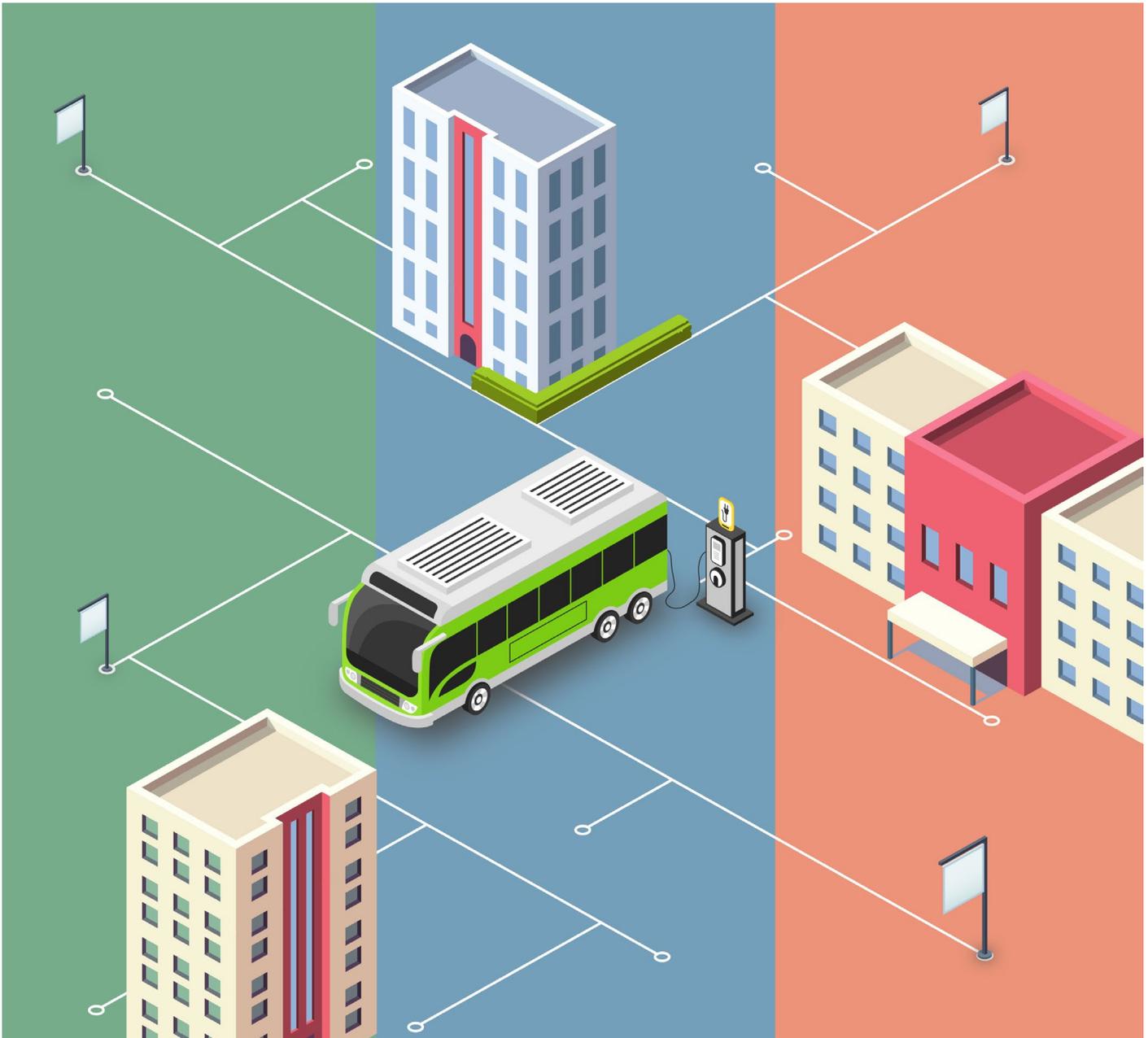


EXECUTIVE SUMMARY

Training Needs Assessment (TNA) for Electric Buses in India



VOLUME I

Identification of
Training Needs

VOLUME II

E-Bus Training
Programme
Structure

VOLUME III

Proposed
Organisational
Structure For
E-Buses



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EXECUTIVE SUMMARY

1. INTRODUCTION

India is on an ambitious journey to electrify 30% of its vehicle fleets by 2030, as proposed by NITI Aayog, with an eye to reduce GHG emissions and promote sustainable means of transport. As of April 2021, India has reported to have about 800 electric buses plying on roads (DHI), a mere contribution of 0.4% to the total PTAs fleet of 1,40,000 [CIRT State Transport Undertakings (STUs) Profile and Performance 2016-17] buses. These deployments are supported through a combination of subsidies from the Government of India under FAME-I and the respective State Governments. In the year 2019, the Government of India, under FAME-II, further sanctioned subsidies for a total of 5,595 e-Buses to 64 cities in favour of intra-city and inter-city operations. These initiatives of the Central Government coupled with the active response from states, cities, Public Transport Authorities (PTAs) and other industry stakeholders, contribute to an increasing priority and support for the adoption of e-Buses. These schemes are encouraging the country to leapfrog a transition from conventional fuels (Diesel/ CNG) to electric buses.

