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# India-Nepal Electric Mobility Knowledge Exchange

Summary Note

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# India-Nepal Electric Mobility Knowledge Exchange

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## Abbreviations

ARAI	Automotive Research Association of India
BEST	Brihanmumbai Electricity Supply and Transport
DoE	Department of Environment
EV	electric vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles
GCC	gross cost contract
GGGI	Global Green Growth Institute
GHG	greenhouse gas
ICE	internal combustion engines
ICEV	internal combustion engine vehicles
kWh	kilowatt hours
LIB	lithium-ion battery
MoFE	Ministry of Forests and Environment
NCC	net cost contract
PMPML	Pune Mahanagar Parivahan Mahamandal Limited
PPP	public-private partnership
STU	State Transport Undertaking
WBTC	West Bengal Transport Corporation

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# Chapter 1. Introduction

## 1.1. Background

During 2018-2019, interest and commitment to electric mobility grew significantly within federal, provincial and local governments in Nepal. As part of this, the federal government as well as the governments of Bagmati Province, Kathmandu Metropolitan City and Lalitpur Metropolitan City committed to investing in electric buses. Specifically, the Cabinet of Ministers, Government of Nepal, decided to deploy 300 electric buses in Nepal and committed NPR 300 crore (USD 26.8 million)<sup>1</sup> to this end in July 2019. That same month, Bagmati Pradesh, Kathmandu Metropolitan City and Lalitpur Metropolitan City also committed to investing NPR 45 crore (USD 4.0 million) in electric buses.

In support of electric mobility promotion, the Global Green Growth Institute (GGGI) is providing technical assistance to its government partners. This support began in 2017, when the Ministry of Forests and Environment (MOFE), in consultation with the Ministry of Physical Infrastructure and Transport (MOPIT), launched phase one of the Electric Mobility Program with GGGI. This phase saw the delivery of a pre-feasibility study for the deployment of electric buses for Sajha Yatayat, and the development of the *National Action Plan for Electric Mobility*, which was launched by the Honorable Prime Minister KP Sharma Oli. Under phase two of the program, further technical and financial analysis is being undertaken for investment in electric buses, and the *Bagmati Province Electric Mobility Strategy* is being developed in partnership with the provincial government. To strengthen understanding of electric mobility amongst key government partners, and gather technical findings and key operational lessons, a knowledge exchange to India was undertaken in July 2019.

## 1.2. India's Adoption of Electric Mobility

Several cities in India have deployed electric buses for public transport, including Mumbai, Kolkata, Pune and Shimla and others. India has also developed a range of electric mobility policies and incentives, including the Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme. A number of Indian auto manufacturers, including Ashok Leyland and TATA, have begun production of electric buses, and through a joint venture between China's BYD and Olectra, Olectra-BYD has also started operations in India. There are various measures being adopted by the central and state governments of India to implement electric buses on existing routes. Under FAME, state governments have been able to access federal subsidies on electric buses since 2015. In addition, to make operation of electric vehicles most efficient, the State Transport Undertakings (STUs) are exploring, testing and adopting different business models.

### ***Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME)***

FAME was introduced in 2015 to promote the manufacturing and adoption of electric and hybrid vehicles in India. Phase I of FAME came to an end in March 2019 with a total disbursement of INR 529 crore (USD 75.3 million). The areas that FAME I was focusing on were i) demand creation, ii) technology platform, iii) pilot project and iv) charging infrastructure. All vehicle segments, including two-wheelers, three-wheelers, four-wheelers, light commercial vehicles and buses were incentivized through this scheme. In FAME I, an upfront subsidy was provided to electric vehicles and grants were provided to specific pilot projects, research and development along with public charging infrastructure projects.

