024</li> </ul>	Reimbursement of Registration charges, Road tax & Net SGST for all private EVs until 2024
Kerala (Policy announced in 2019)	<ul> <li>Deploy pilot fleet of 3000 e-buses by 2020</li> <li>Up-gradation of 6000 plus existing buses to e-buses by 2025</li> </ul>	<ul> <li>Provide battery swapping system at bus depots to cater trip lengths upto 35 kms</li> </ul>
Karnataka  (olicy announced in 2017 and applicable up to 2022)	<ul> <li>To attain 100% e-mobility by 2030, school buses in Bengaluru city shall be encouraged to move towards EV</li> <li>Launch of 1000 new e-buses during the policy period</li> </ul>	Exemption from the payment of taxes on all EVs
Delhi (Policy announced in 2020 and applicable for 3 years)	<ul> <li>Induction of 1000 e-buses by 2020</li> <li>Pure e-buses to constitute at least 50% of all new public transport vehicles with 15 seats or more procured for the city fleet including for last mile connectivity.</li> </ul>	<ul> <li>Road tax and registration fees to be waived for all BEVs during the 3 year period of this policy</li> </ul>
Maharashtra  (Policy announced in 2018 and applicable up to 2023)		<ul> <li>User subsidy of 10% on base fare will be available for first 1,000 private/ public passenger bus with maximum limit of Rs. 2000000 per vehicle (first 5 years)</li> <li>Road tax &amp; registration fees - 100% exemption</li> </ul>
Tamil Nadu  (Policy announced in 2019 and applicable up to 2029)	State Transport Undertaking (STU) operates 21000 public transport buses. Around 5% of buses shall be replaced as EV every year and around 1000 EV buses shall be introduced every year and Gradual transition of institutional buses to Evs	
Uttar Pradesh  (Policy announced in 2019 and applicable up to 2024)	<ul> <li>To launch 1000 electric buses (BEVs/FCEVs) and achieve 70% EV public transportation on identified green routes in identified 10 EV cities by 2030.</li> </ul>	10 cities including Noida, Ghazia- bad, Meerut, Mathura, Agra, Kan- pur, Lucknow, Allahabad, Gorakh- pur and Varanasi will be declared as model cities in first phase to adopt EVs,





State	Targets	Incentives/Concessions/Other Initiatives
Madhya Pradesh  (Policy announced in 2019 and applicable up to 2024)	Replace 50% of fleets under city Public transport Special Purpose Vehicle (SPVs) with e-buses by 2026.	<ul> <li>The first 1500 electric buses or total electric buses in 5 years, whichever is less, will be charged 1% motor vehicle tax.</li> <li>Vehicle registration fees will be exempted for 2250 electric buses or total electric buses in 5 years, whichever is less.</li> <li>If permit requires for operations of E-Buses, then first 1500 E-Buses or total e-buses in 5 years, whichever is less, will be exempted by transport department.</li> </ul>
Telangana (Policy announced in 2020)	<ul> <li>100% electric buses by 2030 (for intra-city, intercity and interstate transport in phased manner;</li> <li>Phase 1 -25% by 2022, Phase 2-50% by 2025, Phase 3-100% by 2030</li> <li>Airport flight shuttles and PUSHPAK buses to be transitioned to EV on priority</li> </ul>	100% exemption from road tax and registration fee for first 500 e-buses.
Bihar (In draft stage)		<ul> <li>End user incentive - 15% subsidy on base price with an upper limit of Rupees 20,00,000 (for first 1000 e-buses or Policy period of 5 years, whichever is earlier)</li> <li>Road tax &amp; registration fees -100% exemption.</li> </ul>
Punjab (In draft stage)	<ul> <li>Replace 25% of existing bus fleet to e- buses within 5 years from the date of policy notifica- tion.</li> </ul>	<ul> <li>100% waiver on Permit Fee &amp; Motor Vehicle Tax for private bus opera- tors plying on selected routes for a period of 5 years and 10 years if such bus is manufactured in Punjab</li> </ul>
Uttarakhand		<ul> <li>First 100,000 buyers of EVs to be exempted from motor vehicles tax for five years</li> <li>EV investors will have 100% electricity duty exemption</li> </ul>