However, so far, e-Bus deployments have seen multiple challenges, some that originate from technology risks at the supply side while some from PTAs

i.e., the demand side. PTAs have had a positive experience in procuring e-Buses under FAME-I and FAME-II schemes but are less acquainted with the capacity at which planning, and execution can be undertaken for e-Buses. This initial experience of deployment reveals a paucity of planning and technical specification design skills (to define battery capacity for required operating ranges); planning and managing efficient operations, repair and maintenance processes, and monitoring and control. The improved adoption and integration of e-Buses will require different skill sets and skill upgradation across the e-Bus life cycle and various organisational roles at PTAs.

The identification of these required skill sets for specific functions and sub-functions across PTA roles for a smooth transition from conventional buses to e-Buses calls for a systematic assessment and evaluation of current skill sets at PTAs vis-a-vis those required for the deployment of e-Buses across all the life-cycle stages.

2.HIGHLIGHTS

The project focuses on Training Needs Assessment (TNA), related to e-Buses, in Public Transport Authorities (PTAs) and development of skill upgradation and additional mechanisms. The outcomes of this study are presented in three volumes as stated below:

Volume I identifies clear training needs in PTAs across e-Bus life cycle functions, various departments, and hierarchies.

Volume II presents detailed training modules coverage, their delivery mechanisms and national level institutional structure for sustainability and adoption.

Volume III reviews the existing organisational structure of large State Transport Undertakings (STUs) and city level Special Purpose Vehicles (SPVs). In addition, the study proposes changes in the organogram and recommends upskilling required at different staff levels for transition from Internal Combustion Engine buses to Electric buses.

3.INSIGHTS AND OUTCOMES

3.1 VOLUME I – TRAINING NEEDS ASSESSMENT FOR ELECTRIC BUSES

Volume I of the study included data collection through in-person and online survey questionnaires targeting PTAs and supply-side stakeholders respectively, to assess current skill sets at PTAs. The key highlights at different functional levels are:

	In Strategy Roadmap and Planning function, PTAs show 'fair' skill level but an absence of holistic planning and delayed actions leading to insufficient preparations for providing requisite infrastructure support to the operator, further yielding a delay in deployment and sub-optimal performance.
	In Technical Specification Design function, PTAs have 'medium' skill level leading to sub-optimal choice of battery size which results in operational challenges of not meeting the expected range and energy requirement, besides a decline in e-Bus productivity and revenue shortfalls.
	In Procurement function, PTAs have 'high' skill level due to their former experience in procuring e-Buses under FAME-I/II, however, there are challenges leading to delayed and/or cancellation of tenders multiple times; high price of acquisition of e-Buses with a lesser chance for discovery of optimal price; delayed delivery; and/or weaknesses in contract enforcement.
	In Operations function, PTAs have 'medium' skill level reflected in weak operation plans followed by poor utilization of assets, in view of keeping a large number of e-Buses on standby in order to meet unpredictable battery-range-charging requirements, consequently hampering fleet productivity. Moreover, it leads to irregular route schedules stirring customer services because of the disruption in the schedule of e-Bus charging. and/or weaknesses in contract enforcement.
	In Repair and Maintenance function, PTAs have 'low' skill level leading to delays in undertaking preventive and maintenance activities of e-Buses, delays in breakdown repairs, etc., ergo a higher downtime of e-Buses.
	In Monitoring and Control function, PTAs have 'medium' skill level in using data analytics and systematic Management Information Systems (MIS), leading to failure in the diagnostic process and inadequacy in identifying the reasons for reduced operational ranges vs. those contracted (due to the consequent ambiguity in fixing respective responsibilities of PTA, vehicle manufacturer and private operator).
	In Scrapping and Recycling function, PTAs have 'low' skills, leading to the lack of clarity on battery life expectancy and its reuse/recycling procedure, albeit this approach is required at a later stage.

