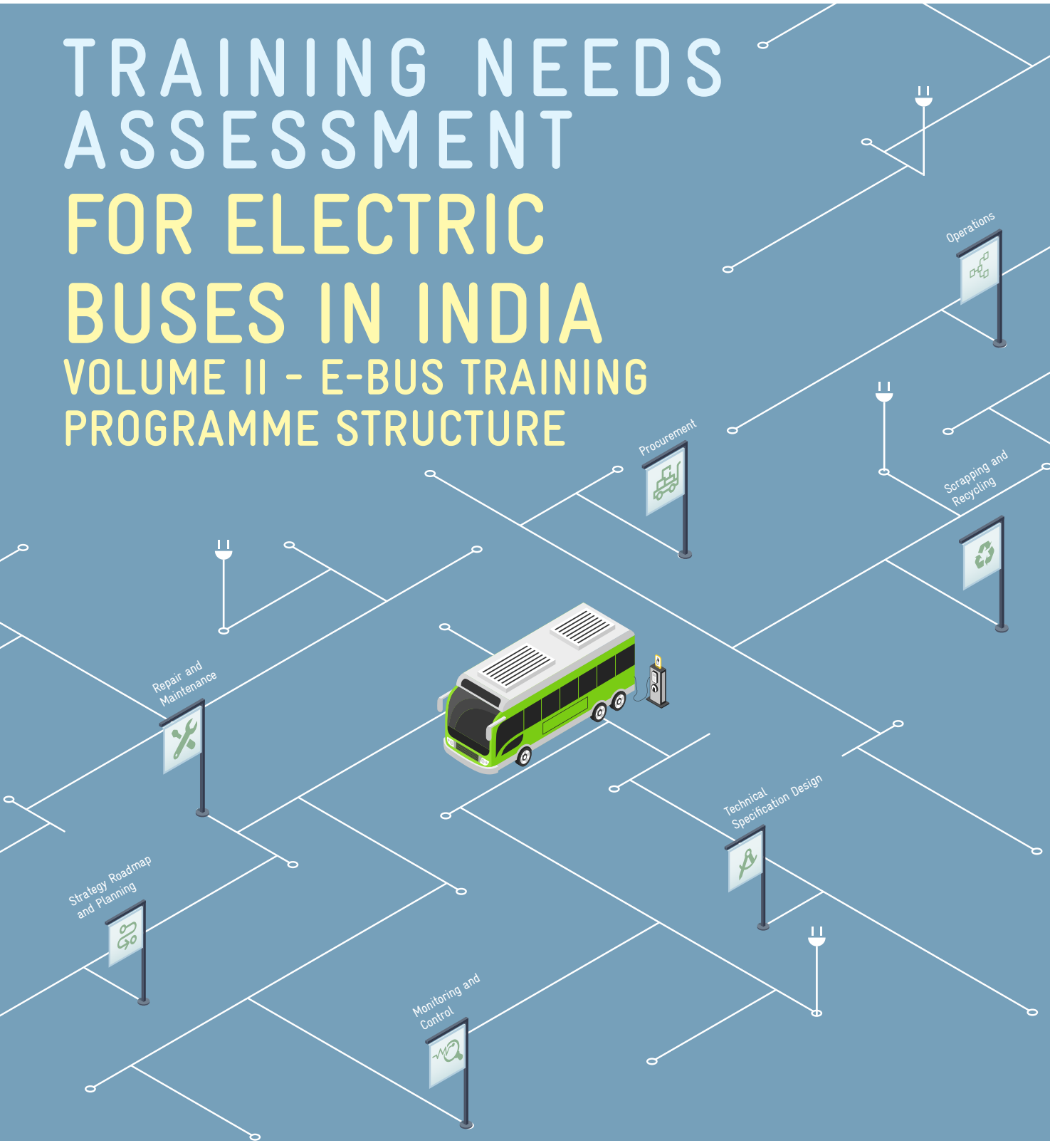
german cooperation
DEUTSCHE ZUSAMMENARBEIT

Published by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Green Urban Mobility Partnership

TRAINING NEEDS ASSESSMENT FOR ELECTRIC BUSES IN INDIA

VOLUME II - E-BUS TRAINING PROGRAMME STRUCTURE



Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Integrated Sustainable Urban Transport Systems
(SMART-SUT)
B-5/2, Safdarjung Enclave
New Delhi-110029
India

T 011-49495353
F 011-49495391
E giz-indien@giz.de

As at May 2021, New Delhi

Photo credits/ sources: GIZ and pManifold

Registered offices
Bonn and Eschborn, Germany

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

Prepared by
SMART-SUT (GIZ), pManifold Business Solutions Pvt Ltd and Vercos

Responsible
Juergen Baumann
Project Director, SMART-SUT (GIZ)

Project Advisor
Laghu Parashar (GIZ)

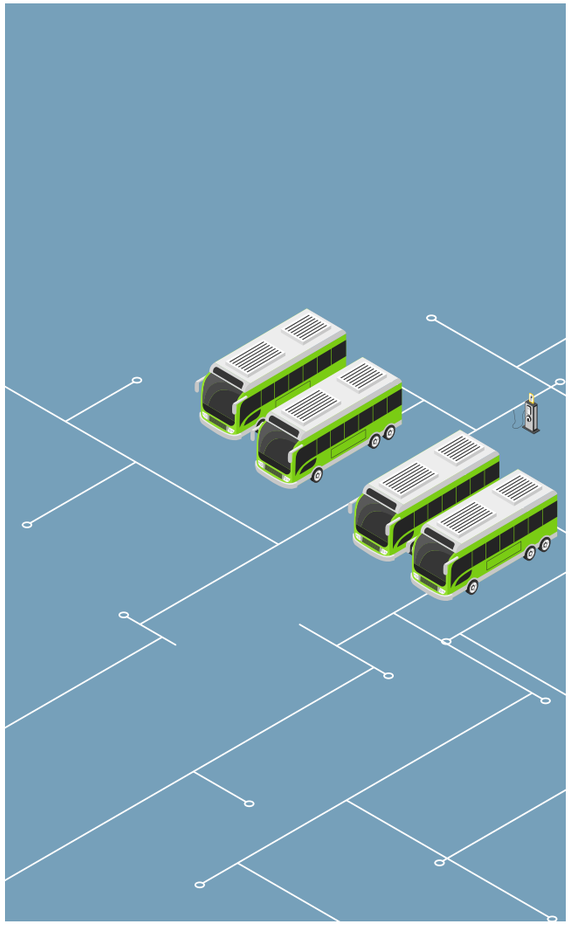
Project Coordinator
Amegh Gopinath (GIZ)

Project Team
GIZ: Sudhanshu Mishra and Shirish Mahendru
pManifold Business Solutions: Rahul Bagdia, Kunjan Bagdia, Shalini Chaudhary, Amarjit Singh Lakra, Jayant Deshmukh, Narayanan Sankar and Ajit Ganguly
Vercos: Amit Singh Baghel

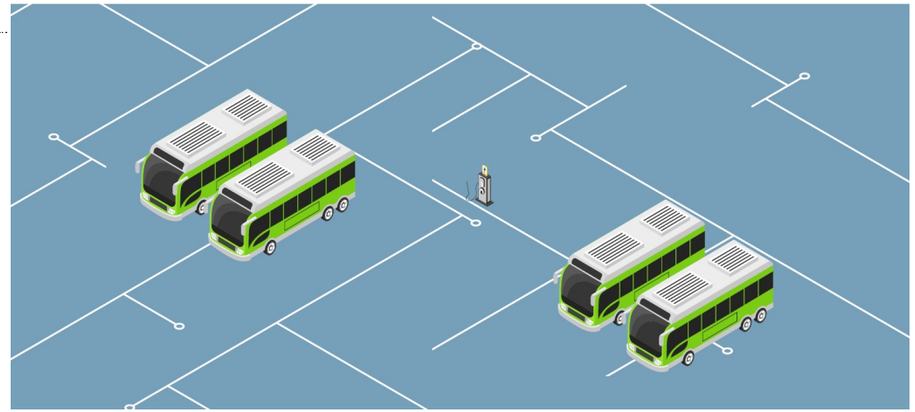
Editor
Shailendra Kaushik (Cities Forum)

Designer
Trinankur Banerjee

Photo Credits
pManifold Business Solutions and GIZ



Contact
GIZ is responsible for the content of this publication.
On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ)



ABOUT THIS REPORT

The report has been prepared as part of the bilateral technical cooperation project "Integrated Sustainable Urban Transport Systems for Smart Cities (SMART-SUT)" commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and jointly implemented by Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH and Ministry of Housing and Urban Affairs (MoHUA), Government of India. The objective of the project is to improve the planning and implementation of sustainable urban transport systems in selected Indian cities.

The study focuses on e-Bus related Training Needs Assessment (TNA) in Public Transport Authorities (PTAs) and development of skill upgradation and addition 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.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

Abbreviation	Full-Form
ASDC	Automotive Skills Development Council
ASRTU	Association of State Road Transport Undertakings
BMS	Battery Management System
CCS	Combined Charging System
CEPT	Centre for Environmental Planning and Technology
CMVR	Central Motor Vehicles Rules
DHI	Department of Heavy Industries
DTC	Delhi Transport Corporation
DoD	Depth of Discharge
FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
FDA	Fire Detection and Alarm
GHG	Greenhouse Gases
GoI	Government of India
ICCT	International Council on Clean Transportation
ICE	Internal Combustion Engine
IEC	Information Education and Communication
IIT	Indian Institute of Technology
ITMS	intelligent transit management system
KPI	Key Performance Indicators
kWh	Kilowatt-hour
LCC	Life cycle Cost
LiB	Lithium-Ion Battery
MIS	Management Information System
MM	Middle Management
MoUD	Ministry of Urban Development
MoHUA	Ministry of Housing and Urban Affairs
NITI	National Institution for Transforming India
NMT	Non-motorised Transport
OBD	On-board diagnostics
OEM	Original Equipment Manufacturer
PIS	Passenger Information System
PPP	Public Private Partnership
RFQP	Request for Qualifications and Proposals
SLAs	Service Level Agreements
SM	Senior Management
SOC	State of Charge
SOP	Standard Operating Procedure
SPA	School of Planning and Architecture
TCO	Total Cost of Ownership
TLT	Trainer-led Training
TM	Top Management
TNA	Training Need Assessment
TOT	Training of Trainers
UITP	International Association of Public Transport
VM	Vehicle Manufacturers
WF	Workforce

1 INTRODUCTION

1.1 Background

Globally, three-fourth of the energy-related emissions are due to transportation[1]. Presently, Indian cities witness an increased level of GHG emissions and poor air quality due to rapid urbanisation. Tailpipe emissions are a major source of air pollution in our cities. Public transportation is key to developing a sustainable urban transport system for cities. Given its ability to carry many commuters, an effective public transportation system powered by clean energy can reduce energy consumption, CO2 and, other GHG emissions, and noise pollution and congestion.

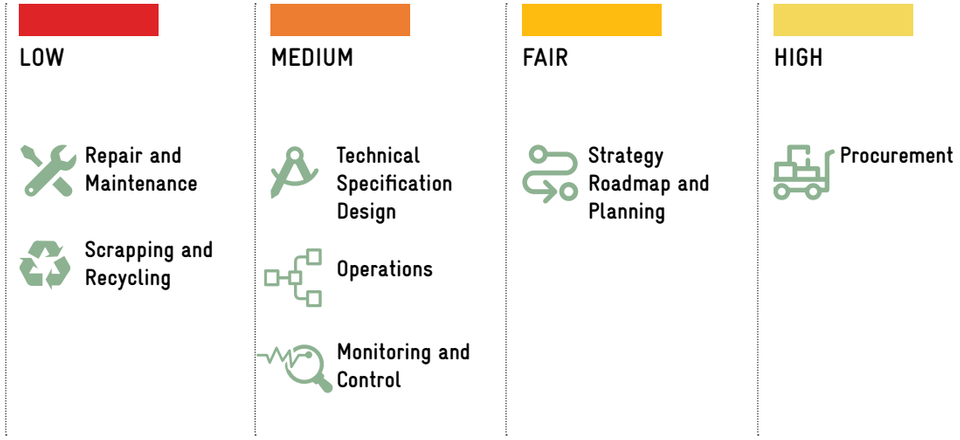
In recent years, the investment in the electric vehicles segment has increased, and policymakers and urban leaders are keen on incorporating the electrification of public transport buses to reduce the transport sector emissions. The government of India is constantly promoting e-Buses and has launched financial incentives programmes like FAME-I and FAME-II schemes to boost electric mobility.