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<sup>1</sup> Exchange rate: 1 USD = NPR 112.01



Phase II of FAME began in March 2019 with a planned financial outlay of INR 10,000 crore (USD 1.4 billion)<sup>2</sup> for 3 years. Out of the total allotment, INR 10 billion (USD 140 million) has been allocated for charging infrastructure and INR 86 billion (USD 1.2 billion) has been allocated for demand incentives. In addition to this centralized fund, the Government of India mandates state governments to provide additional fiscal and non-fiscal incentives to promote electric mobility within the country.<sup>3</sup>

Under FAME II, the Government of India has planned to support the procurement of 7,090 electric buses with a total financial outlay of INR 35.45 billion (USD 496.4 million). The federal government is providing a subsidy of INR 50 lakh (USD 70,028) per bus, under FAME I, with the condition that the price of the vehicle does not exceed INR 2 crore (USD 280,112).<sup>4</sup>

### **Operation Models**

STUs across India have tended to adopt one of three operating and business models. Two of these are public-private partnerships (PPP), and one involves outright purchase. These business models are described below.

1. **Gross Cost Contract (PPP):** Through the gross cost contract (GCC) model, the transport operator, which is usually the original equipment manufacturer (OEM), is paid by the STU to operate buses for a specified time. The STU collects all revenue, monitors operations, and makes performance-based payment to the operator. The operator provides the bus and driver whereas the STU provides the bus conductor. Amongst a range of STUs, the Pune Mahanagar Parivahan Mahamandal Limited (PMPML) and Brihanmumbai Electricity Supply and Transport Undertaking (BEST) have adopted this model for operation of their initial electric bus fleet. The Ahmedabad Janmarg Limited (AJL), for example, has adopted the GCC model whereby payment to the operator is made on the basis of total kilometers run per month and the revenue risk falls on AJL. AJL ensures service quality is maintained through frequent checks and penalties.
2. **Net Cost Contract (PPP):** The net cost contract (NCC) model works similarly to the GCC model, as a partnership between an STU and an operator. The primary difference is that under an NCC model, the operator provides the bus driver as well as the conductor (whereas in the GCC model, these two staff are provided by the STU for financial management). In some cases, the STU may provide electricity to the operator at a preferential tariff. The NCC contract was adopted by the Vadodara Municipal Corporation (VMC) in India in 2008 whereby the operator was responsible for procurement, ownership and operation of the buses. The private sector operator was liable to pay an annual premium to VMC. This proved to be a failure because of the rising costs of CNG as well as the high premium the private operator had to pay to VMC.<sup>5</sup>
3. **Outright Purchase:** This model, also referred to as CAPEX model, is a traditional approach adopted by many STUs in India. This is not a PPP model. This entails the STUs procuring, owning and operating the buses. The original equipment manufacturers (OEMs) are generally responsible for maintenance and warranty. Cities such as Kolkata, Lucknow, Guwahati, Indore and Jammu have adopted this model for operation of the electric buses. All of these operators have no experience in running electric buses in the past.<sup>6</sup>

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<sup>2</sup> Exchange rate: 1 USD = INR 71.4

<sup>3</sup> Government of India. FAME India II Scheme. Department of Heavy Industry. Retrieved from: <https://www.dhi.nic.in/UserView/index?mid=1378>

<sup>4</sup> The Tribune. 2019. Mumbai's BEST to buy 500 electric buses. Retrieved from: <https://www.tribuneindia.com/news/nation/mumbai-s-best-to-buy-500-electric-buses/801602.html>

<sup>5</sup> School of Petroleum Management. 2014. Energy & Infrastructure Management: Prospects & Challenges in Emerging Economies. International Conference on Energy and Infrastructure.

<sup>6</sup> Swamy, S. India-Electric Buses. CEPT University. Ahmedabad. Retrieved from: <http://www.urbanmobilityindia.in/Upload/Conference/4e5f5412-a7a6-4438-aab4-f716912149ad.pdf>

### 1.3. The Knowledge Exchange to India

Within this context, it was concluded that a knowledge exchange to India would be useful and interesting to the Government of Nepal. The core objectives of the knowledge exchange were:

- To meet and exchange experiences with bus operators that have deployed electric buses, in order to learn about their ground operations
- To meet manufacturers and learn more about their vehicle production, and discuss suitable options for the Nepali context
- To gain a wider overview of the public transport sector in India by attending 'Prawaas India International Bus and Car Transport Show', a public transport conference

For the purposes of the knowledge exchange, the cities of Kolkata, Pune and Mumbai were selected for the delegation to visit. Visits to these cities took place over the course of one week, with a primary focus on meeting and interacting with operators of electric buses, and STUs involved in the management of operators. The operators and cities visited are outlined in Table 1 below. The exchange took place over Monday 22 July – Saturday 27 July 2019. A summary of the agenda is outlined in Table 3. The delegation from Nepal included ten officials of the federal, provincial and local governments, as well as Nepal's primary government-owned public bus operator Sajha Yatayat (see Table 2). In addition, the delegation was supported by three staff of GGGI.