Following are the extent of training needs across PTA hierarchies and roles:

- **Top Management** includes MD/ CMD/ Joint MD level of roles and their training needs range from 'medium' to 'fair' for Strategy Roadmap and Planning function. It will be useful for the individuals to undergo familiarisation training on major e-Bus management functions for making important decisions.
- **Senior Management** includes various Functional Heads (i.e., Traffic, Mechanical, Civil, Procurement, IT) and their training needs range from 'medium' to 'high' for

most functions. These Functional Heads play a vital role at PTAs as they lead e-Bus management across important functions.

- **Middle Management** includes Depot Manager, Maintenance Manager and Supervisors and their broad training needs range from 'medium' to 'fair' across all functions. These roles at PTAs play major responsibility of managing day-to-day operations and upkeep of buses and chargers so as to ensure prompt customer service.
- **Drivers and Technicians** - their broad training coverage ranges from 'fair' to 'high' 'fair' to 'high' for their routine involvement in driving, safety, repairing and in maintaining e-Buses.

3.2 VOLUME II – E-BUS TRAINING MODULES AND DELIVERY PROGRAMMES

Volume II presents a detailed structure and design of Training Modules and Delivery Mechanisms for imparting e-Bus skills upgradation to varying roles at PTAs in order to meet the needs identified in Volume I. The key objective targeted is institutionalization and practical usefulness of the programme through accurate involvement of the PTAs, industry, and the Government for longer sustenance. The training modules are intended to impart a national level e-Bus training programme to PTAs and are developed through multiple consultations with Indian and global electric mobility experts,

public transportation experts and organisational training experts. The sub-modules were detailed and enhanced based on the preferred mode of delivery, including classroom teaching and practical sessions. The report further helps understand the required infrastructure facilities for classroom sessions, practical workshops, and an institutional structure for sufficient training experience. It proposes the design and rollout of a two-year pilot training programme, aimed at developing pre-requisites for the training and engaging potential industry stakeholders for national scale-up.

3.2.1 PROPOSED E-BUS TRAINING MODULES

As per the TNA study in Volume I, a total of eight training modules have been identified, and further sub-divided into 31 sub-modules. The grouping of proposed training modules is similar to the e-Bus life cycle stages. Module 1 'Fundamentals and Safety' is designed to provide orientation to all PTA personnel,

including those not interacting with e-Buses in the initial stages of deployment. This will allow them to have a common basic understanding of e-Buses, its safety, and advantages to PTAs, and gradually transition towards an increased percentage of e-Buses fleet in the mix.

ES1 – E-BUS TRAINING MODULES AND SUB-MODULES

Proposed Training Modules	Sub-modules
M1.Fundamentals and Safety 	S1.1.Overview and Usage at PTAs
	S1.2.Safety and Fire Hazards, SOPs, Prevention and Emergency Handling
M2.Technology Planning, Selection and Specifications Design 	S2.1.Battery Technologies, Sizing and Selection
	S2.2.Charging Technologies Sizing and Selection
	S2.3.Charging, Energy and ICT Infrastructure Planning
	S2.4.Depot Infrastructure and Equipment Planning
	S2.5.Overall System Planning and Optimisation: Scenario Analysis and Trade-offs
M3.Financial Planning and Strategy 	S3.1.Life Cycle Cost Benefit Analysis and PTA Business Case
	S3.2.Investments and Financing for different Procurement Models
	S3.3.Manpower Planning and Capacity Building
	S3.4.Long term Transition Planning from ICE to electric fleet for PTA
M4.Procurement 	S4.1.Procurement: Purchase Specifications Design
	S4.2.Procurement: Models and Performance Contract Design
	S4.3.Evaluation, Testing and Inspection Best Practices for PTA
M5.Operations Planning and Implementation 	S5.1.Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers
	S5.2.Intelligent Charging and Optimisation
	S5.3.Driver Training
	S5.4.Driving Behaviours impact on e-Bus Energy Performance