Early e-bus deployments in India faced multiple challenges; some rooted in the technological risks on the supply side, and others because of Public Transport Authorities (PTAs) lacking the required e-bus specific skill sets. A systematic and organised training strengthens the trainees' skills and improves their productivity and performance. In public transportation, a shift from ICE buses to e-Buses is a major technology transition for PTA. It, thus, requires comprehensive training and capacity building across all life cycle stages.

To address the capacity building issues related to the e-Bus deployment, GIZ India has undertaken a detailed study on **Training Needs Assessment for Electric Buses in India** and has published the Volume 1 Report on identifying the skills gaps across various organisational functions. Figure 1 summarises the current skills levels for the seven e-bus

[1] https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf

Figure 1 Skill levels of e-Bus life cycle functions



life cycle functions that were used for assessment. This is the Second Report of the three volume series and identifies the courses that need to be organised to fill the skills gap.

There is an urgent need to plan and organise a national-level e-Bus training and capacity building programme to overcome the identified skill gaps and build capacity across PTAs systematically. A fully developed and well-executed training programme will help with the PTA personnel's skill up-gradation. It will prepare them to tackle the challenges faced for the transition from ICEs to e-Buses and make the organisation more efficient.

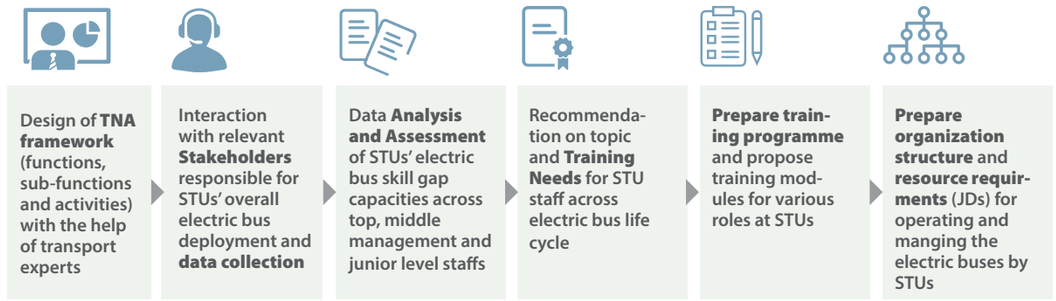
As part of this study a comprehensive capacity building programme has been prepared considering the following objectives :

i. Addressing the training needs identified for various organisation functions related to e-Bus operations
ii. Develop specific modules with content coverage of all e-bus life cycle functions
iii. Customise for varying organisation level roles at the PTAs
iv. Suitable for various e-bus contract type (outright purchase or PPP)
v. A proper institutional setup to ensure the programme can be delivered on a self-sustenance basis by involving potential public and private industry stakeholders

1.2 Proposed Delivery Approach

A structured approach is proposed for planning and delivering the national level capacity building programme. While Volume 1 of the Training Needs Assessment Report focused on the identification of the training needs for various stakeholders, this Report (Volume 2) is prepared to identify and design modules and structure based on the findings of Volume 1 Report. Figure

Figure 2. Approach and Methodology



2, below, shows the proposed approach for delivering the National e-Bus Capacity Building programme.

Identification of Training modules for e-Bus Training Programme

The first step towards building the training programme included the identification of training modules across e-Bus life cycle stages based on conducted Training Needs Assessment (TNA). A total of 8 modules, subdivided into 31 sub-modules are identified for skill up-gradation of PTA staff. Each sub-module consists of detailed objectives, coverage (theory and practical), and expected benefits for target participants. These modules and sub-modules are also mapped to PTA roles and responsibilities as per their level of training needs.

Design of e-Bus Training Programme

The second step for designing the training programme was to understand the structure as well as the roles and responsibilities of involved stakeholders, including Government/Ministry, Training Institutes, Trainers (Content Development and Delivery Partners), Certification Partner, PTAs' Industry Partners. Subsequently, the training modules are developed including course structure, duration, delivery methods, target groups, and training locations, and required infrastructure

2 E-BUS TRAINING MODULES AND DETAILS

2.1 Identification of E-Bus Training Modules

Based on a comprehensive review of skills gaps as detailed out in the Volume 1 Report, a total of eight Training Modules have been identified, and these are further sub-divided into 31 Sub-modules as shown in Table 1. These sub-modules are identified based on various roles and functions associated with e-Bus deployment and operations and current skills level within PTAs. These modules cover all aspects related to planning, procurement, operations, and maintenance functions and a specific training structure is identified for various organisation levels.

2.2 Training Level Details

The training duration is based on the course coverage at the following two levels:

Level-1 (Concise) is a shorter duration programme. It will cover the training aspects essential to familiarise the participants with important concepts, needs, planning considerations, outputs, and impact on the PTAs. Practical aspects shall not be covered under the concise module, and the training duration shall be half of the Level-2 (Detailed) programme.

Level-2 (Detailed) is a programme that focuses on the essential training aspects covered in Level-1, along with additional in-depth content on methodology, execution, and application skills. It is mapped to suit the varying training needs of the staff, including those with no prior knowledge on the topic and the ones primarily responsible for the execution of specific functions.

2.3 Application Model

PTAs are procuring the Electric buses either under outright purchase model or under PPP model. The relevant training sub-modules are prepared considering the PTA's mode of procurement (outright purchase or PPP) and the staff's varying roles and responsibilities.

Table 1. E-Bus Training Modules and Sub-modules

Module	Sub-module	
M1. **Fundamentals and Safety**	S1.1.	System 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 and Energy 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. **Bus 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. **Bus Operations Planning and Implementation**	S5.1.	Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers
	S5.2.	E-Bus Intelligent Charging and Optimisation
	S5.3.	E-Bus 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. **e-Bus 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

2.4 Training Attendees

The target participants are identified under each sub-module of the training programme based on their area of function, level of familiarisation, and training requirements. The mode of procurement mentioned against **'applicable to'** recommends course content identified for participants based on their respective electric bus function.

2.5 Module Structure

2.5.1 Module 1: Fundamentals and Safety

Fundamentals and Safety is the first introduction module, with **two sub-modules** for all stakeholders to orient them to the basic understanding of e-Buses, their systems, and sub-systems (and their technical terms), safety hazards, and emergency handling.

SUB MODULE 1.1 SYSTEM OVERVIEW AND USAGE AT PTAs

Objective	To orient the participants about common technology terms and physical system overview of e-Buses, its key differentiation over ICE buses and usage at PTAs			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	• Managing Director • CEO	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works / Maintenance Manager • Supervisor	• Driver • Technicians
Contents (Classroom)	L2 Course Duration 1 Hour	• Introduction to key terminologies of e-Bus system • Environmental benefits of e-Bus over ICE buses (GHG emission reduction, reduction in dependence on imported fuel and air quality improvement) • Overall need and usefulness of e-Bus to PTAs • Limitations of e-Buses (provision for bus services in events of electricity grid failure; energy security in view of the availability of raw materials for batteries, etc.) • Overview of e-Bus sub-systems comprising of bus, battery, charging system, and their different technology choices • Functions of different e-Bus sub-systems and their impact on bus energy and range performance • Comparison of e-Bus and ICE bus based on their system configuration, infrastructure, operation, management, and life cycle cost • E-Bus distinct best practices in life cycle management		
Contents (Practical)	L2 Course Duration 1 Hour	• E-Bus workshop visits at PTA and demo of bus systems and sub-systems (also below the pit) • Raising discussions on challenges faced with existing e-Buses (and if e-Buses not procured yet, then issues heard)		
Expected Outcomes	• The participants should be able to understand the need for e-Bus and have an overview of e-Bus operation. • The participants should be able to locate and briefly understand all sub-systems, their impact on e-Bus energy, and range performance			

SUB MODULE 1.2 SAFETY AND FIRE HAZARDS, SOPS, PREVENTION, AND EMERGENCY HANDLING

Objective	To familiarise PTAs on the safety and fire hazards across different e-Bus systems and sub-systems, their preventions and emergency handling requirements			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering)	• Depot Manager • Works / Maintenance Manager • Supervisor	• Driver • Technicians
Contents (Classroom)	L2 Course Duration 1 Hour	• Overview of key e-Bus systems and sub-systems (battery, charging infrastructure, electrical, etc.) and their related safety aspects • Battery safety and role of BMS; fire and emergency handling during the useful life of the battery (including disposal) and precautions at end-of-life. • Electrical safety protocols for operation charging systems and their related power systems • High voltage electrical systems (onboard in depots) handling, potential safety hazards, fire hazards, and mitigation measures • Driving and en-route emergency handling of fire and other preventive measures for overcrowding conditions, driver behaviour, and road conditions • Safety and precautionary measures during operations and maintenance of e-Bus and its sub-systems • Tools, equipment, accessories, etc. requirements for safe operation		
Contents (Practical)	L2 Course Duration 1 Hour	• Mock drill of various safety hazards and the procedure to overcome them • Display fuses/sockets that need to be disconnected while carrying out various jobs on the buses (welding, replacement of units, etc.)		
Expected Outcomes	• All participants should be able to understand safety measures while Planning, Setup, Operations, and Maintenance of e-Buses			

2.5.2 Module 2: Technology Planning, Selection and Specifications Design

This module has five sub-modules with a focus on e-Bus battery and charging related Technology Planning, Specification Design, and Selection. It also emphasis on the understanding of electrical infrastructure planning, depot requirement, and overall system optimisation.