The conference 'Prawaas India International Bus and Car Transport Show' was organized by Bus and Car Operators Confederation of India (BOCI). The delegation participated in various sessions including "Innovative Technology for Transforming Passenger Mobility", "Public Private partnership in Delivering Bus Transport," and "Shared Mobility: A Game-Changer or Trouble Maker?". Prawaas was a platform for the delegates to understand the future of passenger mobility in India and its neighboring countries.

**Table 1. Summary of Electric Bus Operators**

City	Bus Operator	Objectives of Discussions
Kolkata	West Bengal Transport Corporation (WBTC)	<ul style="list-style-type: none"><li>• Learn about technical specifications and operational experiences</li><li>• Learn about financing and revenue model of operator</li><li>• Learn about upcoming investments and plan</li><li>• Discuss the opportunities and challenges with electric bus operation</li></ul>
Pune	Olectra (under Pune Mahanagar Parivahan Mahamandal Limited (PMPML))	
Mumbai	Brihan Mumbai Electricity Supply and Transport Undertaking (BEST) <sup>7</sup>	

**Table 2. Summary of Delegates**

Organization	Number of delegates
Sajha Yatayat	2
Kathmandu Metropolitan City	2
Lalitpur Metropolitan City	1
Bagmati Pradesh (Province)	3
Department of Environment	1
Mahalaxmi Municipality	1

<sup>7</sup> NEWS18. 2019. BEST Deploys 10 Olectra-BYD Made e-Buzz K7 Electric Buses in Mumbai. Retrieved from: <https://www.news18.com/news/auto/best-deploys-10-olectra-byd-made-ebuzz-k7-electric-buses-in-mumbai-2302321.html>



"The trip to India strengthened our interests in moving ahead with electric mobility and helped us shape the newly formulated Bagmati Pradesh Electric Mobility Strategy."

**Deepak Niraula, Member of Assembly, Bagmati Province**

"Discussions with transport officials and engineers in Kolkata, Pune and Mumbai shed light on e-bus procurement and operational good practices. This has helped strengthen our knowledge on e-bus operations."



**Purusotam Shakya, Senior Mechanical Engineer, KMC**



"Mahalaxmi Municipality wants to be a clean and green city. We came back from the trip to India with a better understanding of the costs and benefits of electrifying our transport services. We plan to invest new funds in electric buses servicing Mahalaxmi."

**Nirmala Thapa, Deputy Mayor, Mahalaxmi Municipality**

# Chapter 2. Three Electric Bus Operations in India

## Introduction

In India, the delegation interacted with the West Bengal Transport Corporation (WBTC) in Kolkata, Mahanagar Parivahan Mahamandal Limited (PMPML) in Pune, and Brihanmumbai Electricity Supply and Transport Undertaking (BEST) in Mumbai. WBTC is deploying TATA Ultra Electric buses and PMPML as well as BEST are deploying BYD-Olectra buses. WBTC has added a total of 80 electric buses in its fleet. Similarly, PMPML and BEST have plans to include a total of 500 and 40 electric buses in their fleet, respectively.

Since FAME II mandates that STUs adopt the GCC model and because manufacturers have become more willing to operate buses under a GCC set-up, both PMPML and BEST are operating on GCC models. In Kolkata, however, the buses are owned and operated by WBTC, the STU. There are options for both fast and slow charging at WBTC, whereas PMPML and BEST have adopted fast charging regimes. In both PMPML and BEST the cost of operation of electric buses is around INR 8/km, which is less than half the cost of diesel at INR 20/km. The price of the BYD-Olectra K7 buses is almost double that of the TATA Ultra Electric 9-meter buses (see Table 4).