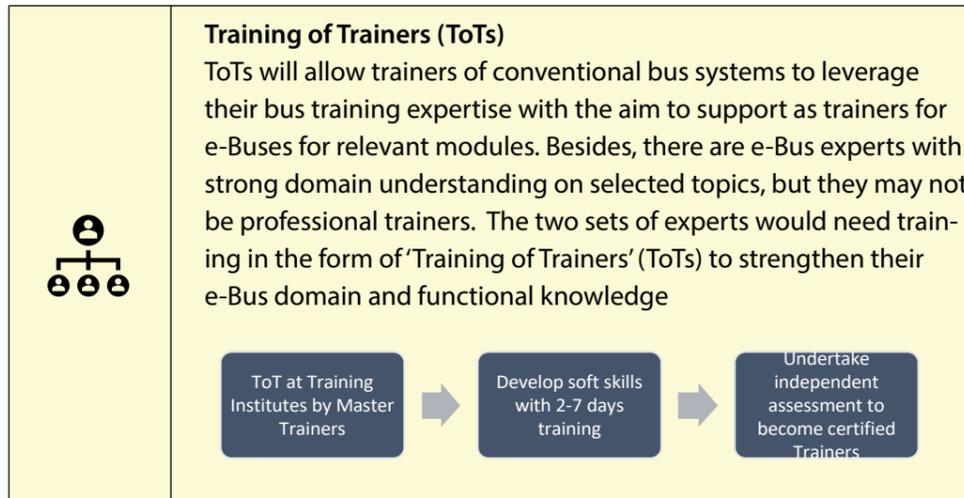
	M6. Monitoring and Control	S6.1. Performance Monitoring and Evaluation at Depot level
		S6.2. Contract Management and Monitoring Best Practices for PTA
		S6.3. ITMS/MIS Systems for overall e-Bus Fleet, Charging and PTA integration
	M7. Repair and Maintenance	S7.1. R&M: Batteries and BMS
		S7.2. R&M: Cooling Systems (Bus, Batteries, Motors)
		S7.3. R&M: Traction and other Motors, Drive, Controller and Regenerative Braking
		S7.4. R&M: Electronics and High voltage Electrical Systems
		S7.5. R&M: Off-Board Chargers and back-end High voltage Electrical Systems
		S7.6. R&M: On-Board Diagnostics and Communications
		S7.7. R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices
		S7.8. Spare Parts & Inventory Planning and Management
	M8. End-of-life, Scrapping and Recycling	S8.1. Warranty and End-of-Life Management
		S8.2. E-Bus and Lithium-ion Batteries Scrapping and Recycling

3.2.2 TRAINING PROGRAMME COMPONENTS

The tactical delivery of training programme will require design and further detailing on training aspects such as training duration, target groups, training locations, delivery channels and mechanisms for conducting Training

of Trainers (ToTs). Delivery of training content includes both theory and practical learning. Practical sessions include visits to e-Bus workshops, and organized visits to PTAs and VMs' plants.

	<p>Training Duration</p> <p>At submodule level, training is divided in two parts, based on the depth of coverage required by the targeted roles at the PTA:</p> <ul style="list-style-type: none"> • Level 1 (Concise): with 50% content of detailed Level-2 training of the sub-modules • Level 2 (Detailed): with additional focus on detailed content, execution methodology and real-life application skills over and above Level-1 coverage
	<p>Training Locations</p> <p>The programme proposes three locations for delivery of the training, namely, (1) On-site PTA location, (2) Plant Facility of e-Bus VMs, battery & charger OEMs and (3) Training Institutes.</p> <ul style="list-style-type: none"> • The on-site PTA location is well-suited for most of the trainings and can be leveraged to further develop the PTAs' in-house training eco-system. • The contracted VM/OEMs can facilitate the practical sessions at PTA workshop and supplement classroom trainings and organize visit to its e-Bus manufacturing/ assembly plant for selected personnel. • The Training Institute(s) can host different modules' training at their centre for cross PTA batches, for selected executives in PTAs and encourage experiential learning through peer exchanges. Inclusion of national and international visits to study the global best practices can also be facilitated to the selected Top Management roles.
	<p>Delivery Channels</p> <p>The training programme is designed to disseminate the content with a mix of Offline and Online delivery channels, allowing optimization of the logistic costs for both the trainers and the trainees. These delivery channels are further elaborated below.</p> <p>Top and senior management personnel are generally time pressed, and this restricts them from committing to important trainings. The online-recorded sessions with access to Trainers for live questions and answers will allow them to pursue flexible learning and improve the adoption of training with them.</p>