SUB MODULE 2.1 BATTERY TECHNOLOGIES, SIZING, AND SELECTION

Objective	To help understand different battery technologies with its relevance to e-Buses operations, their technical sizing considerations, and techno-commercial selection matrix			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Different battery types and their performance characteristics • Different LIB chemistries comparison and impact on performance • Lithium-Ion Battery (LIB) bus level system diagram • LIB pack composition, technical parameters (capacity, weight, depth of discharge, energy efficiency, lifespan, degradation rate, safety, costs, etc.) and specifications, and impact on performance • Location of LIB packs and impact on performance • Battery Management System (BMS) features and functions specific to e-Buses and its various operating scenarios • E-Bus battery selection matrix and trade-offs for PTA		
	L2 Course Duration 2 Hours	• Typical energy breakup between different bus sub-systems and loading • E-Bus range definition and battery sizing estimation (incorporating required Range, bus performance, and charging time) • Battery performance and range variations arising from different loading, driving, traffic, and weather conditions (including battery degradation with time) • E-Bus batteries technical specification for procurement		
Expected Outcomes	• All participants should understand LIB functioning, key technical parameters, their impact on PTA's operations (range in km) • They should understand the important inter-connection of battery capacity (kWh), state of charge (SOC), Depth of Discharge (DOD) and Range (in km) and different aggregates' loading and parameters that impact range • They should be able to define the adequate size and specification of battery for e-Bus that operate one route with specific conditions. • They should be able to review OEM technical specifications around batteries and appropriate inclusion in the tender document for procurement			

SUB MODULE 2.2 CHARGING TECHNOLOGIES, SIZING AND SELECTION

Objective	To help understand different e-Buses charging technologies and configurations with relevance to PTA operations, their technical sizing, back-end civil and electrical infrastructure considerations along with techno-commercial selection matrix			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Different types of chargers (on-board vs. off-board; AC vs. DC; fixed battery vs. swap battery chargers) • Charging system diagram and composition • Charger technical parameters, specifications and their impact on charging performance • Different charging protocols (CCS, CHAdeMO, GB/T, Bharat) and their operational competencies for selection by PTAs • Different charging technologies (conductive, inductive, and battery swapping) typical use-cases, and merits and demerits • Different operating models (e.g. large capacity battery with slow overnight charging at the depot, small battery with en-route opportunity plus depot charging, swapping of a small battery size with slow charging at the depot, etc.) • e-Bus charging system selection matrix and trade-offs for PTA		
	L2 Course Duration 2 Hours	• Charging time estimation for different SOC levels of battery and charging power (kW) levels • Estimation of the number of chargers required for a given e-Bus fleet, battery size, and daily operational coverage. • Civil infrastructure required for the installation of the charging system • e-Bus Charging system technical specification, warranty, terms and conditions considerations for procurement (including chargers' auto-monitoring system)		
Expected Outcomes	• Participants should understand the brief functioning of a charging system, key technical parameters, and their impact on PTA's operations (charging time) • They should be able to define the adequate size and specification charger for e-Bus that operate one route with specific conditions. • They should understand how to calculate basic charging time from chargers' capacity (kW), battery capacity (kWh), SOC level, and Depth of Discharge (DOD), and other real parameters that influence charging time • They should be able to review OEM technical specifications around the charging system and appropriate inclusion in the tender document for procurement			

SUB MODULE 2.3 CHARGING AND ENERGY INFRASTRUCTURE PLANNING

Objective	To help understand e-Buses charging, energy requirements, necessary infrastructure, and technology relevant to different battery types for PTA operations, their technical sizing and back-end civil and electrical infrastructure considerations and techno-commercial selection matrix			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Standards and regulations related to charging and grid infrastructure • Charging power demand estimation and load distribution for typical e-Bus fleet daily charging schedules • Electrical low voltage infrastructure requirement for different charging configurations (depot charging, opportunity charging, battery swap); setup and installation • Electrical high voltage infrastructure requirement (e.g. dedicated distribution transformer) for power supply to e-Bus Charging station; setup and • Estimation of land area requirement for setting up of charging and electrical infrastructure		
	L2 Course Duration 2 Hours	• Technical and financial aspects related to electrical/ power grid infrastructure • Electricity New Service Connection and Tariff Category for e-Buses as applied to PTAs and impact of demand and energy charges • Typical costs of setting up an e-Bus charging station and associated grid infrastructure • Electrical safety, its emergency handling, and countermeasures requirements during charging operations, load shedding, or grid failure		
Expected Outcomes	• All participants should understand charging and energy infrastructure requirements, key technical parameters, their impact on PTA's operations (charging time) • They should understand how to calculate power requirements from available charging time, required operational time for various battery capacity (kWh), SOC level, and Depth of Discharge (DOD) • They should be able to understand other real parameters that influence charging and electrical infrastructure • They should be able to review suppliers' technical specifications around charging infra setup and appropriate inclusion in the tender document for procurement			

SUB MODULE 2.4 DEPOT INFRASTRUCTURE AND EQUIPMENT PLANNING

Objective	To help understand equipment planning for e-Buses including charging stations, back end civil and electrical infrastructure considerations, and best-suited depot layout design in accordance with all requirements			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• Overview of additional depot Infrastructure requirement for the transition from ICE buses to e-Buses (operational, maintenance, safety, resilience, etc. challenges and procedures) • New equipment, tools, etc. requirement at the depot for undertaking effective e-Bus operations • Additional number and land size estimation of the depot for e-Buses (for existing and advancing e-Bus procurement) • Depot location planning and selection considering routes for optimising dead mileage and battery productivity		
	L2 Course Duration 3 Hours	• Depot infrastructure layout design with respect to e-Buses charging and energy requirement for high voltage power supply to chargers • e-Bus fleet parking planning, its challenges in block formation, circulation, and charging are the requirement for simultaneous charging of buses during the night. • Electrical infrastructure planning at depots and handling of such high voltage electrical system on-board • Resilient infrastructure design and planning for e-Buses depot to handle adverse disaster events like floods etc.			
Expected Outcomes	• Participants should understand depot infrastructure and equipment planning for e-Buses and their impact on PTA's operations • They should be able to understand the procedure in the identification and selection of depots • They should be able to understand electrical and its infrastructure requirements at depots • They should be able to understand depot infrastructure design from potential adverse scenarios affecting operations			

SUB MODULE 2.5 OVERALL SYSTEM PLANNING AND OPTIMISATION: SCENARIO ANALYSIS AND TRADE-OFFS

Objective	To help understand e-Bus and its systems (batteries, chargers, depot location, routes, grid infrastructure), their interlinkages, and integrated planning for efficient operations			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• Overview of e-Bus system performance parameters and challenges faced by PTAs • Typical e-Bus system design and planning trade-offs faced by PTAs for fleet management • Impact of battery, charging systems, and grid infrastructure/ systems on e-Bus operational efficiency (including charging location, charging duration, and other Infrastructural requirements)		
	L2 Course Duration 3 Hours	• E-Bus route planning, depot/ terminal selection, and network planning and their linkages with battery and charging system • E-Buses and chargers scheduling, their KPIs, and overall fleet performance • E-Bus life cycle costs, battery life, and optimisation		
Contents (Practicals)	L1 Course Duration 1 Hour	• Hands-on excel and simulation software-based scenarios development showing different trade-offs as a result of choice of battery size and charging technology		
	L2 Course Duration 2 Hours	• Analysis of scenario trade-offs as a result of depot/ terminal selection, routes and schedules, and lifecycle costs		
Expected Outcomes	• All participants should be able to understand the importance of planning and optimisation of e-Buses and its systems • They should be able to understand parameters that influence overall system planning and optimisation (e.g. battery size, charging strategy, grid, etc.) • They should be able to understand, and use excel models/ simulation software for building different case scenarios and its impact on performance			

2.5.3 Module 3: Financial Planning and Strategy

This module has **four sub-modules** with a focus on overall e-Bus financial planning and its long-term transition from ICE to electric fleets. It includes the understanding of e-Bus Total Cost of Ownership (TCO) analysis and total investments thereof, manpower planning, and the importance of integration of other necessary tools/ systems.

SUB MODULE 3.1 LIFE CYCLE COST-BENEFIT ANALYSIS AND PTA BUSINESS CASE

Objective	To help understand life cycle cost-benefit analysis (including TCO) for e-Buses and its comparison with ICE buses, their expected benefits, and risks for PTA to make a strategic decision			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	• Managing Director • CEO	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works / Maintenance Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Overview of capital costs – e-Bus, battery, charging and civil infrastructure, electrical grid connectivity, new connection costs, etc. • Overview of operational costs – repair and maintenance, workforce, and charging costs, etc. • Life cycle cost and TCO of e-Bus (with and without government subsidy, depreciation, insurance, fuel cost, etc.) considering different combinations like battery size, battery chemistry, bus size, AC/non-AC, etc.		
	L2 Course Duration 2 Hours	• E-Bus TCO analysis and its comparison with ICE buses • E-Bus technology limitations/ risks (electricity grid failure, energy security in view of battery raw material availability, etc.) • Sensitivity analysis scenarios of important parameters (e.g. battery size and its declining cost, operating range, charging time, etc.) and its impact on the cost • Illustration of potential business case with revenue-expenditure from e-Buses vs. ICEs for PTA		
Expected Outcomes	• Participants should understand and calculate e-Bus life cycle cost and TCO (including its various elements) and its comparison with ICEs • They should be able to understand the benefits and risks of e-Buses vs. ICEs • They should be able to understand critical parameters and its sensitivity that influence the cost of e-Buses • They should be able to understand a top-level business case with expected revenue-expenditure from e-Buses vs. ICEs			

SUB MODULE 3.2 INVESTMENTS AND FINANCING FOR DIFFERENT PROCUREMENT MODELS

Objective	To help understand total investment for e-Buses, chargers and their infrastructure, their financing options, and techno-commercial evaluation for different procurement models			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	• Managing Director • CEO	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Depot Manager • Works / Maintenance Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Different e-Bus business (or procurement) model and contract types (GCC, NCC, Outright purchase, etc.), their contractual parameters and SLAs • Contract types pros and cons, their right selection with other contractual details • Other PTAs innovative experience/ best practices on financing options		
	L2 Course Duration 2 Hours	• e-Bus techno-commercial analysis of different business (or procurement) models/ contract types • Funding sources, its availability, and risks for e-Buses over ICEs		
Expected Outcomes	• All participants should understand different e-Bus business models and contract types • They should be able to understand the quantum of funds needed and identify the potential sources thereof			

SUB MODULE 3.3 MANPOWER PLANNING AND CAPACITY BUILDING

Objective	To help understand existing and additional workforce skills planning, their capacity building requirement and up-gradation for e-Buses			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	• Managing Director • CEO	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works / Maintenance Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Skill-wise and grade-wise workforce requirement for e-Buses across departments and roles (depending on types of business models and roles amongst different partners) • Skill up-gradation planning and strategy for utilising existing workforce • New skills and roles addition strategy (like charging operations, e-Bus repair and maintenance, safety, and emergency management, etc.)		
	L2 Course Duration 2 Hours	• Clear roles and responsibilities allocation between different e-Bus execution teams (e.g. PTA, e-Bus VM, Private Operator, Charger OEM, Discom, etc.) • Clear roles and responsibility allocation across PTA departments for various hierarchies (top, senior, middle and junior management, and Workforce)		
Expected Outcomes	• All participants should understand the skill and grade wise workforce requirement for e-Buses • They should be able to understand training requirements for existing and new roles • They should be able to understand and define roles and responsibilities allocation between partners			

SUB MODULE 3.4 LONG TERM TRANSITION PLANNING FROM ICE TO ELECTRIC FLEET FOR PTA

Objective	To help understand long term strategy and planning for the transition from ICE to electric fleet for PTA, their decision matrix and e-Bus roadmap over the years, and potential funding sources			
Applicable to	Outright Purchase and PPP			
Target Participants	**Top Management**	**Senior Management**	**Middle Management**	**Workforce**
	• Managing Director • CEO	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works / Maintenance Manager •	**N.A.**
Contents (Classroom)	**L1 Course** **Duration** **1 Hour**	• Overview of feasibility analysis (capital costs, operational costs, and life cycle costs) of e-Buses and its comparison with ICEs • Global best practices adopted by Transport Authorities on e-Bus transition and growth over the years • E-Bus sustainability analysis to facilitate planning for growth • Overall strategy recommendations to replace ICE buses and support growth and funding of e-Buses		
	L2 Course **Duration** **2 Hours**	• Identification of potential sources of funds to bridge current e-Bus revenue – expenditure gaps and scarcity of funds • Investment and funding challenges, risks, and mitigations measures • Comprehensive growth plan with a year-wise number of e-Bus and funding options • Investment decision matrix and road map for year-wise e-Bus fleet size		
Expected Outcomes	• All participants should understand and be able to plan and strategise the replacement of ICE buses with e-Buses • They should be able to understand Global best practices adopted by Transport Authorities on their e-Bus growth • They should be able to understand funding options, its risks, and potential sources of funds • They should be able to understand the decision matrix and devise a roadmap for year-wise e-Bus inclusion in their fleet size			

2.5.4 Module 4: Procurement

This module has three sub-modules with a focus on e-Bus purchase specification design, its key performance indicators/ SLAs, and e-Bus testing and inspection best practices for PTAs.