Source: JMK Research



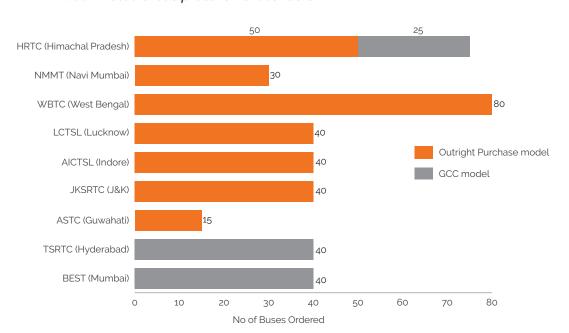
## TENDER ANALYSIS

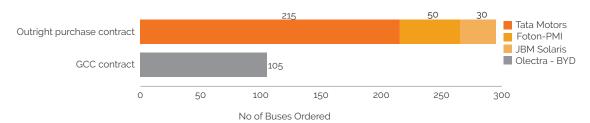
## FAME-I

On October 31, 2017, the DHI issued an EoI inviting proposals from million-plus cities and special category states for multi-modal electric public transport. 47 proposals were submitted by 44 cities. 11 out of these 44 cities were selected for the project. But, only 8 cities finalised the tendering process before 31 March 2018 (Delhi retracted from floating the tender as it had opted to procure

e-buses separately from state budget, whereas, Ahmedabad and Jaipur had floated tenders but did not complete the process). Subsequently, many more tenders were floated by various transport authorities during the FAME 1 period. Some of these tenders were terminated by the transport authorities primarily due to project non-viability associated with the price of the winning bid. The table below represents summary of sanctioned tenders under FAME 1 that have

FAME 1 – Culminated e-bus procurement tenders





Source: UITP, JMK Research





reached culmination. Except Olectra-BYD, all supplier OEMs had bid via outright purchase mode. WBTC floated the largest (individual or cumulative) tender for e-bus supply order (80) which reached the contract awarding stage, followed by HRTC (75). Tata motors bagged the largest supply order (215) under FAME 1, followed by Olectra-BYD (115).

Traditionally, public buses were operated by staffs employed by state or city transport undertaking, hence, most of these corporations released tenders under Outright Purchase Model, leading to more successful tenders/ contract awards under this model than opex or GCC model. Among all the culminated tenders under FAME 1, about 74% of the total bus order quantity were procured through outright purchase mode/ capex mode.

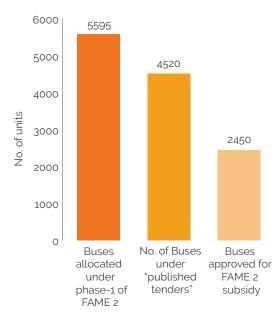
Only TSRTC (Telangana) and BEST (Mumbai) placed e-bus orders solely through GCC mode.
HRTC (Himachal Pradesh) is the only transport authority to procure e-buses via both GCC and Outright purchase models.

#### FAME-2

GCC gradually became the preferred model for many cash-strapped SRTCs (especially when the procurement order was large), though, later, under the FAME 2 scheme, this operation model became a mandate for availing central subsidy. A total of 5595 e-buses were allocated across India in the phase-I of FAME 2. Out of this, tenders for 4520 buses were issued of which, about 2450 buses had been approved by DHI for FAME 2 subsidy by the end of FY2020.

Uttar Pradesh published RfP with the largest e-bus order under FAME 2, ordering up to 600 buses across 11 cities. PMI-Foton bagged the entire order of 600 buses. Following UP in the e-bus procurement race is Maharashtra, having published tenders with cumulative bus orders of 550.