Summaries of these operations are discussed in the following sections.

## 2.1. West Bengal Transport Corporation, Kolkata, West Bengal



Source: TATA motors<sup>8</sup>

### Background

The West Bengal Transport Corporation was established in 1920. The transport corporation operates buses and ferries across West Bengal. It is operating a fleet of 1,337 buses, which includes 80 TATA Ultra Electric buses, as of December 2019. The transport corporation has made the decision to purchase only electric and CNG buses going forward.

TATA has had to improve some of the components of the 40 Ultra Electric buses after their deployment in Kolkata. One of the major components that was modified was the capacity of the air conditioner in the buses, since they were not adequate for the high summer heat of Kolkata. Some minor operational and mechanical problems related to opening and closing of the doors were also encountered but TATA has resolved the issue.

### Technology and Infrastructure

Since TATA does not manufacture chargers for its electric vehicles, third party charging facilities - namely TELLUS chargers – have been used and installed in Kasba Depot, Kolkata. There are 20 fast chargers with a capacity of 120 kW and 60 slow chargers having capacity of 60 kW.

WBTC had included 80 electric buses of which half were 9 m buses and the other half 12 m buses. The 9-meter buses have two battery packs, each with a capacity of 66 kW, whereas for the 12-meter buses, three battery packs are used with a total capacity of 188 kW.

<sup>8</sup> TATA Motors. 2019. Tata Motors to supply 80 Electric buses to West Bengal Transport Corporation. Retrieved from: <https://www.tatamotors.com/press/tata-motors-to-supply-80-electric-buses-to-west-bengal-transport-corporation/>

## Operations

**Operation Model:** The WBTC is operating these buses under the outright purchase (CAPEX) model, under which the STU purchases all the buses and is also responsible for operating and maintaining them.

**Drive Range:** As of December 2019, the buses were being operated on a few routes with a maximum round trip distance of 38 km. Each time a bus completes the loop, which takes around 4 hours, it circles back to the depot for fast charging. The operator also stated that it runs the buses until the depth of discharge is 85% at which point it has to go back to the depot for charging. The driving range of these buses has been stated to be 150 km under standard test conditions, but the buses can only travel 80-85% of the stated driving range under real conditions. This is because the practical driving range is affected by passenger load (i.e. vehicle weight), ambient temperature, road gradient, and traffic congestion levels, among other things.

**Operating Cost:** WBTC is increasingly interested in electric buses because of the lower operational cost compared to diesel buses. The per km fuel cost of electric buses ranges from INR 8-14 per km (USD 0.11-0.19), which is lower than INR 18-23 per km (0.25-0.32) for diesel buses. This difference in cost is mainly due to the difference between costs of electricity and diesel.

**Battery Disposal:** WBTC is yet to have a clear understanding of the disposal or recycling of batteries at the end of their life. At the moment, the transport corporation assumes that TATA will take the batteries back at the end of life.

These electric buses are suitable for Kolkata's road conditions as they can operate on roads with 10-12% gradient.

**Revenue Generation:** WBTC procured these buses for INR 77 lakh (USD 107,843)<sup>9</sup> each. The revenue collected by WBTC is around INR 80 per km, compared to INR 60 per km for diesel buses. This higher revenue is due to passengers preferring to travel electric rather than diesel, according to WBTC. This preference is due to the quieter, smoother, more comfortable ride which electric buses provide. WBTC estimates that the cost of a bus will be recovered within 7-8 years.

**FAME Scheme:** All of the buses were purchased in 2018 under FAME I, which provided 60% subsidy or INR 10 million on the price of each bus, whichever is lower, in addition to 10% subsidy for charging infrastructure.

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<sup>9</sup> Exchange rate: 1 USD = INR 71.4



## 2.2. Pune Mahanagar Parivahan Mahamandal Ltd, Pune, Maharashtra



### Background

Pune Mahanagar Parivahan Mahamandal Ltd was established in 2007 to serve Pune and Pimpri-Chinchwad in the Pune Metropolitan Region in India. The transport company operates buses on 371 routes. As of 2019, PMPML has a fleet of 2,000 buses, out of which only 1,277 are in operation. These buses service approximately 900,000 passengers every day.