SUB MODULE 4.1 PURCHASE SPECIFICATIONS DESIGN

Objective	To help understand various technical aspects of e-Buses like power requirements, range definition, battery and charging specifications, ITMS specifications with relevance to PTA operations, and their infrastructure requirements within depots and terminals for procurement			
Applicable to	Outright Purchase and PPP			
Target Participants	**Top Management**	**Senior Management**	**Middle Management**	**Workforce**
	N.A.	• Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	• Works / Maintenance Manager	**N.A.**
Contents (Classroom)	**L1 Course** **Duration** **1 Hour** **30 minutes**	• E-Bus business model decision (GCC vs. Capex model; asset ownership; O&M roles and responsibilities; with or without electricity, etc.) • E-Bus power output and vehicle weight ratio for bus acceleration, its factors, and impact on performance • Range definition i.e. daily bus productivity (km per day) for e-Buses vs ICEs; its correlation with other components like battery, charging system, etc. • Battery size estimation and its other specification (like depth of discharge, degradation rate, etc.), battery replacement procedure, etc. • Charging power estimation and its other specification for daily e-Buses charging • Electrical high voltage and other charging infrastructure requirements		
	L2 Course **Duration** **3 Hours**	• Spares and materials specifications specific to e-Buses and its aggregates • End-use specifications of ITMS systems for effective performance monitoring • Depot/Terminal civil infra and engineering requirements • Resilient infrastructure design and planning for e-Buses Depot to handle adverse disaster events like floods, etc. • Quality assurance system for e-Bus procurement • Supply-side analysis for availability, lead time, quality, warranties.		
Expected Outcomes	• All participants should understand the detailing of purchase specifications of e-Bus and its systems with respect to their operating conditions • They should be able to understand overall power requirements and range estimation for e-Buses • They should be able to understand battery size accounting for battery specifications and replacement needs • They should be able to understand the total number of chargers required for e-Buses, their market availability, and manufacturers readiness			

SUB MODULE 4.2 MODELS AND PERFORMANCE CONTRACT DESIGN

Objective	To help understand e-Bus and its aggregates performance parameterisation for different contracting models and their RFQP documentation for procurement purpose			
Applicable to	Outright Purchase and PPP			
Target Participants	**Top Management**	**Senior Management**	**Middle Management**	**Workforce**
	N.A.	• Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement)	**N.A.**	**N.A.**
Contents (Classroom)	**L1 Course** **Duration** **1 Hour** **30 minutes**	• E-Bus and its aggregates performance parameters definition (including warranty, after-sales support, fleet availability, energy consumption, etc.) and benchmarking and their evaluation/ testing processes • E-Bus contract design, new standard for service reliability, SLAs definition and benchmarking (including penalties and rewards) • Various other contract clauses across different scenarios, their non-performance, and measures to be taken • Clear duties and responsibilities allocation of all e-Bus execution partners		
	L2 Course **Duration** **3 Hours**	• Minimum service standards for operation and maintenance, spare parts, consumable parts, workforce performances, etc. depending on contract model (PPP/ Outright purchase) • Training and capacity building criteria for the PTA staff (from OEMs) for long-term sustenance of e-Bus technology • RFQP documents preparation with relevant Technical requirements (including e-Bus specifications, depot location, route details, etc.)		
Expected Outcomes	• All participants should understand detailed performance parameterisation depending on the contract model (PPP/ Outright purchase) and its associated terms and conditions • They should be able to understand detailed RFQP documentation with technical requirements • They should be able to understand the process of monitoring and enforcing operations related to SLAs for improved performance			

SUB MODULE 4.3 EVALUATION, TESTING AND INSPECTION BEST PRACTICES FOR PTA

Objective	To help understand the testing and inspection of best practices of the prototype e-Bus for the specification compliance as indicated in the tender			
Applicable to	Outright Purchase and PPP			
Target Participants	**Top Management**	**Senior Management**	**Middle Management**	**Workforce**
	N.A.	• Head (Mechanical Engineering)	• Works / Maintenance Manager • Supervisor	**N.A.**
Contents (Classroom)	**L1 Course** **Duration** **1 Hour**	• E-Bus all dimensions testing and its compliance with AIS-052 (e.g. floor height, first step height, seat pitch, gangway width, saloon height, emergency door dimensions, etc.) • E-Bus components and systems check (e.g. battery energy, motor power, brake, steering system, panic button, signboards, tyre condition, etc.) as per specifications mentioned in the tender • Batteries location to prevent its damage during bus operation on various road conditions • E-Bus inspection stages and quality assurance mechanism for overall performance improvement		
	L2 Course **Duration** **2 Hours**	• Proper clamping of all the wiring harness, pipes and its fouling, oil and coolant leakages check • Electrical fitments, various gauges/meters on the dashboard and their working and evaluation • Air conditioning system working, it's even cooling at the front and rear side of the bus • ITS equipment checks (e.g. signboards, cameras, two-way communication system, bus driver console, etc.) • Safety features provision in e-Bus (FDA system, fire extinguishers, etc.) • E-Bus inspection using the documents such as homologation certification/ type approval certificate, test certificates of various bus body components, etc.		
Contents (Practicals)	**L1 Course** **Duration: 1 Hour**	• E-Bus road field trials to check the functioning of all components, their procedure to operate and manage during driving		
	L2 Course **Duration: 2 Hours**	• E-Bus drive testing to check the drumming noise (or other types of noise) and inspection of mileage in city driving condition		
Expected Outcomes	• All participants should understand the testing and inspection process of e-Bus and its aggregates individually and in an integrated manner • They should be able to understand the working of all the e-Bus components, their design features, and safety systems • They should be able to understand whether the prototype bus is manufactured as per the tender specifications • They should be able to understand the road-testing condition of the bus, their evaluation/ testing processes • They should be able to understand the effective monitoring and inspection mechanism of services offered by e-Bus vehicle Manufacturers and ensuring strong quality			

2.5.5 Module 5: Operations Planning and Implementation

This module has four sub-modules with a focus on e-Bus operations planning & scheduling, charging and optimization, drivers training and impact of driving behaviour on energy consumption.

SUB MODULE 5.1 ROUTE SELECTION, OPERATIONS PLANNING & SCHEDULING OF E-BUS FLEET AND CHARGERS

Objective	To help understand the e-Bus route network and its selection, their operations planning and scheduling with respect to charger type, its installation at depot and terminals for optimal usage and operations.			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (ITS/MIS)	• Depot Manager	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• Identification of e-Bus routes and depots to minimise dead km • Route survey analysis (considering parameters like energy consumption estimation, range variation, acceleration, speed, spatial map, congestion, idling, AC requirements, etc.) and its network optimisation for various routes to firm up duty cycles for e-Buses • Route network planning through optimisation model scenarios considering e-Bus range, route characteristics, and charging systems (number and type of chargers, opportunity charging locations, charging schedules, estimating float buses, etc.)		
	L2 Course Duration 3 Hours	• E-Bus schedules design for different routes (over the day, week, month, and year) to meet bus operations SLAs • Charging and crew schedules design with its operational schedule, its execution, and handling deviations for smooth operations • E-Buses schedules integration with the legacy system for strong services adherence to end-users		
Contents (Practicals)	L1 Course Duration 1 Hour	• Charging station visit to understand operational functioning of chargers (i.e. its connection, disconnection with e-Bus), its charging schedule, maintenance requirement, and electrical/ safety precautions		
	L2 Course Duration 2 Hours	• Visit PTAs to understand the bus scheduling process		
Expected Outcomes	• All participants should understand the systematic planning procedure for route identification and selection, their impact on energy performance and other bus components • They should be able to analyse routes and schedules to minimise range variation and meet operation SLAs • They should be able to understand the integration of e-Bus schedules with legacy system for improved services • They should be able to understand other real parameters that affect overall operations			

SUB MODULE 5.2 INTELLIGENT CHARGING AND OPTIMISATION

Objective	To help understand the importance of intelligent charging and optimisation, its various methods, and effective integration with other sub-systems			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (ITS/MIS)	• Depot Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Overview of intelligent charging, its importance, and benefits • Effect of different charging conditions on the overall efficiency of the e-Bus operations • Various methods to manage collected data and ways to integrate with other sub-system and optimise charging		
	L2 Course Duration 2 Hours	• Important data points related to charging (e.g. duration, power consumption, etc.), its collection, and their analyses to further optimise e-Bus operations • Charging strategy (including number and type of chargers, charging locations, and charging duration) for route network optimisation • Charging schedules design, its execution, and handling deviations through optimisation model scenarios for smooth operations • E-Bus fleet charging monitoring for smooth charging operations		
Contents (Practicals)	L1 Course Duration 1 Hour	• Depot visit to develop the understanding of charging process, schedule important data points and its correlation for optimisation		
	L2 Course Duration 2 Hours	• Depot virtual visit to learn the application of an intelligent charging system		
Expected Outcomes	• All participants should understand the importance of intelligent charging and optimisation • They should be able to take decisions on charging schedules using important data points and optimise the charging process			

SUB MODULE 5.3 DRIVER TRAINING

Objective	To help understand broader e-Bus functioning and their different dashboard gauges, its driving, safety, and mitigation measures over ICE bus			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	N.A.	N.A.	• Driver
Contents (Classroom)	L2 Course Duration 2 Hours	• Overall e-Bus and the charging system broader composition and functioning • E-Bus handling, driving and charging and effect service reliability key distinction over ICE buses • Roadworthiness inspection checklist and other compliance to technical requirements and regulations (like CMVR, etc.) • Different dashboard gauges and passenger load monitoring to meet SLAs with optimum energy consumption • Electrical safety and fire hazards, its emergency handling and mitigation measures requirements • Operational hazards, safety, and precautionary measures, emergency handling procedures during driving • Use of regenerative mechanism and re-energising the battery while driving • Diagnostics procedure and communication in the event of a breakdown during the road journey		
Contents (Practicals)	L2 Course Duration 5 Hours	• E-Bus driving in local city driving conditions across different types of routes to meet bus and charging schedules • Discussions with drivers on their driving experience and challenges faced and proposed measures for improved driving • Discussions with drivers to understand the use of all the control systems on the dashboard		
Expected Outcomes	• All participants should understand e-Bus functioning, its components, and different gauges in the bus • They should be able to understand the importance of driving e-Bus and its impact on bus performance • They should be able to understand the possible driving hazards, emergency handling and measures to be taken			

SUB MODULE 5.4 DRIVING BEHAVIOURS IMPACT ON E-BUS ENERGY PERFORMANCE

Objective	To help understand driving habits and behavioural impact on e-Bus energy performance and range for effective execution of bus and charging schedules			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic	• Depot Manager • Works/ Maintenance Manager • Supervisor	• Driver
Contents (Classroom)	L1 Course Duration 1 Hour	• E-Bus technical parameters, their specifications, and driving impact on bus performance • Driving impact on battery energy consumption and range variations • Operational hazards, safety, and precautionary measures, emergency handling procedures during driving		
	L2 Course Duration 2 Hours	• Different dashboard gauges and passenger load monitoring to meet SLAs with optimum energy consumption • Importance of driving parameters like acceleration, braking, doors on/ off, AC on/off, etc. and its impact on energy performance		
Contents (Practicals)	L1 Course Duration 1 Hour	• E-Bus driving in local city driving conditions across different types of routes and its impact on energy performance, range, others		
	L2 Course Duration 2 Hours	• E-Bus driving demo with scenarios that leads to positive regeneration		
Expected Outcomes	• All participants should understand the e-Bus driving habits, its difference over ICE buses, and impact on performance • They should be able to understand the new parameters involved in driving e-Bus, including practical experience of driving			

2.5.6 Module 6: Monitoring and Control

This module has three sub-modules with a focus on overall e-Bus fleet and charging systems performance monitoring, their regular monitoring of important data sets, and integration through ITMS/ MIS at all levels (i.e. Corporate and Depot level).