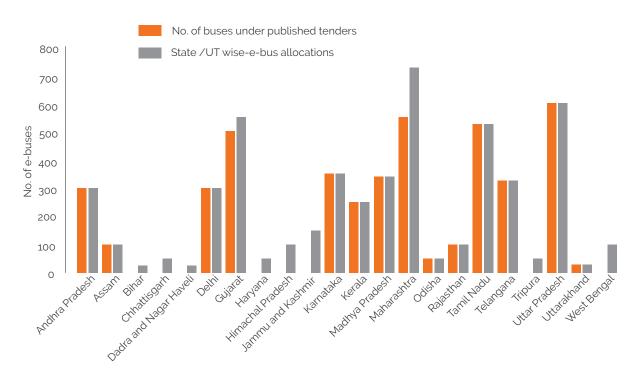
## E-bus procurement status under FAME 2



Source: UITP, DHI, JMK Research

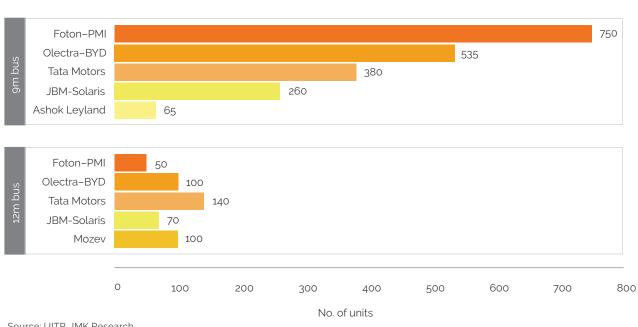


## State/Union territory-wise Intra-city e-bus procurement status under FAME 2 scheme



Source: UITP, JMK Research

## Supplier-wise sanctioned e-bus orders under FAME 2









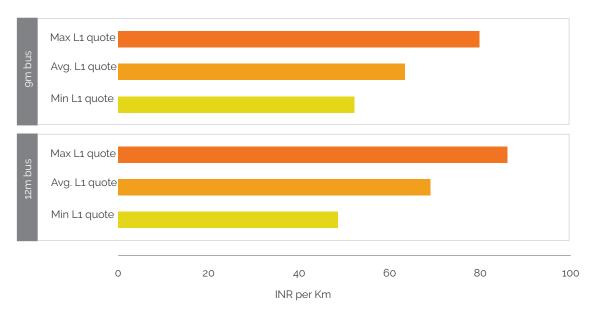
Amongst all the FAME 2 tenders that have been sanctioned which includes a total of 2450 buses across 13 states, the average least details and payment security risks associated cost (L1) per km quoted was Rs. 63.3 per km for 9 metre buses and Rs. 69 per km for 12m buses.

The L1 prices quoted for tenders under FAME 2 are distinctly higher than the L1 prices quoted during the FAME 1 period. The reasons quotes. for this increase in bid prices under the

second phase of FAME scheme are the risk premium adjusted with regards to the tender with STUs.

If additional costs such as cost of development of ancillary infrastructure like depots, administrative expenses, contract management etc. are also included, the actual rate per km would be much higher than the L1

## L1 bid quotes approved under FAME scheme



Source: UITP, JMK Research

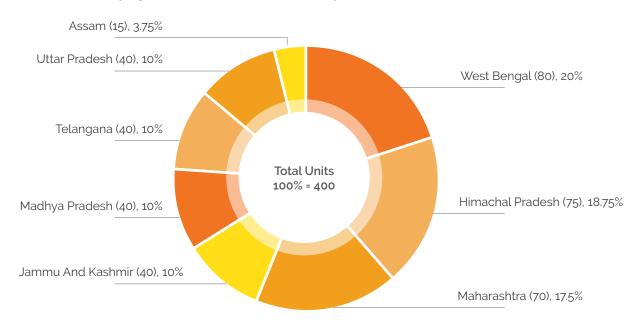


## **MARKET SIZE**

Clenching 400 unit mark, FY19 saw an increment of 369 e-buses in sales over that of FY18. Sale of e-buses increased Y-o-Y by 50% in FY20 to reach 600 units. This rise in e-bus sales in the last two fiscals can be attributed to aggressive governmental push through FAME scheme (including state-wise e-bus allocations).