The PMPML introduced its fleet of 25 BYD-Olectra K7 and K9 electric buses in February 2019. As of December 2019, PMPML has a fleet of 133 electric buses, being operated in 19 routes in the city.<sup>10</sup> PMPML plans to increase its electric bus fleet to 150 of which 25 will be 9 meter buses (32 seats) and 125 will be 12 meter (33 seats) buses.<sup>11</sup> It has a longer-term plan of operating a total fleet of 500 electric buses. Due to low noise pollution, air pollution and higher efficiency of electric buses, PMPML has decided that it is only going to procure and operate electric buses, along with CNG buses in the future.

### Technology and Infrastructure

The BYD-Olectra K7 procured by PMPML has a 180 kWh battery and a drive range of 180-200 km. The BYD-Olectra K9 has a 350 kWh battery and a drive range of 300 km. PMPML currently has charging points in only two of its depots namely, Bhekrai Nagar and Nigdi.

<sup>10</sup> QuartzIndia. 2020. Can electric buses solve India's transit crisis? This city may hold the answer. Retrieved from: <https://qz.com/india/1766123/punes-e-bus-experiment-may-be-the-answer-to-india-transit-woes/>

<sup>11</sup> PMPML. 2019. Pune Mahanagar Parivahan Mahamandal Ltd. 12<sup>th</sup> Urban Mobility India Conference & Expo 2019.

## Operations

**Operation Model:** PMPML is operating these buses under a GCC model. Olectra is the contractor that is operating as well as maintaining the buses. In this model, Olectra is also responsible for hiring the driver and paying for the cost of fuel. As per the agreement between PMPML and Olectra, the operator bears a maximum of INR 2.8 lakh (USD 3,921) per month in operating costs. PMPML will then bear any operating cost that goes beyond that agreed amount.<sup>12</sup>

**Driving Range:** One of the criteria that PMPML put forth was that a bus should achieve 225 km driving range in a single charge. The bus operator guarantees battery life for 5-8 years.

**Operating Cost:** The operating cost of these buses is estimated at INR 73.4 per km, which is lower than diesel buses, which have an estimated operating costs of INR 90 per km, accordingly to PMPML. The fuel cost is approximately INR 5.6 per km for electric buses, whereas for diesel buses it is INR 20 per km and for CNG buses it is INR 18 per km.<sup>13</sup>

**FAME Scheme:** The Department of Heavy Industries of the central government of India has allotted 150 electric buses to the PMPML under FAME II. In addition to the INR 50 lakh (USD 68,054) subsidy per bus, FAME II will also provide a grant of INR 55 lakh (USD 77,030) per bus to the public bus utility to build infrastructure and boost adoption of the buses.<sup>14</sup>

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<sup>12</sup> Sakal Times. 2019. Charging e-buses costs PMPML Rs 9 L per month. Retrieved from: <https://www.sakaltimes.com/pune/charging-e-buses-costs-pmpml-rs-9l-month-34739>

<sup>13</sup> PMPML. 2019. Pune Mahanagar Parivahan Mahamandal Ltd. 12<sup>th</sup> Urban Mobility India Conference & Expo 2019.

<sup>14</sup> Hindustan Times. 2019. PMPML gets 150 electric buses under Fame-II scheme from central government.

## 2.3. Brihanmumbai Electricity Supply and Transport Undertaking Mumbai, Maharashtra



Source : UITP India, 2019<sup>15</sup>

### Background

The Brihanmumbai Electricity Supply and Transport Undertaking was established in 1873 as a tramway company. In 1926, BEST started operating buses and was taken over by the Municipal Corporation. Today, BEST has over 1,500 CNG buses on its fleet.