SUB MODULE 6.1 PERFORMANCE MONITORING AND EVALUATION AT DEPOT LEVEL

Objective	To help understand performance monitoring of e-Buses and its systems/ sub-systems, their important data points, its analysis and evaluation at depot level for handling deviations and efficient operations			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Mechanical Engineering) • Head (ITS/MIS)	• Depot Manager • Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• e-Bus monitoring and its importance – risks and associated costs with an increased number of e-Buses, and with scaled-up operations • Function of ITMS/ MIS system and integration with other systems • e-Bus scheduling trade-offs depending on battery capacity, number of recharging events, etc.		
	L2 Course Duration 3 Hours	• Collection and storage of data points for different contract parameters (e.g. battery performance, charger utilisation, repair and maintenance, spare parts inventory, vehicle location, alert management, etc.) • e-Bus performance monitoring and building cause-effect relationships to improve further operations from existing • e-Bus fleet performance monitoring for smooth operations and handling any changes and resolution for best asset performance and management		
Contents (Practicals)	L1 Course Duration 1 Hour	• Visit the Control Centre to help understand the process involved in system management		
	L2 Course Duration: 2 Hours	• Visit the Control Centre to help understand the technicalities in overall fleet management		
Expected Outcomes	• All participants should understand the importance of e-Bus monitoring, its functionalities, and integration with other systems • They should be able to understand the important data points and their analysis, reporting formats for driving continuous improvements			

SUB MODULE 6.2 CONTRACT MANAGEMENT AND MONITORING BEST PRACTICES FOR PTA

Objective	To help understand the methodology of contract management of the overall bus operations, their effective monitoring using data analysis and MIS reports for continuous services improvement			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Civil Engineering/ Electrical) • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• PTA organisation structure recommendation for the monitoring of e-Bus operations • Devise duties and responsibilities of PTA officials in the monitoring process and adequate workforce availability checks for operation and maintenance of the buses • SLAs and other key compliance monitoring as specified in the tender/bus operator's agreement • Periodic review meetings within PTA staff and also jointly with e-Bus VMs to improve the e-Bus operational efficiency		
	L2 Course Duration 3 Hours	• Collection and storage of data points for different contract parameters (e.g. battery performance, charger utilisation, repair and maintenance, spare parts inventory, vehicle location, alert management, etc.) • Devise daily, weekly, monthly, and yearly MIS reports for effective monitoring of e-Bus operations • Monitoring the cases of en-route violations and necessary corrective actions, levy the penalties for any deviations as per contract • Warranty related issues on any component with e-Bus VMs for settlement of claims to ensure compliance of contract agreement		
Expected Outcomes	• All participants should understand the overall organisation structure and their duties to ensure effective supervision and monitoring • They should be able to understand the data requirement for different contract parameters • They should be able to prepare and analyse MIS reports for effective and strong monitoring and take corrective actions			

SUB MODULE 6.3 ITMS/MIS FOR OVERALL E-BUS FLEET, CHARGING AND PTA INTEGRATION

Objective	To help understand ITMS/MIS Systems for overall e-Bus Fleet, Charging and integration with PTA			
Applicable to	Outright Purchase and PPP			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head Traffic • Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Depot Manager • Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Overview of ITMS/ MIS system, its benefits, and importance in e-Bus management • Function of ITMS/ MIS system to mitigate e-Buses technical constraints for operations and its integration with other systems for overall PTA performance monitoring		
	L2 Course Duration 2 Hours	• Collection and storage of data points for different contract parameters (e.g. battery performance, charger utilisation, repair and maintenance, spare parts inventory, vehicle location, alert management, etc.) • Analysis and production of MIS reports for different bus teams (e.g. route-wise performance report; driver complaints and breakdown report (loss of KMs and loss of trips due to breakdown), etc.) • Non-conformance audits and any issues with e-Buses performance and drive further improvements		
Expected Outcomes	• All participants should understand the use and benefits of ITMS/ MIS across e-Bus stages to mitigate complexities in planning, operation, and scheduling. • They should be able to understand the important data points and their analysis, reporting formats for driving continuous improvements			

2.5.7 Module 7: Repair and Maintenance

This module has eight sub-modules with a focus on different e-Bus systems and sub-systems, their repair and maintenance requirements, and best practices (including spare parts management), and their replacement mechanisms.

SUB MODULE 7.1 R&M: BATTERIES AND BMS

Objective	To help understand the design composition and functioning of battery (and BMS) systems, repair and maintenance processes, and their safe handling procedures during emergency			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Mechanical Engineering)	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• Battery system design composition, its functioning and technical specifications • Battery location, its bus level system diagram, and interconnection with other systems and sub-systems • Battery Management System (BMS) features and functions specific to e-Buses operating scenarios • Battery performance and range variations arising from different loading, driving, traffic, and weather conditions (including battery degradation with time) • Safe handling of emergencies and hazardous events related to battery and other electronic components		
	L2 Course Duration 2 Hours	• Battery periodic calibration and service frequency checklist • Battery repair and maintenance, arising challenges like batteries shut-off, malfunction, etc. • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on Batteries and BMS • Conditions and procedure for BMS up-gradation and replacement of Battery • Safety precautions and emergency handling during repair and maintenance of batteries and connectors		
Contents (Practicals)	L1 Course Duration: 2 Hours	• Safe handling of emergencies and hazardous events related to battery/ BMS		
	L2 Course Duration 4 Hours	• Battery and BMS fault diagnosis, their understanding of error codes and necessary corrective actions • Discussions with Workforce staff to understand actual problems faced and their mitigation measures adopted, maintenance frequency, best practices, etc. in handling batteries		
Expected Outcomes	• All participants should be able to understand the design composition of batteries and BMS • They should be able to understand a systematic approach for the repair and maintenance of batteries and BMS • They should be able to diagnose and take appropriate measures for repair and maintenance activities of batteries and BMS			

SUB MODULE 7.2 R&M: COOLING SYSTEMS (BUS, BATTERIES, MOTORS)

Objective	To help understand the design composition and functioning of cooling systems, their types and its impact on bus operation, their service frequency checklist, fault diagnosis, and resolution processes			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	N.A.	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• e-Bus cooling systems design composition, its functioning and technical specifications • System-level diagram of cooling systems of e-Bus, Batteries, and Motors • Different cooling systems and their interconnection with other systems and sub-systems • Cooling systems repair and maintenance, arising challenges like coolant leakage, thermal runaway in batteries, etc.		
	L2 Course Duration 2 Hours	• Service frequency checklists, and maintenance of cooling systems and associated all sensors and wiring • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on all types of cooling systems • Conditions and procedures for the replacement of cooling systems		
Contents (Practicals)	L1 Course Duration 2 Hours	• Cooling systems fault diagnosis, their error codes, and subsequent corrective actions		
	L2 Course Duration 4 Hours	• Discussions with Workforce staff to understand actual problems faced and their mitigation measures adopted, maintenance frequency, best practices, etc. while handing cooling systems		
Expected Outcomes	• All participants should be able to understand the design composition of cooling systems for e-Bus, batteries, and motors • They should be able to understand a systematic approach for the repair and maintenance of cooling systems • They should be able to diagnose and take appropriate measures for repair and maintenance activities of cooling systems			

SUB MODULE 7.3 R&M: TRACTION AND OTHER MOTORS, DRIVE, CONTROLLER, AND REGENERATIVE BRAKING

Objective	To help understand the design composition and functioning of motors and regenerative braking, their service frequency checklist, fault diagnosis, and resolution processes			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	N.A.	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• Traction (and other motors) design composition, its functioning and technical specifications • Traction motors system-level diagram, motors locations, and interconnection with other systems and sub-systems • Regenerative braking, retarders and convertor systems and functioning • Conditions and procedures for the replacement of traction and other motors		
	L2 Course Duration 2 Hours	• Different scenarios for regeneration and impact on battery SoC and operating range • Service frequency checklists, and maintenance of motors, drive, controller, and regenerative braking system • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on all types of motors and regenerative braking system		
Contents (Practicals)	L1 Course Duration 2 Hours	• Motors, drive, controller, and regenerative braking system fault diagnosis, their error codes, and subsequent corrective actions • Safe handling of emergencies and hazardous events related to motors, drive, controller, and regenerative braking		
	L2 Course Duration 4 Hours	• Discussions with Workforce staff to understand actual problems faced and their mitigation measures adopted, maintenance frequency, best practices, etc. in handing motors and braking system		
Expected Outcomes	• All participants should be able to understand the design composition of motors and braking systems • They should be able to diagnose and understand a systematic approach for the repair and maintenance of motors (drive, controller) and braking systems			

SUB MODULE 7.4 R&M: ELECTRONICS AND HIGH VOLTAGE ELECTRICAL SYSTEMS

Objective	To help understand the electronics and high voltage electrical system requirements, their repair and maintenance, service frequency checklist, fault diagnosis, and resolution processes			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	N.A.	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• Different low voltage electronic systems, sensors, fuses, their locations, wiring diagrams, wiring harnesses, and colour codes • High voltage electrical systems, protection switches, wiring diagrams, wiring harnesses, and colour codes • Difference between low and high voltage systems and circuits, wirings, and fuses inside e-Bus • Conditions and procedures for the replacement of different electronic systems, sensors, fuses, and wiring		
	L2 Course Duration 2 Hours	• Service frequency checklist and maintenance of different electronic components and high voltage electrical systems • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on electronic and high voltage electrical systems • Safety precautions and emergency handling during repair and maintenance of high voltage electrical systems • Safe handling of emergencies and hazardous events related to high voltage electrical systems • On-Board-Diagnostic (OBD) tool functioning, understanding and handling its reading and measurements		
Contents (Practicals)	L1 Course Duration 2 Hours	• Depot and charging station visit to understand the functioning of different electronics and electrical systems • Safe handling of emergencies and hazardous events related to high voltage electrical systems		
	L2 Duration 4 Hours	• Low voltage electronics and high voltage electrical systems fault diagnosis, their error codes, and subsequent corrective actions • Discussions with Workforce staff to understand actual problems faced and their mitigation measures adopted, maintenance frequency, best practices, etc. in handing electronics and high voltage systems		
Expected Outcomes	• All participants should be able to understand the design composition of electronics and high voltage electrical systems • They should be able to diagnose and understand a systematic approach for the repair and Course maintenance of electronics and high voltage electrical systems			

SUB MODULE 7.5 R&M: E-BUS R&M: OFF-BOARD CHARGERS AND BACK-END HIGH VOLTAGE ELECTRICAL SYSTEMS

Objective	To help understand the charging mechanism and its related high voltage electrical system, functioning, repair and maintenance, service frequency checklist, fault diagnosis, and resolution			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Civil Engineering/ Electrical)	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• Overall charging system design composition, its functioning, infrastructure, and operational processes • Chargers and their charging procedure, back-end high voltage electronic systems, sensors, fuses, wiring diagrams, wiring harnesses, and colour codes • Operational hazards and precautionary measures during charging of e-Buses • Safety precautions and emergency handling during repair and maintenance of chargers and high voltage electrical systems • e-Bus fleet charging monitoring for smooth operations and any required change management • Conditions and procedure for replacement of chargers and any other electrical infrastructure		
	L2 Course Duration 2 Hours	• Differentiation of low and high voltage systems and circuits, wirings, and fuses inside e-Bus • Service frequency checklist and maintenance of charging systems and high voltage electrical systems • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on chargers and high voltage electrical systems		
Contents (Practicals)	L1 Course Duration 2 Hours	• Depot, charging station, and its electrical substation infrastructure visit to understand the functioning of chargers and electrical systems • Safe handling of emergencies and hazardous events related to chargers and high voltage electrical systems		
	L2 Course Duration 4 Hours	• Chargers and high voltage electrical systems fault diagnosis, their error codes, and subsequent corrective actions • Discussions with Workforce staff to understand actual problems faced and their mitigation measures adopted, maintenance frequency, best practices, etc. in handing charging systems and high voltage systems		
Expected Outcomes	• All participants should be able to understand the design composition of chargers and high voltage electrical systems • They should be able to understand a systematic approach for the repair and maintenance of chargers and high voltage electrical systems • They should be able to diagnose and take appropriate measures for repair and maintenance activities of chargers and high voltage electrical systems			