The highest number of e-buses deployed in a state under FAME 1 as on 16th April 2020 is 80 in West Bengal, which is closely followed by Maharashtra (70). Out of the total 400 buses deployed under FAME 1 in the country, the majority of 215 buses have been supplied by Tata motors, covering 5 out of 8 states.

#### Electric buses deployed under FAME 1 (as on 16th April 2020)



Source: Department of Heavy Industry, Gol

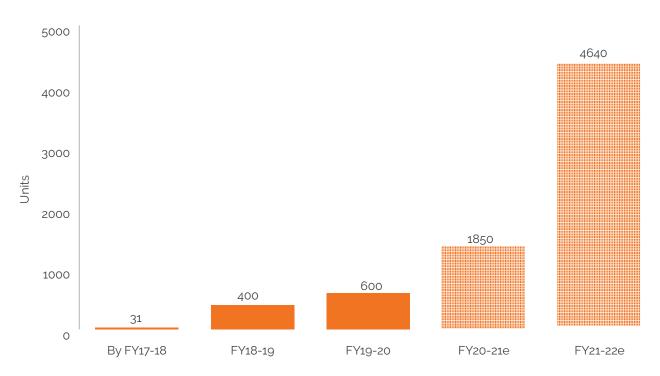




Under the purview of FAME-2, assuming that 7090 e-buses would be procured between FY2020 and FY2022 and considering the number of FAME-2 sanctioned-buses so far, FY20-21 is estimated to witness sales of 1850 units. E-bus sales, during the FAME 2 period (FY2020 to FY2022), is expected to grow at a CAGR of 178%. This high growth

rate can be anticipated on the grounds of an ever-growing central government impetus as well as stronger consumer affinity (post COVID-induced lockdown) for electrification of mobility.

#### E-Bus sales in India



 $Source: FY17-18\ till\ Fy19-20\ numbers\ are\ taken\ from\ SMEV,\ projections\ for\ FY20-21\ and\ FY21-22\ by\ JMK\ Research$ 





## **INVESTMENTS**

In last few years, there were considerable financial deals that emerged in the e-bus market. Investments were seen across companies of different business nature. The stakeholders in the e-bus value chain that

were involved in various business transactions included OEMs, App-based bus service provider, EV solutions provider and also a state transport department.

Company	Date	Company type	Deal type	Investor	Deal value (in \$ Mn)
JBM Solaris	Jul16	OEM	JV	JBM & Solaris	44.6
Ashok Leyland	Jul17	OEM		Ashok Leyland & SUN Mobility	Undisclosed
ZipGo Technologies Pvt. Ltd	Aug18	App: Online bus aggregator	Equity	Essel Green Mobility Ltd (EGM)	29.13*
Mytrah Mobility	Sep19	EV solutions provider	Debt	GCF (Green Climate Fund)	1,000

\*For e-buses; Total deal value - \$43.7 Mn (for both e-buses & e-rickshaws) Source: JMK Research

JBM Auto entered into a JV with Solaris Bus & Coach S.A. of Poland in July 2016 with the aim of designing, engineering and developing electric and hybrid buses in India. JBM Solaris laid the plan then, to invest \$44.6 Mn phasewise over 2-3 years following the date of JV deal. Solaris has technical expertise in developing e-buses whereas JBM Auto has in-house engineering & design expertise and also advantages of market know-how and manufacturing facilities.

In July 2017, Ashok Leyland formed a strategic alliance with SUN Mobility to develop electric buses with 'swap and charge' battery technology. The partnership was created with an intention to integrate Ashok Leyland's state-of-the-art e-buses and SUN Mobility's proprietary batteries along with a network of quick interchange battery stations. The deal

value was undisclosed.