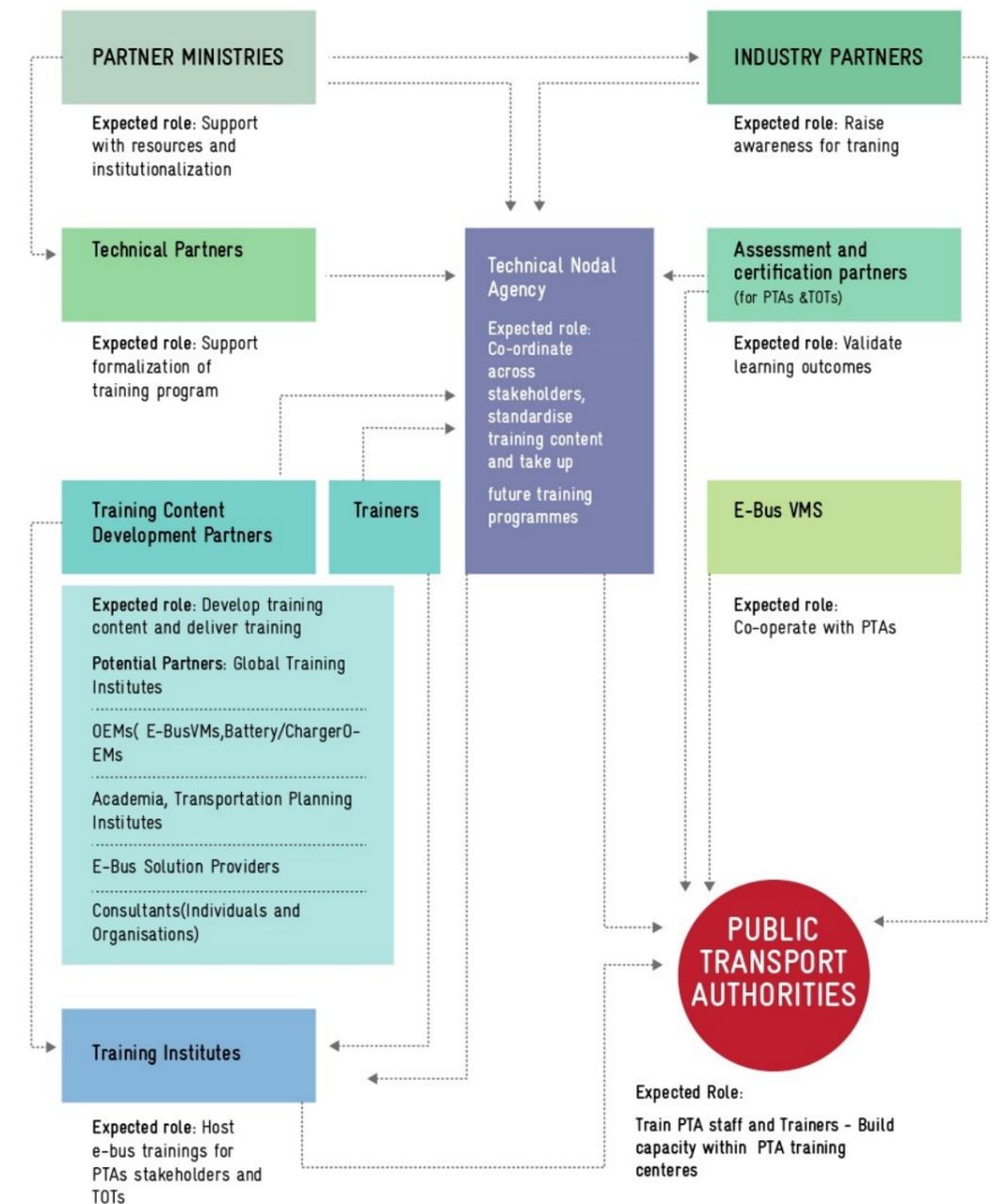


3.2.3 E-BUS NATIONAL TRAINING PROGRAMME

Development of such a holistic training programme on e-Buses for PTAs will involve multiple responsibilities such as development of training content and materials, engagement of expert trainers, development of training institutes with required e-Bus training infrastructure, institutionalisation and

organisation of required resources, coordination with PTAs and industry, quality governance of teaching and training outcomes, and overall programme management with technical inputs. These roles and responsibilities as envisaged under an e-Bus National Training Programme are shown below.