SUB MODULE 7.6 R&M: ON-BOARD DIAGNOSTICS AND COMMUNICATIONS

Objective	To help understand on-board diagnostics and communication system, its functioning, their repair and maintenance, fault diagnosis and resolution processes			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (ITS/MIS)	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour	• Wired and wireless communication systems in e-Bus and their functioning (e.g. vehicle communication between different sub-systems, PIS on and off-board, automatic vehicle location and tracking system, alert and panic management systems, etc.)		
	L2 Course Duration 2 Hours	• On-board communication connectivity checks, service frequency, and maintenance • Fault diagnosis with an understanding of error codes, and subsequent corrective actions on the communication system		
Contents (Practicals)	L1 Course Duration 2 Hours	• e-Bus driving in local city driving conditions across different types of routes to understand the role of on-board diagnostic in overall operational efficiency		
	L2 Course Duration 4 Hours	• Discussions with Workforce staff to understand fault diagnosis, their error codes, and subsequent corrective actions		
Expected Outcomes	• All participants should be able to understand OBD and communication, its working and connection to other in-vehicle systems • They should be able to identify any issues generated related to OBD and communications, diagnose and repair the issue			

SUB MODULE 7.7 R&M: OVERALL PREVENTIVE MAINTENANCE PLANNING, CHECK LISTS, TOOLS, BEST PRACTICES

Objective	To help understand overall preventive maintenance of e-Buses (its systems and sub-systems), their maintenance planning, best practices, workforce and tools requirements, and checklists			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Mechanical Engineering) • Head (ITS/MIS)	• Works/ Maintenance Manager • Supervisor	• Technician
Contents (Classroom)	L1 Course Duration 1 Hour 30 minutes	• Basic principles of working of e-Buses to understand the need for preventive measures (inter-se complexities of operating systems and sub-systems) • Different battery and charging systems, their operating characteristics, safety precautions, etc. • Special characteristics for different on-board systems; their powering, wiring, and electrical circuit diagrams; voltage/ current levels in various circuits and related hazards and precautions • workforce requirements assessment (new skills and incremental change over existing numbers) to carry out preventive maintenance/ major repairs/ reconditioning for e-Buses • Procedure and tactics to manage en-route breakdown of e-Buses to the extent of being different from ICE buses		
	L2 Course Duration 3 Hours	• Process of estimation of tools and testing requirements for carrying out preventive maintenance/ major repairs/ reconditioning of e-Buses • Recordkeeping, report generation, and MIS for all preventive maintenance/ major repairs/ reconditioning of e-Buses • Tooling, testing, jigs, fixtures requirements for preventive maintenance/ major repairs/ reconditioning of e-Buses		
Contents (Practicals)	L1 Course Duration 2 Hours	• Visit the repair and maintenance centre to understand the procedure of preventive maintenance on sample unit cuts for systems and sub-systems		
	L2 Course Duration 4 Hours	• Understand the best practices and procedure to maintain records, reports for all preventive maintenance/ major		
Expected Outcomes	• All participants should be able to understand the basics of e-Bus, its systems, and their working characteristics • They should be able to estimate tools, testing, fixtures, etc. requirements for preventive maintenance/ repairs • They should be able to understand the procedure to maintain records, reports and its further usage for regular maintenance activities			

SUB MODULE 7.8 SPARE PARTS AND INVENTORY PLANNING AND MANAGEMENT

Objective	To help understand the spare parts and inventory planning and management for repair and maintenance of e-Buses and its systems			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• Procedure to develop specifications of required spare parts for repair and maintenance activities • Process of estimation of spare parts requirement w.r.t their consumption pattern, warranty period, etc. • Market availability and manufacturers readiness to supply spare parts at competitive prices, their after-sales services, etc.		
	L2 Course Duration 2 Hours	• Spare parts availability, inventory management, etc. as per procurement cycle times to meet immediate repair and maintenance • Monitor timely delivery, inspection & testing, installation, commissioning of spare parts for effective operationalisation of e-Buses • Storage of spare parts and potential challenges while handling different spare parts		
Expected Outcomes	• All participants should be able to develop specifications and estimate spare parts for repair and maintenance of e-Buses • They should be able to understand the spare parts inventory plan and its management considering the market scenario • They should be able to understand the best practices for spare parts storage, its handling, overall management, etc.			

2.5.8 Module 8: e-Bus End-of-Life, Scrapping and Recycling

This module has two sub-modules with a focus on end-of-life management for e-Bus and its systems and sub-systems, their scrapping and recycling mechanisms.

SUB MODULE 8.1 WARRANTY AND END-OF-LIFE MANAGEMENT

Objective	To help understand the warranty period and end-of-life management of e-Bus, and their systems and sub-systems			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• The warranty period and end-of-life definition of e-Bus, its systems, and sub-systems • Associated challenges/ hazards during storage and necessary guidelines for their phase-out • Best practices about utilisation and safe disposal at end of their serviceable lives		
	L2 Course Duration 2 Hours	• Processes for execution and enforcement of end-of-life activity (if required jointly with OEMs) • Planning for e-Bus and its systems reuse, recycle, and replacement		
Expected Outcomes	• All participants should be able to define/ set end-of-life of e-Bus and its systems and sub-systems • They should be able to understand the consequences of storage, non-use, and handling • They should be able to execute related reuse and recycling processes			

SUB MODULE 8.2 E-BUS AND LITHIUM-ION BATTERIES SCRAPPING AND RECYCLING

Objective	To help understand the scrapping and recycling mechanisms of e-Bus and Lithium-ion batteries			
Applicable to	Outright Purchase			
Target Participants	Top Management	Senior Management	Middle Management	Workforce
	N.A.	• Head (Mechanical Engineering) • Head (Stores and Purchase/ Procurement) • Head (ITS/MIS)	• Works/ Maintenance Manager • Supervisor	N.A.
Contents (Classroom)	L1 Course Duration 1 Hour	• e-Bus and Li-ion batteries reuse and recycle process • Safety measures, its emergency handling during scrapping and recycling of e-Bus and batteries		
	L2 Course Duration 2 Hours	• Processes for execution and enforcement of scrapping and recycling of e-Bus and battery (if required jointly with OEMs)		
Expected Outcomes	• All participants should be able to understand and execute the process of scrapping and recycling of e-Bus and battery			

3 TRAINING DELIVERY

3.1 Modules Duration

The table below shows the training length of classroom and practical sessions for all the sub-modules.

Table 2. Training Module and Sub-Module Coverage

Modules	No.	Modules	L-1 Course Duration	L-2 Course Duration
1	**Module 1 (Classroom Training Duration)**		-	**2 Hours**
	S1.1	System Overview and Usage at PTAs	N.A.	1 Hour
	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	N.A.	1 Hour
2	**Module 2 (Classroom Training Duration)**		**6 Hours**	**12 Hours**
	S2.1	Battery Technologies, Sizing, and Selection	1 Hour	2 Hours
	S2.2	Charging Technologies, Sizing, and Selection	1 Hour	2 Hours
	S2.3	Charging and Energy Infrastructure Planning	1 Hour	2 Hours
	S2.4	Depot Infrastructure and Equipment Planning	1 hour 30 minutes	3 Hours
	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	1 hour 30 minutes	3 Hours
3	**Module 3 (Classroom Training Duration)**		**4 Hours**	**8 Hours**
	S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	1 Hour	2 Hours
	S3.2	Investments and Financing for different Procurement Models	1 Hour	2 Hours
	S3.3	Manpower Planning and Capacity Building	1 Hour	2 Hours
	S3.4	Long term Transition Planning from ICE to electric fleet for PTA	1 Hour	2 Hours
4	**Module 4 (Classroom Training Duration)**		**4 Hours**	**8 Hours**
	S4.1	Purchase Specifications Design	1 hour 30 minutes	3 Hours
	S4.2	Models and Performance Contract Design	1 hour 30 minutes	3 Hours
	S4.3	Evaluation, Testing, and Inspection Best Practices for PTA	1 Hour	2 Hours
5	**Module 5 (Classroom Training Duration)**		**4 Hours 30 Minutes**	**9 Hours**
	S5.1	Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers	1 hour 30 minutes	3 Hours
	S5.2	Intelligent Charging and Optimisation	1 Hour	2 Hours
	S5.3	Driver Training	1 Hour	2 Hours
	S5.4	Driving behaviours impact on e-Bus Energy Performance	1 Hour	2 Hours

Modules	No.	Modules	L-1 Course Duration	L-2 Course Duration
6	**Module 6 (Classroom Training Duration)**		**4 Hours**	**8 Hours**
	S6.1	Performance Monitoring and Evaluation at Depot level	1 hour 30 minutes	3 Hours
	S6.2	Contract Management and Monitoring Best Practices for PTA	1 hour 30 minutes	3 Hours
	S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	1 Hour	2 Hours
7	**Module 7 (Classroom Training Duration)**		**8 Hours 30 Minutes**	**17 Hours**
	S7.1	R&M: Batteries and BMS	1 Hour	2 Hours
	S7.2	R&M: Cooling Systems (Bus, Batteries, Motors)	1 Hour	2 Hours
	S7.3	R&M: Traction and other Motors, Drive, Controller, and Regenerative Braking	1 Hour	2 Hours
	S7.4	R&M: Electronics and High voltage Electrical Systems	1 Hour	2 Hours
	S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	1 Hour	2 Hours
	S7.6	R&M: On-Board Diagnostics and Communications	1 Hour	2 Hours
	S7.7	R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices	1 hour 30 minutes	3 Hours
	S7.8	Spare Parts and Inventory Planning and Management	1 Hour	2 Hours
8	**Module 8 (Classroom Training Duration)**		**2 Hours**	**4 Hours**
	S8.1	Warranty and End-of-Life Management	1 Hour	2 Hours
	S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling	1 Hour	2 Hours
Total Classroom Training Duration			**33 Hours**	**68 Hours**
Practical Training Details				

Modules	No.	Modules	L-1 Course Duration	L-2 Course Duration
1	**Module 1 (Practical Training Duration)**		**-**	**2 Hours**
	S1.1	System Overview and Usage at PTAs	N.A	1 Hour
	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	N.A	1 Hour
2	**Module 2 (Practical Training Duration)**		**2 Hours**	**4 Hours**
	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	1 Hour	2 Hours
4	**Module 4 (Practical Training Duration)**		**1 Hour**	**2 Hour**
	S4.3	Evaluation, Testing, and Inspection Best Practices for PTA	1 Hour	2 Hours
5	**Module 5 (Practical Training Duration)**		**3 Hours**	**11 Hours**
	S5.1	Route Selection, Operations Planning & Scheduling, and Chargers	1 Hour	2 Hours
	S5.2	Intelligent Charging and Optimisation	1 Hour	2 Hours
	S5.3	Driver Training	N.A	5 Hours
	S5.4	5.4 Driving behaviours impact on e-Bus Energy Performance	1 Hour	2 Hours
6	**Module 6 (Practical Training Duration)**		**1 Hour**	**2 Hours**
	S6.1	Performance Monitoring and Evaluation at Depot level	1 Hour	2 Hours

Modules	No.	Modules	L-1 Course Duration	L-2 Course Duration
7	**Module 7 (Practical Training Duration)**		**14 Hours**	**28 Hours**
	S7.1	R&M: Batteries and BMS	2 Hours	4 Hours
	S7.2	R&M: Cooling Systems (Bus, Batteries, Motors)	2 Hours	4 Hours
	S7.3	R&M: Traction and other Motors, Drive, Controller, and Regenerative Braking	2 Hours	4 Hours
	S7.4	R&M: Electronics and High voltage Electrical Systems	2 Hours	4 Hours
	S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	2 Hours	4 Hours
	S7.6	R&M: On-Board Diagnostics and Communications	2 Hours	4 Hours
	S7.7	R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices	2 Hours	4 Hours
Total Practical Training Duration			**20 Hours**	**47 Hours**

3.2 Target Group of PTA Staff

PTAs staff is broadly divided into hierarchies' as: Top Management (TM), Senior Management (SM), Middle Management (MM), and Technicians(WF). The level of training needs for these hierarchies are grouped under Level-1 (L1) and Level-2 (L2) across various sub-modules, as shown in Table 3 below.