In August 2018, Zipgo, a bus service app based in Bengaluru had raised a total funding of \$43.7 Mn from Essel Green Mobility Ltd (EGM) for venturing into e-bus and e-rickshaws integrated transport options. Two-third's of this fund i.e \$29.13 Mn was allocated for transitioning to a pure electric bus fleet. The company, in April 2019, suspended its operations pan-India.

For its grand plan of financing approx. 5000 electric buses and allied infrastructures in India, Mytrah Mobility sought funding of \$1 billion from the UN-backed Green Climate Fund in January 2019. GCF allows loan term of 15 years at low interest rates. Mytrah will receive the funding through the Indian accredited agency, Small Industries Development Bank of India.





Also, recently, the transport department of Tamil Nadu government and German development bank, KfW in September 2019 signed a project agreement by which 500 electric buses along with 2,213 new buses under BSVI norms would be purchased for INR15.80 billion. This capital raised would support infrastructure for e-bus operation, procurement of software and hardware for enhancing the efficiency of transport department as well as Passenger Information System.





## **CHARGING INFRASTRUCTURE**

## Charging technology

On the basis of charging technology used, charging infrastructure can be broadly classified into three types: conductive charging, inductive charging and battery swapping.

Conductive charging type is the predominant technology deployed for charging infrastructure due to its design simplicity and lower infrastructural expenses in comparison with the other two forms of technology. Conductive charging can be further classified into AC charging and DC charging.

Reportedly, there is no case of AC-1 and AC-2 charging technology for e-buses worldwide. These two types have service voltage levels of 120V and 230V respectively, which, in the Indian context, cannot be used for charging of e-buses. AC-3 type charging utilizes 3-phase AC voltage level i.e. 415V. AC-3 charging requires e-buses to have on-board chargers. Employing this charging technology for e-bus charging is more economical but the charging time is considerably longer than DC charging.

DC plug-in also involves service voltage level of 415V and unlike AC-3, DC plug-in does not require e-buses to have on-board chargers. Charging time can be as low as half an hour for full charging. DC charging technology is highly expensive.

Inductive charging technology is basically any wireless charging method. The required service voltage level in India for inductive charging is 415V or above. This kind of charge transfer technology has very limited application all across the world because its highly expensive and its infrastructure is quite complex.

Battery swapping method of charging for e-buses is in limited deployments. The first and the only such case in India was introduced by Ashok Leyland-Sun Mobility partnership for Ahmedabad BRTS. Though ordinary e-buses have a range of 200-300 kms, these buses with swappable batteries only have 40 kms of range but the swapping takes less than 4 minutes, making it suitable for intra-city transport.

#### Charging technology for E-buses prevalent in India

Power type	Classification basis	Type of AC/DC charging	Used in E-bus charging? (Y/N)
		AC level 1	N
AC	Service voltage level	AC level 2	N
		AC level 3	Υ
50	Charging system design	DC Plug-in	Υ
DC		DC Pantograph	N





## Challenges

#### Lack of clarity in stakeholders' roles

One of the critical challenges hampering the growth of e-bus charging infrastructure in India is the lack of clarity in the role and extent of responsibilities assigned to the state or city transport authority and bus operators with regard to setting up of charging stations under the GCC model. Due to this issue, there is a potential imposition of significant operational and safety risks on both the parties post the commencement of charging service.

#### Depot infra planning & management

A vast majority of city bus depots across all states face hindrances in accomodating charging systems in their allotted spaces as these depots were not planned to dock e-buses or facilitate charging service. Thus, it is highly important to plan and develop smart bus depots with efficient depot management system that can manage multiple conventional and electric buses optimally.

#### Low power supply connection

Closely linked to the depot design dilemma is the challenge of limited capacity of power connection to existing depots or bus stops to cater to e-bus charging requirements. The slow and fast chargers typically provide 50 kW and 150 kW service power respectively. So, in order to facilitate uninterrupted charging service, the bus terminal or depot must have about 1 MW or more capacity electricity connection. This implies that the concerned transport authorities need to work in coordination with the discoms for electrification of bus depots.