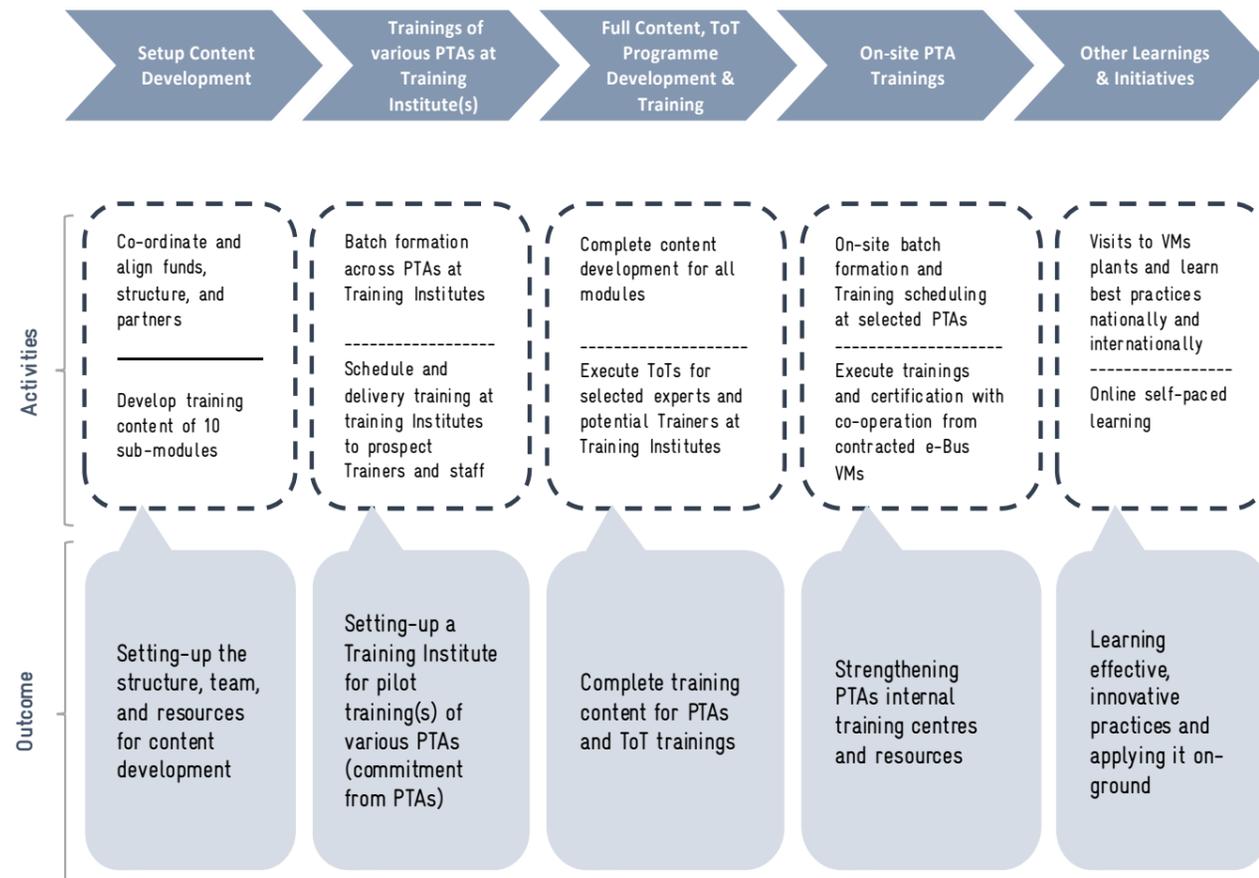
ES2 – E-BUS TRAINING PROGRAMME STAKEHOLDERS



3.2.4 THE KEY OUTPUTS OF E-BUS NATIONAL TRAINING PROGRAMME

- Establish e-Bus Training Institutes with strong infrastructure and create a self-sustained e-Bus training ecosystem by engaging potential stakeholders together. It is estimated to take 15-20 months' duration for an initial setup and systematic execution with all its envisaged components.
- Bring together various industry stakeholders for successful programme implementation that would help build applied skills in PTAs to improve e-Bus performance.
- Conduct off-site trainings at established training institutes equipped with an e-Bus workshop.
- Formalise Training of Trainers (ToTs) and their certification.
Develop more trainers within and outside PTAs to grow the industry.
- Conduct on-site e-Bus training for PTAs with certification to cater to large PTAs and build internal capacity of their team and training centres.
- The proposed training programme is expected to set the foundation for training and capacity building of PTAs and other stakeholders in e-Bus sector.