It is also proposed that the training programme shall be conducted for various levels by including several PTAs. This will allow a better exchange of peer knowledge and experiences.

Table 3: Training Programme Coverage

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Top Management	Managing Director/ Chief Managing Director/ CEO/ Joint Managing Director	S2.1	Battery Technologies, Sizing, and Selection	S1.1	System Overview and Usage at PTAs	2 Days
		S2.2	Charging Technologies, Sizing, and Selection	S2.4	Depot Infrastructure and Equipment Planning	
		S2.3	Charging and Energy Infrastructure Planning	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		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	
Senior Management	Head (Traffic)	S2.1	Battery Technologies, Sizing, and Selection	S1.1	System Overview and Usage at PTAs	4 Days
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
		S3.3	Manpower Planning and Capacity Building	S2.2	Charging Technologies, Sizing, and Selection	
		S5.1	Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers	S2.4	Depot Infrastructure and Equipment Planning	
		S5.4	Driving Behaviours impact on e-Bus Energy Performance	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		S6.1	Performance Monitoring and Evaluation at Depot level	S3.2	Investments and Financing for different Procurement Models	
		S6.2	Contract Management and Monitoring Best Practices for PTA	S3.4	Long term Transition Planning from ICE to electric fleet for PTA	
		S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	S5.2	Intelligent Charging and Optimisation	

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Senior management				S1.1	System Overview and Usage at PTAs	
	Head (Civil Engineering/ Electrical)	S2.1	Battery Technologies, Sizing, and Selection	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	5 days
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S2.2	Charging Technologies, Sizing, and Selection	
				S2.3	Charging and Energy Infrastructure Planning	
		S3.3	Manpower Planning and Capacity Building	S2.4	Depot Infrastructure and Equipment Planning	
		S4.1	Purchase Specifications Design	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		S6.2	Contract Management and Monitoring Best Practices for PTA	S3.2	Investments and Financing for different Procurement Models	
				S3.4	Long term Transition Planning from ICE to electric fleet for PTA	
				S5.2	Intelligent Charging and Optimisation	
				S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Senior management	Head (Mechanical Engineering)	S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S1.1	System Overview and Usage at PTAs	8 days
		S5.2	Intelligent Charging and Optimisation	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
		S6.1	Performance Monitoring and Evaluation at Depot level	S2.1	Battery Technologies, Sizing, and Selection	
		S6.2	Contract Management and Monitoring Best Practices for PTA	S2.2	Charging Technologies, Sizing, and Selection	
		S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	S2.3	Charging and Energy Infrastructure Planning	
		S7.1	R&M: Batteries and BMS	S2.4	Depot Infrastructure and Equipment Planning	
		S7.2	R&M: Cooling Systems (Bus, Batteries, Motors)	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		S7.3	R&M: Traction and other Motors, Drive, Controller, and Regenerative Braking	S3.2	Investments and Financing for different Procurement Models	
		S7.4	R&M: Electronics and High voltage Electrical Systems	S3.3	Manpower Planning and Capacity Building	
		S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	S3.4	Long term Transition Planning from ICE to electric fleet for PTA	
		S7.6	R&M: On-Board Diagnostics and Communications	S4.1	Purchase Specifications Design	
		S7.7	R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices	S4.2	Models and Performance Contract Design	
		S7.8	Spare Parts and Inventory Planning and Management	S4.3	Evaluation, Testing, and Inspection Best Practices for PTA	
		S8.1	Warranty and End-of-Life Management			
		S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling			

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Senior management	Head (Stores & Purchase / Procurement)	S2.1	Battery Technologies, Sizing and Selection	S1.1	System Overview and Usage at PTAs	3 days
		S2.2	Charging Technologies, Sizing and Selection	S3.2	Investments and Financing for different Procurement Models	
		S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	S4.1	Purchase Specifications Design	
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S4.2	Models and Performance Contract Design	
		S3.4	Long term Transition Planning from ICE to electric fleet for PTA	S7.8	E-Bus Spare Parts & Inventory Planning and Management	
		S6.2	Contract Management and Monitoring Best Practices for PTA	S8.1	E-Bus Warranty and End-of-Life Management	
				S8.2	E-Bus and Lithium-ion Batteries Scrapping and Recycling	
Senior management	Head (ITS/MIS)	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	S1.1	System Overview and Usage at PTAs	3 days
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S3.4	Long term Transition Planning from ICE to electric fleet for PTA	
		S5.1	Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers	S5.2	Intelligent Charging and Optimisation	
		S6.1	Performance Monitoring and Evaluation at Depot level	S6.2	Contract Management and Monitoring Best Practices for PTA	
		S7.1	R&M: Batteries and BMS	S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	
		S8.1	Warranty and End-of-Life Management	S7.6	R&M: On-Board Diagnostics and Communications	
		S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling	S7.8	Spare Parts and Inventory Planning and Management	

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Middle Management	Depot Manager	S2.1	Battery Technologies, Sizing, and Selection	S1.1	System Overview and Usage at PTAs	9 Days
		S2.2	Charging Technologies, Sizing, and Selection	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
		S2.3	Charging and Energy Infrastructure Planning	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		S2.4	Depot Infrastructure and Equipment Planning	S5.1	Route Selection, Operations Planning & Scheduling of e-Bus Fleet and Chargers	
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S5.2	Intelligent Charging and Optimisation	
		S3.2	Investments and Financing for different Procurement Models	S6.1	Performance Monitoring and Evaluation at Depot level	
		S3.3	Manpower Planning and Capacity Building	S7.1	R&M: Batteries and BMS	
		S3.4	Long term Transition Planning from ICE to electric fleet for PTA	S7.4	R&M: Electronics and High voltage Electrical Systems	
		S5.4	Driving Behaviours impact on e-Bus Energy Performance	S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	
		S6.2	Contract Management and Monitoring Best Practices for PTA	S7.8	Spare Parts and Inventory Planning and Management	
		S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration			
		S7.2	R&M: Cooling Systems (Bus, Batteries, Motors)			
		S7.3	R&M: Traction and other Motors, Drive, Controller, and Regenerative Braking			
		S7.6	R&M: On-Board Diagnostics and Communications			
		S7.7	R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices			
		S8.1	Warranty and End-of-Life Management			
		S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling			

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Middle Management	Works/ Maintenance Manager	S2.1	Battery Technologies, Sizing, and Selection	S1.1	System Overview and Usage at PTAs	11 days
		S2.2	Charging Technologies, Sizing, and Selection	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
		S2.3	Charging and Energy Infrastructure Planning	S2.5	Overall System Planning and Optimisation: Scenario Analysis and Trade-offs	
		S2.4	Depot Infrastructure and Equipment Planning	S3.3	Manpower Planning and Capacity Building	
		S3.1	Life Cycle Cost-Benefit Analysis and PTA Business Case	S3.4	Long term Transition Planning from ICE to electric fleet for PTA	
		S3.2	Investments and Financing for different Procurement Models	S4.1	Purchase Specifications Design	
		S3.4	Long term Transition Planning from ICE to electric fleet for PTA	S6.1	Performance Monitoring and Evaluation at Depot level	
		S4.3	Evaluation, Testing, and Inspection Best Practices for PTA	S6.2	Contract Management and Monitoring Best Practices for PTA	
		S5.2	Intelligent Charging and Optimisation	S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	
		S5.4	Driving Behaviours impact on e-Bus Energy Performance	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: e-Bus 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 and Inventory Planning and Management	
				S8.1	Warranty and End-of-Life Management	
				S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling	

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Middle Management	Supervisor	S2.4	E-Bus Depot Infrastructure and Equipment Planning	S1.1	System Overview and Usage at PTAs	9 days
		S7.8	E-Bus Spare Parts & Inventory Planning and Management	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
				S4.3	Evaluation, Testing, and Inspection Best Practices for PTA	
				S5.2	Intelligent Charging and Optimisation	
				S5.4	Driving Behaviours impact on e-Bus Energy Performance	
				S6.1	Performance Monitoring and Evaluation at Depot level	
				S6.2	Contract Management and Monitoring Best Practices for PTA	
				S6.3	ITMS/MIS for overall e-Bus Fleet, Charging and PTA integration	
				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: e-Bus 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	
				S8.1	Warranty and End-of-Life Management	
				S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling	
Workforce	Driver	S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	S1.1	System Overview and Usage at PTAs	2 days
				S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
				S5.3	Driver Training	
				S5.4	Driving Behaviours impact on e-Bus Energy Performance	

Level	Role	L-1 Course Coverage		L-2 Course Coverage		Time
Workforce	Technician	S7.5	R&M: e-Bus R&M: Off-Board Chargers and back-end High voltage Electrical Systems	S1.1	System Overview and Usage at PTAs	6 days
		S8.1	Warranty and End-of-Life Management	S1.2	Safety and Fire Hazards, SOPs, Prevention, and Emergency Handling	
		S8.2	e-Bus and Lithium-ion Batteries Scrapping and Recycling	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	
				S7.6	R&M: On-Board Diagnostics and Communications	
				S7.7	R&M: Overall Preventive Maintenance Planning, Check Lists, Tools, Best Practices	

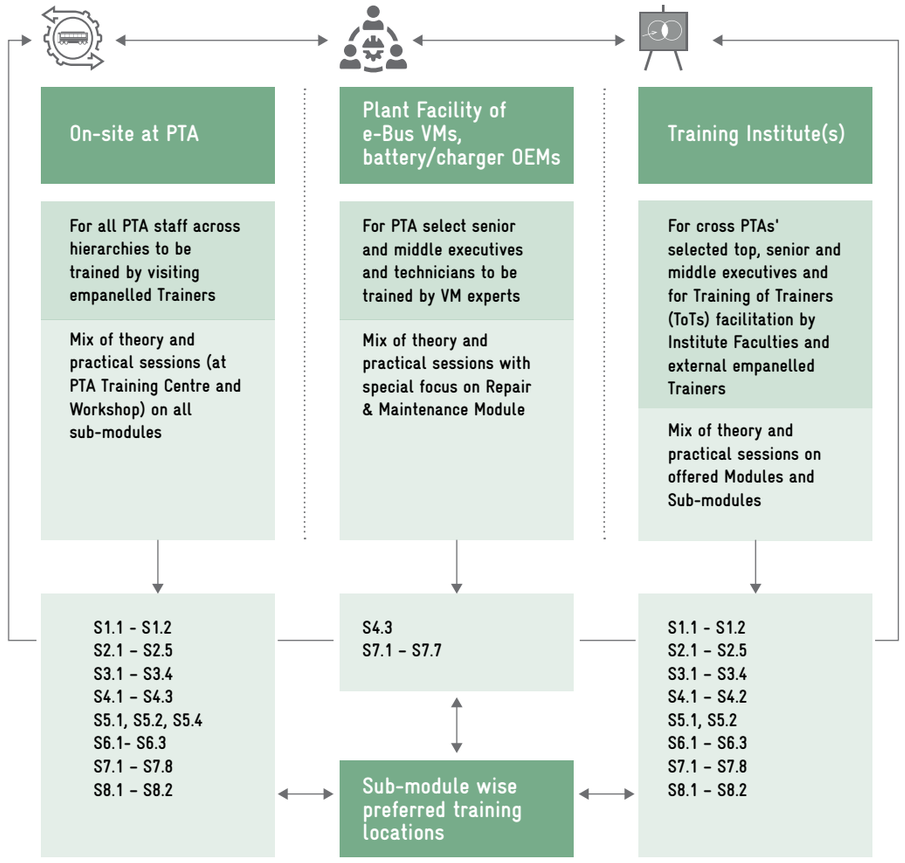
3.3 Training Locations

E-Bus Vehicle Manufacturers (VMs) are currently providing on-site training to PTA drivers and technicians. Most of these trainings are disseminated by VMs along with managing contracted services with the PTAs. They also organise plant visits and training for selected middle management and technicians.