BEST currently owns 3,207 buses, out of which 2,879 are in operation.<sup>16</sup> The transport operator currently has 16 BYD-Olectra K7 buses and plans to add 40 more. BEST purchased 6 electric buses in 2017 and added 10 electric buses towards the end of 2019. BEST estimates that with a total of 46 electric buses, the STU will save 3.7 mil litres of diesel and avoid 12 mil ton CO<sub>2</sub> per year.<sup>17</sup> Longer-term, BEST plans to build a fleet of 500 electric buses.<sup>18</sup>

### Technology and Infrastructure

As of December 2019, BEST was operating Olectra-BYD's 9-meter eBuzz K7. The buses have a capacity of 32 seats (including driver) and have an electronically controlled air suspension which provides more comfort to passengers. These buses also utilize a regenerative braking system that helps recover part of the kinetic energy

<sup>15</sup> UITP India. 2019. BEST Mumbai inducted fleet of electric buses. Retrieved from: <https://india.uitp.org/articles/best-mumbai-launched-electric-buses>

<sup>16</sup> MumbaiMirror. 2019. With 10 new electric buses, BEST set to restart long routes. Retrieved from: <https://mumbaimirror.indiatimes.com/mumbai/other/with-10-new-electric-buses-best-set-to-restart-long-routes/articleshow/70404156.cms>

<sup>17</sup> News18. 2019. BEST Deploys 10 Olectra-BYD Made eBuzz K7 Electric Buses in Mumbai. Retrieved from: <https://www.news18.com/news/auto/best-deploys-10-olectra-byd-made-ebuzz-k7-electric-buses-in-mumbai-2302321.html>

<sup>18</sup> Cleantechnica. 2019. Indian Cities Now Plan to Buy Thousands of Electric Buses. Retrieved from: <https://mercomindia.com/mumbai-best-issues-tender-electric-buses/https://cleantechnica.com/2019/07/17/indian-cities-now-plan-to-buy-thousands-of-electric-buses/>

lost during braking. BEST has also installed AC fast charging systems that fully charge the batteries of each bus within 2-3 hours.<sup>19</sup>

## Operations

**Operation Model:** As of December 2019, BEST was operating 16 buses under the GCC model, whereby Olectra-BYD provides the drivers. Olectra-BYD also has the responsibility of operating as well as maintaining the vehicles. Through the GCC model, the operator is also responsible in setting up charging stations and training drivers to operate buses. The cost of installing related infrastructure, such as electrical connection of the power load, was borne by both the power distribution utility and BEST.<sup>20</sup>

**Driving Range:** The battery capacity of 9-meter buses is 180 kWh and the stated driving range is around 200 km. As on December 2019, the electric buses in BEST were being deployed on route 302 originating in Pratiksha Nagar in central Mumbai and ending in Mulund.<sup>21</sup>

**Operating Cost:** The manufacturer states that the buses run at a fuel cost of INR 8/km (USD 0.11/km), which is almost half of that of CNG buses and 40% of the operating cost of diesel buses.<sup>22</sup> The total operating cost of the air conditioned electric buses is around INR 55.7/km (USD 0.78/km) and about INR 51.7/km (USD 0.72/km) for non-airconditioned electric buses.<sup>23</sup>

**FAME Scheme:** The buses deployed until December 2019 were under FAME I. BEST is preparing to procure additional 340 buses under FAME II. 140 of these buses will be standard AC buses and 200 will be mid-sized AC buses.

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<sup>19</sup> News18. 2019. BEST Deploys 10 Olectra-BYD Made eBuzz K7 Electric Buses in Mumbai. Retrieved from: <https://www.news18.com/news/auto/best-deploys-10-oletra-byd-made-ebuzz-k7-electric-buses-in-mumbai-2302321.html>

<sup>20</sup> MERCOM India. 2020. Mumbai's BEST Issues Tender for 340 Electric Buses. Retrieved from:

<sup>21</sup> Business Standard. 2019. BEST deploys 10 electric buses on Mumbai roads. Retrieved from: [https://www.business-standard.com/article/pti-stories/best-deploys-10-electric-buses-on-mumbai-roads-119091000602\\_1.html](https://www.business-standard.com/article/pti-stories/best-deploys-10-electric-buses-on-mumbai-roads-119091000602_1.html)

<sup>22</sup> UITP India. 2019. BEST Mumbai inducted fleet of electric buses. Retrieved from: <https://india.uitp.org/articles/best-mumbai-launched-electric-buses>