ES3 - KEY STAGES OF E-BUS NATIONAL TRAINING PROGRAMME



3.3 VOLUME III – E-BUS ORGANISATION STRUCTURE FOR PTAs

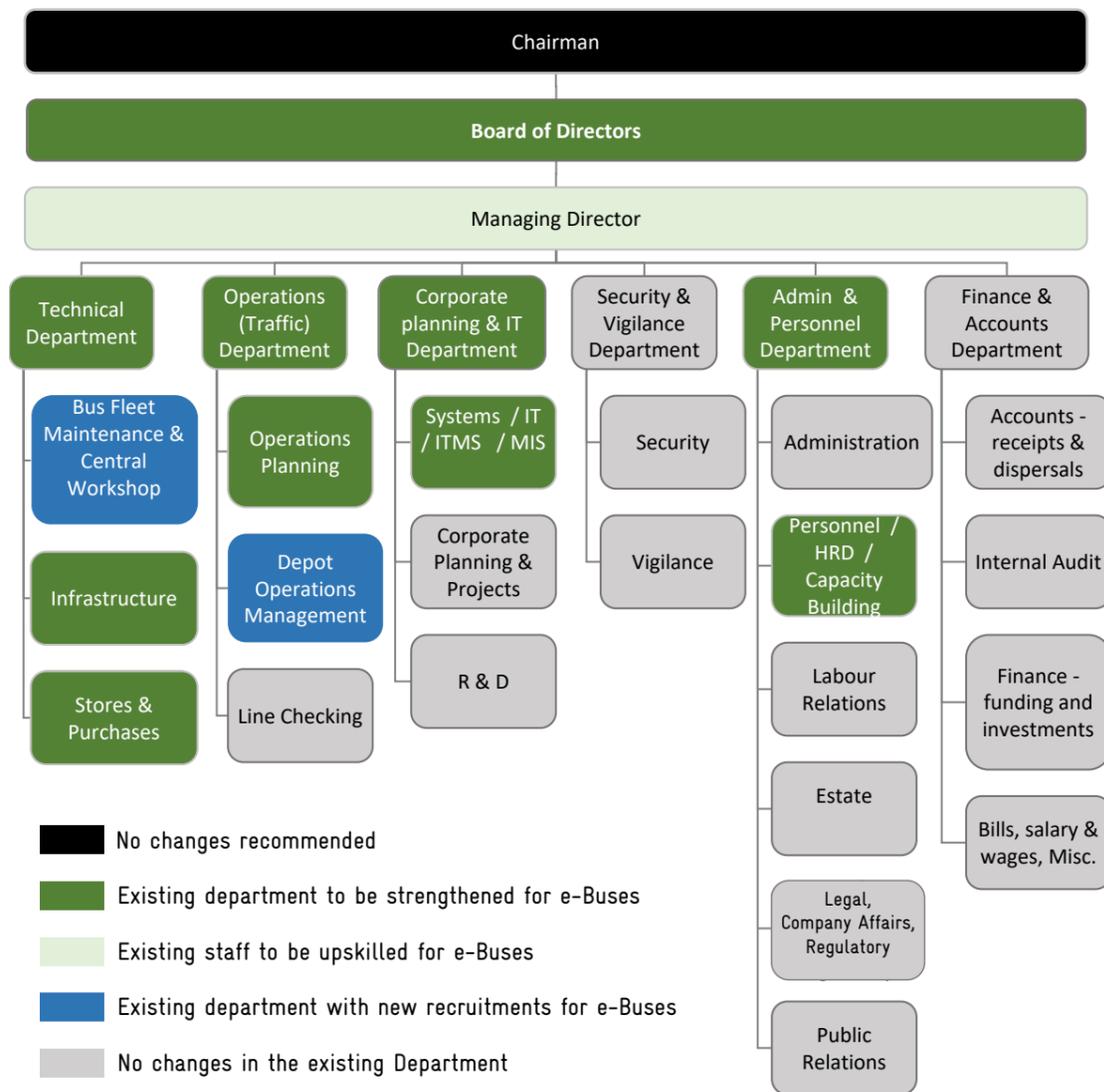
Volume III provides a ready reckoner on organisation structure, staff numbers and job descriptions for 100% transition to a fleet of e-buses for two types of PTAs, namely i) Complete in-house operations and ii) SPVs with PPP model. It further details out staff to be upskilled/ recruited and their roles and responsibilities for different units and functions at a typical PTA including,

Head Office, Central Workshops, and Depots. This will allow PTAs of different structures and sizes and at different e-bus adoption stages to draw their custom HR road map and plan appropriate upskilling and/or new recruitments. It further expands on roles at PTAs that will interact with e-buses and map them to 31 sub-modules established in Volume II.

3.3.1 ORGANISATIONAL STRUCTURE FOR PTAs WITH IN-HOUSE OPERATIONS

The proposed changes in the organisational structure of a typical large size PTA with in-house operations and own Central Workshops (example 3,000 fleet size and 100 buses in one depot) to transition to 100% e-Bus fleet is shown below. The Central Workshop and Depot