## **KEY PLAYERS**

There are six big OEMs present in the Indian e-bus market. Tata motors and Olectra-BYD are two of the oldest players in this segment. There are renowned international players eyeing the huge market potential in India leading to formation and operation of 4 JVs (Olectra-BYD, Foton PMI, JBM Solaris, VECV) in this market.

E-bus OEM	Description	E-bus models	Typical range	Charging technology
Tata Motors	<ul> <li>Manufacturing facility – Dharwad, Karnataka</li> <li>Typical e-bus maximum speed – 75 kmph</li> </ul>	Tata Ultra (9m), Tata Urban (12m), Starbus EV (12m)	Min. 150 km	Plug-in
Olectra- BYD	<ul> <li>A JV between Indian Olectra Greentech and China's BYD</li> <li>Manufacturing plant – Hyderabad</li> <li>Annual capacity - 1,000 buses.</li> </ul>	ebus K6 (7m), ebus K7 (9m), ebus K9 (12m)	200 – 300 km	Plug-in
Foton PMI	<ul> <li>A JV between PMI Electro Mobility Solutions Pvt Ltd (PEMSPL) and its chinese partner Beiqi Foton Motor Co (Foton).</li> <li>Manufacturing base – Daruhera, Haryana.</li> </ul>	Urban (12m) Regio (9m) Lito (7m)	150-200 km	Plug-in
Ashok Leyland	<ul> <li>In collaboration with Sun Mobility, the first of its kind electric bus powered by swappable battery was launched.</li> <li>Charging time – &lt;4 minutes.</li> </ul>	Circuit-S (9m to 12m)	50 km	Battery Swapping
JBM Solaris	<ul> <li>A JV between the Indian firm, JBM Auto and Polish bus manufacturer, Solaris.</li> <li>Manufacturing base – Faridabad and Kosi</li> <li>Annual capacity – 2000 units.</li> </ul>	Eco-Life eg (gm), Eco-Life e12 (12m)	150-200 km	Plug-in, Pantograph
VECV	<ul> <li>A Volvo Group and Eicher Motors joint venture.</li> <li>Eicher Skyline Pro electric bus was developed in partnership with KPIT Technologies.</li> <li>Manufacturing base – Indore.</li> </ul>	Eicher Skyline Pro electric	177 km	Plug-in

Source: JMK Research





## CONCLUSION

With strong government thrust for EV transition, the public transport authorities and the e-bus suppliers are encouraged to drive the market growth on the back of proper regulatory framework and market mechanism. Going forward, many private players are also expected to foray into various businesses in the e-bus market such as e-bus components, passenger services, etc. Many central initiatives (for ex: lower GST rates, FAME scheme) and EV policy incentives of several states (Eg: Road tax or permit fee concessions, manufacturing incentives) have been able to streamline different processes such as e-bus financing and procurement and also promote creation of entire e-bus value chain within these states.

Though the aforementioned aspects around e-bus are being implemented in accordance with set governmental guidelines, there is an incumbent challenge of setting up and managing e-bus charging infra in terms of planning, scope of stakeholders' responsibilities, operation, etc. that must be addressed and resolved on high priority in order to fast-track the e-bus ecosystem development in India.

E-bus market has the potential to fill the voids that exist in the Indian public transport system. By reducing expenses related to O&M and also cutting down hidden costs linked to public health and environment, mass electrification of public buses would not only let the concerned stakeholders reap huge benefits but also help strike a balance of "providing returns" between the service providers and the service users over the long run.





Copyright (c) JMK Research & Analytics 2020

## JMK Research & Analytics

E: contact@jmkresearch.com

M: +91-7428306655

A: 27/2C, Palam Vihar, Gurgaon, Haryana-India

W: www.jmkresearch.com