<sup>23</sup> DNA India. 2019. Reducing carbon footprints, 10 e-buses hit Mumbai's roads. Retrieved from: <https://www.dnaindia.com/mumbai/report-reducing-carbon-footprints-10-e-buses-hit-mumbai-s-roads-2788681>

Table 4. Summary of Electric Bus Operation in 3 Cities in India (as of December 2019)

STU	Bus Operator	Operation model	Vehicle type	Number of Vehicles in Operation	Drive range	Charging regime	Operating cost (INR/km)	Cost per bus (INR) <sup>24</sup>	Cost per charger (INR)
West Bengal Transport Corporation (WBTC), Kolkata		Outright Purchase	TATA Ultra Electric	<ul style="list-style-type: none"> <li>80 units are in operation</li> </ul>	Stated drive range: 150 km Actual driving range: 120-128 km	Slow charging Fast charging	The per km fuel cost of electric buses ranges from INR 8-14 per km (USD 0.11-0.19), which is lower than INR 18-23 per km (0.25-0.32) for diesel buses	<ul style="list-style-type: none"> <li>9 meter bus – 77 Lakh (USD 107,843)</li> <li>12 meter bus – 88.0 Lakh (USD 123,249)</li> </ul>	<ul style="list-style-type: none"> <li>Slow chargers – 9.1 Lakh (USD 12,745)</li> <li>Fast chargers – 14.8 Lakh (USD 20,728)</li> </ul>
Pune Mahanagar Parivahan Mahamandal Limited (PMPML), Pune	Olectra	GCC	BYD K9 and K7	<ul style="list-style-type: none"> <li>108 K7s are in operation</li> <li>A further 125 K7s have been ordered</li> <li>A further 350 units will be tendered in 2020</li> </ul>	K7 Stated drive range: 200 km Actual drive range: 160-180 km  K9 Stated drive range: 300km	Fast charging	<b>Total operating cost per km:</b> Electric – 41 (USD 0.57) CNG – 45 (USD 0.63)  <b>Fuel cost per km:</b> Electric – 6 (USD 0.08) CNG – 18 (USD 0.25) Diesel – 20 (USD 0.28)	<ul style="list-style-type: none"> <li>9 meter bus - 1.5 crore (USD 210,084)<sup>25</sup></li> <li>12 meter bus – 2.5 crore (USD 360,000)</li> </ul>	-
Brihanmumbai Electricity Supply and Transport Undertaking (BEST) <sup>26</sup> , Mumbai	Olectra	GCC	BYD K7	<ul style="list-style-type: none"> <li>16 units are in operation</li> <li>A total of 40 units are intended in the near future</li> </ul>	Stated drive range: 200 km Actual driving range: 180-200 km	Fast Charging	<b>Total operating cost per km<sup>27</sup>:</b> AC electric - INR 55.7/km (USD 0.78/km) non AC electric - INR 51.7/km (USD 0.72/km).  <b>Fuel cost per km:</b> Electric – 8 (USD 0.11) CNG – 15 (USD 0.21) Diesel – 20 (USD 0.28)	<ul style="list-style-type: none"> <li>9 meter bus – INR 1.61 crore (USD 225,490)</li> </ul>	-

<sup>24</sup> West Bengal Transport Corporation. 2019. Inauguration of 20 Electric Buses by Hon'ble Chief Minister on 20<sup>th</sup> February, 2019. Retrieved from: <https://wbtc.co.in/wbtc-inaugurates-20-electric-buses/>

<sup>25</sup> <https://www.hindustantimes.com/pune-news/rs-62-lakh-earned-in-45-days-e-buses-in-pune-a-hit/story-BAhQ842AufZhqW1bVsFzaM.html>

<sup>26</sup> <https://www.news18.com/news/auto/best-deploys-10-olectra-byd-made-ebuzz-k7-electric-buses-in-mumbai-2302321.html>

<sup>27</sup> DNA India. 2019. Reducing carbon footprints, 10 e-buses hit Mumbai's roads. Retrieved from: <https://www.dnaindia.com/mumbai/report-reducing-carbon-footprints-10-e-buses-hit-mumbai-s-roads-2788681>



# Chapter 3. Key Considerations

## 3.1. General Findings

**Under real conditions manufacturers' stated drive range is not achievable:** The actual drive range of both the buses surveyed during the knowledge exchange were around 80-85% of that of the stated drive range. This is because real conditions, including ambient temperature, passenger load, operation of AC, and degree of congestion on the roads, affect the driving range.