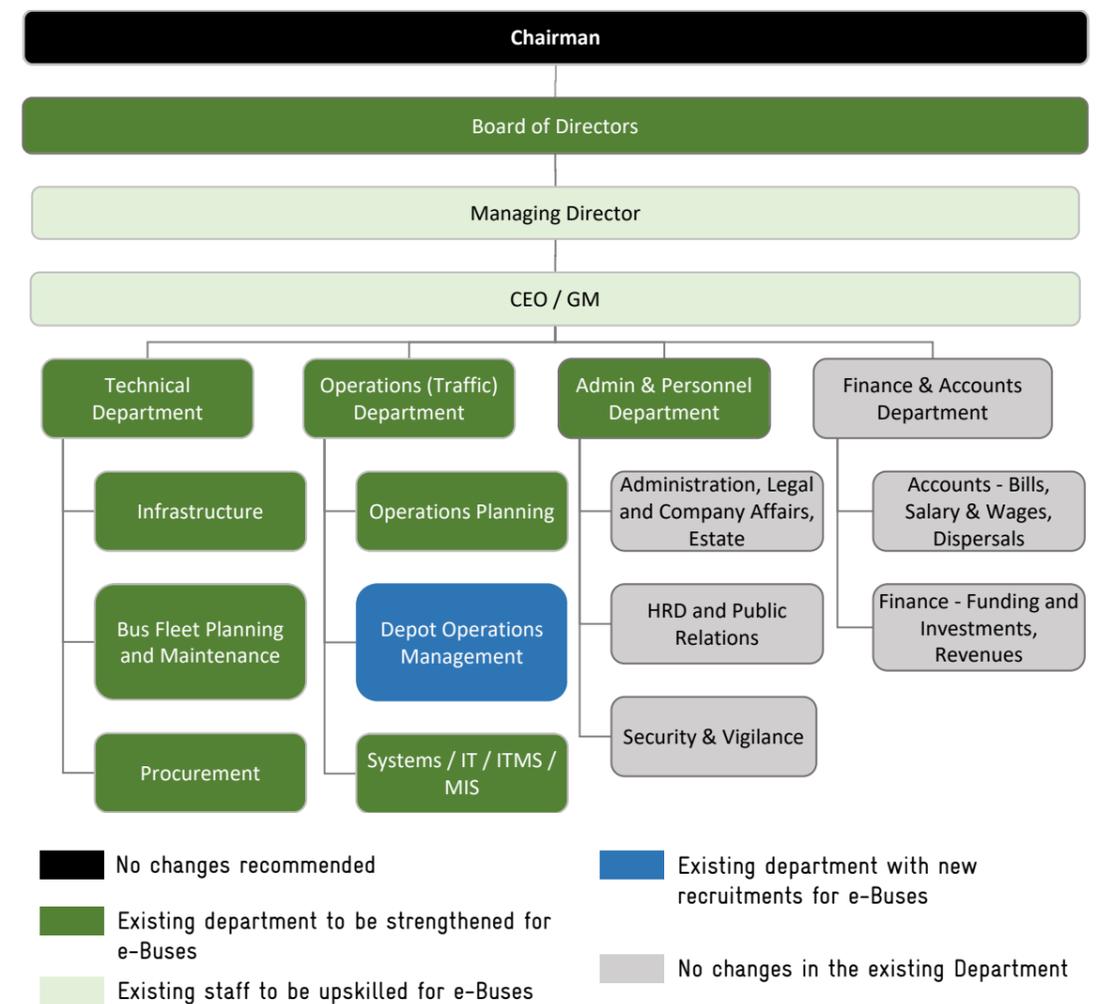
Operations will need major changes, while rest of the functions will need to be strengthened with appropriate upskilling of the staff. The detailed changes and e-Bus upskilling at different departments and role levels are included in the report.



3.3.2 ORGANISATIONAL STRUCTURE FOR SPVS WITH PPP MODEL

The changes in the organisational structure of a city bus SPV organisation with a PPP model (example 200 fleet size and 100 buses in one depot) required for transitioning to 100% e-Bus fleet is stated below. The small fleet size does not necessitate the need for a dedicated Central Workshop. The Depot Operations are also mostly outsourced to the PPP operator. The required administrative supervision and management from

the PTA will need certain modifications and additions. All functions within the purview of PTA as well as the PPP operator will need appropriate upskilling for e-Buses life cycle management across staff. The detailed changes and e-Bus upskilling at different departments and role levels are included in the report.



4. WAY FORWARD

In the past, PTAs have faced bus technology changeovers from diesel powered to CNG powered buses, up-gradation of emission norms i.e., BS I to BS VI, improving accessibility by shifting from high floor to low floor buses and adoption of ITS, digitalisation and others. Various stakeholders have formerly joined hands with PTAs for organising training and capacity building programmes to facilitate a smooth transition to cleaner and sustainable transport systems. Similar approach and coordination are necessary for the current phase of technological transition from ICE buses to battery

powered electric buses in an attempt to achieve faster transition and successful penetration of e-Bus fleet.

India has a strong opportunity to deepen its public transportation share and leverage clean e-Buses for this shift. Timely development of the capacity of PTAs to steer them towards this important transition and to simultaneously retain India's competitive advantage shall only be possible with co-ordinated and complementary working relationships between PTAs and other e-bus stakeholders.