**Operators confident about adding electric buses to their fleet:** All three operators, WBTC, PMPML and BEST, were content with the service provided by the electric buses. All operators are pursuing a future of blended electric and CNG for new acquisitions. This is a very positive signal. They have plans to gradually replace their diesel buses by electric and CNG.

## 3.2. Technology and Infrastructure

**AC requirement determined by local conditions:** The operators have realized that AC provides more comfort to passengers thereby increasing passenger demand. However, it also exerts a load on batteries. The need for AC is mostly governed by local climate conditions, consumer needs and preferences and the cost of the bus. Thus, operators should be cognizant of these factors before deciding whether they need to include AC in the electric buses or not.

**Viable charging regimes:** Both depot charging only and a mix of depot charging and opportunity charging options have been observed to be viable. In the case of TATA Ultra Electric buses, the battery sizes are reduced and opportunity charging regimes have been offered, which reduces bus cost. BYD-Olectra offer larger battery packs and depot only charging, due to which the cost of the bus is more expensive when compared to the TATA Ultra Electric buses. However, operational efficiencies can also be achieved through this approach.

**Similar warranty on battery life offered by TATA and BYD-Olectra:** Both TATA and BYD-Olectra offer warranty on battery life for around 5-8 years.

## 3.3. Operations

**Operators looking to shift to gross cost contract:** FAME II requires STU's to adopt the GCC model. In addition, the GCC model is seen as more successful in India, when compared to the NCC model. This is mainly because it provides operators with greater flexibility during operation and the STU takes on the revenue risk.

**FAME I, II and support from State Government critical to launching STUs:** The FAME schemes have been catalytic in upscaling deployment of electric vehicles and developing the electric mobility market in India. In addition to the FAME schemes, the federal government has mandated the state governments to offer fiscal and non-fiscal incentives. Some of the non-fiscal incentives include waiver on road tax, exemption of permit, waiver on toll tax as well as parking fees, and concessional registration charges. PMPML has received subsidies through FAME to buy 150 electric buses and implementation of infrastructure projects.

**Operators see reduced OPEX and increased air quality as benefits of electric buses:** Careful monitoring of per km costs makes operators more cognizant of immediate benefits of the electric buses in terms of the



reduced operating and maintenance costs, when compared to diesel buses, and the improvement in the air quality. These are key considerations in the ambition of STUs to scale up their electric bus fleets.

### 3.4. Considerations for Nepal

The following are proposed ideas that emerged from India's operational experience. Nepali operators as well as federal and local governments may consider these when procuring and operating electric buses.

1. If operational elements can be managed adequately, electric mobility presents an excellent deployment option for Nepal. The three STUs in India demonstrated strong operational feasibility. The vehicles have been tested on ground by numerous STUs, who are becoming more confident of the technology and adding further electric buses into their fleet in the future.
2. The business case for electric mobility in Nepal is even stronger than in India given that electricity is produced locally from renewable sources (hydro). With the introduction of electric buses, Nepal's reliance on imported fossil fuel is estimated to decrease significantly resulting in decreased trade deficit.
3. Nepal can replicate PPP business models adopted in India since both the countries have similar geographies along with operation and management modalities. Given that the Government of Nepal is actively exploring Nepal's potential to operate electric vehicles, experience from India on electric bus standards, procurement, and operation through the GCC model can be extremely useful. This knowledge base can be utilized to test vehicles in the country and expand, as necessary.
4. Fiscal measures such as the FAME scheme provide adequate incentives to both manufacturers and operators in launching electric mobility services. As seen in India, through incentives from FAME I and II, India has been able to significantly increase its electric vehicle (public and private) fleets and necessary infrastructure.



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