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 Institute(s) as shown in Figure 3.

The **on-site PTA location** is suited for training and this can be leveraged to further develop their in-house Training eco-system. The contracted VM/OEMs can facilitate practical sessions in the PTA workshop and can supplement classroom training. The **Training Institute(s)** can host different modules' training at their Centre for cross PTA batches exclusively for selected executives in PTAs. Inclusion of international visits to study the global best practices can also be facilitated to the selected Top Management roles.

Figure 3. E-Bus Training Locations



3.4 Training Delivery Channels

The training programme is designed to disseminate content **Offline** and **Online**.

Offline training shall be conducted with in-person trainers and participants having access to classroom and computers with workshop-based practical sessions. The right combination of modules with a mix of offline and online delivery can optimise the logistics costs of both Trainer and PTA staff. It can also help access the best of global trainers to acquire skills from their knowledge and experience spectrum for the relevant module. These delivery channels are further elaborated in Table 4

Table 4 Training Delivery Channel for PTA Staff

Delivery Channel	Trainer Support	Classroom Batch	Training Location	Practical's	Applicability (Modules and PTA Roles)	Required Infrastructure
Offline	In-person by Trainer(s)	All learners sit together in the class-room	PTA VM Plant Training Institute	Both Computer and Workshop based practical sessions	All Training Modules and Roles	Classroom training Operation-al e-Bus & Charging Station e-Bus Work-shop (with cut-out units)
Online	Remotely (LIVE) by Trainer(s) Self-paced with interim Q&A assis-tance	Trainees learn togeth-er in live e-classroom Self-paced learning	Home or workplace (for joining online)	Only Com-puter-based practical Workshop based practical facilitation by local Trainer	Modules other than work-shop-based practical (like Repair & Maintenance, Fundamentals & Safety)	Learning Management System (LMS)

For the top and senior management, it is proposed that the training modules can also be made available through online-recorded sessions with access to Trainers for questions and answers. This will allow them to learn with flexibility at their convenience and improving the adoption of training.

3.5 Training of Trainers (ToTs)

The experts-cum-trainers of conventional bus systems require orientation to e-Bus domain knowledge. This would allow them to leverage their bus training expertise to support as trainers for e-Buses for relevant modules. Besides, there are e-Bus experts with a strong domain understanding of selected topics but may not be professional trainers. Both these sets of experts would need training in the form of 'Training of Trainers' (ToTs) to strengthen their domain and functional knowledge.

The proposed programme structure proposes that TOT should be the first step Since they have prior training experience, a brief functional Training for Trainers (ToT) covering soft aspects of teaching and training can be imparted to Content Developers can conduct this training.

These content developers led training (referred to as Master Trainer) can be organised in Training Institutes or at PTA location.

Training of Trainers should follow the following guidelines:

- The prospective trainers should have relevant years of domain experience of working in bus sector with PTAs and good standing to be acceptable as Trainer to PTA staff. Some experience in e-Buses (or broader EVs relevant to training module) and also Training would be useful.
- They should first complete e-Bus training organised at Training Institutes by master trainers in modules they intend to teach.
- They should undergo soft Training of Trainers organised at Training Institutes. This training usually can be done in 2-7 days, and typically covers syllabus covering training delivery methodology, effective communication, soft skills, etc.
- They should undertake an independent assessment to become Certified Trainers, and this can be organised by Training Institutes with support from Assessment and Certification Partner.
- There can be online supervision and feedback by Master Trainer for the first few sessions conduct of formal training by new Trainer(s).

Further, the taster trainer can identify strong candidates within PTAs that could become potential trainers and recommend them for the ToT programme. These PTA internal Trainers can help build capacity to conduct training within their respective e-Bus PTA departments and help internalise training to drive improved processes and actions around teams.

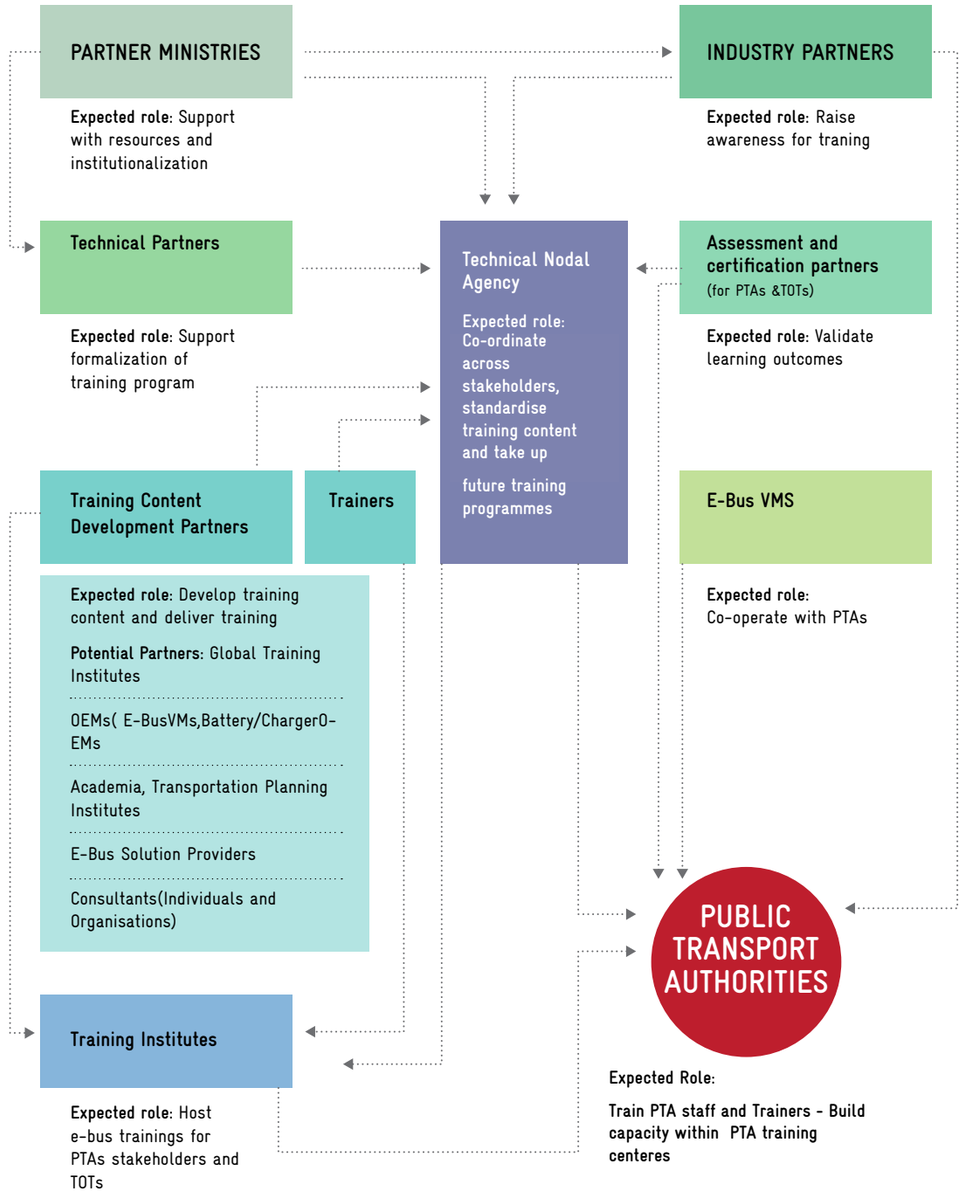
4

PROPOSED INSTITUTIONAL STRUCTURE

For an effective training experience, a structured and holistic training programme conducted by experts, up to date knowledge content, and access to required infrastructure and resources are the key factors. These are all considered while conceptualising the proposed institutional structure. Active support from various stakeholders and industry experts is vital and forms an integral part of the training modules. A nodal training agency is expected to act as an umbrella body to co-ordinate among PTAs to ensure effective dissemination of the training programmes now and in the future.

Considering these aspects, various stakeholders of the proposed National Capacity Building Training Programme are identified as part of the proposed institutional structure and their roles envisaged in the e-Bus training programme is shown in Figure 4:

Figure 4. E-Bus Training Programme Stakeholders



5

CONCLUSION

Electrification of vehicles is one of the key interventions for reducing emissions from the transportation sector. Several Indian cities are adopting e-Buses for state and city transport bus operations – more than 650 buses have already been deployed in various cities. Further, over 2000 new e-Buses are intended to be deployed under the FAME-II Scheme. The process of deployment and management of the e-Buses require updated skill sets and has, thus, shown a strong need for systematic training of staff at the Public Transport Agencies (PTAs).

Need for National e-Bus Training Programme

Considering current skills gaps in e-Bus operations, GIZ has conducted a detailed Training Needs Assessment study and published Volume 1 of the study. It highlights the skills gaps based on five PTA departments' study and associated roles focusing on the e-Bus life cycle.Currently, the training is supported by e-Bus VMs and is limited to drivers, technicians, and safety training. This training is not organised for different PTA departments and ranks; and does not cover the aspects related to planning, managing, and implementation. This is reflected in slower adoption and non-optimal e-Bus deployment and performance.

This is the second report in the three volumes and has identified the training modules required to fill these skills gaps. This report aims to propose the broad structure of the National-level e-Bus training and capacity building programme. Training modules for each stage of e-Bus planning, procurement, management, operation, and scrapping has been proposed along with the proposed delivery methodology.

Training Programme Structure and Potential Stakeholders

This report aims to prepare a detailed and organised training programme structure for PTAs. It identifies a total of eight e-Bus training modules across its life cycle stages – i.e. from fundamentals and safety; technology selection; financial planning and strategy; procurement; operations; monitoring and control; repair and maintenance; and end-of-life, scrapping, and recycling. These modules are further subdivided into 31 sub-modules, with details like target participants/ roles from PTA, training coverage, duration, and expected benefits.

It is important to bring together various industry stakeholders for successful programme implementation that will help build applied skills in PTAs to improve e-Bus performance. Support from stakeholders such as Ministries, PTAs, Vehicle Manufacturers, Training Institutes, Experts, Trainers, Industry Associations, Technical Partners, etc. will be required to deliver a **National e-Bus Training Programme**.

The key stakeholders' category and the potential partners envisaged for the training programme are as follows:

- **Partner Ministries** – The Ministry of Heavy Industries & Public Enterprises (MoHI&PE), the Ministry of Road Transport and Highways, (MoRTH), and Ministry of Housing and Urban Affairs (MoHUA) as Central Ministries can strengthen the institutional structure, allocate funds for scale-up, and can initiate e-Bus adoption and integration at the city level. NITI Aayog can act as the umbrella body since it has taken up industry initiatives for India's Electric Mobility Transformation.
- **Training Institutes** – Institutes including leading academic and professional institutes.
- **Training Content Development Partners and Trainers** –
  - Global Training Institutes
  - OEMs (E-Bus VMs, Battery/ Charger OEMs)
  - Academia in the urban transport sector
  - E-Bus Solution Providers
  - Consultants (Individuals and Organisations)
- **Assessment and Certification Partner** – A leading certification partner can be used to recognise the assessment and certification procedure in EVs and the institute is working with driver training can certify drivers training.
- **Industry Partner** – Collaboration with industry partners that works closely with PTAs needs to be identified that has a strong network to support better participation from PTAs. A body that governs PTA functioning and automobile certification could be a potential industry partner to raise awareness for training.

Right Design and Initialisation of National E-Bus Training Programme

The programme has the following essential elements to kick start acceptance amongst PTAs with the right 'push' and over time develop a strong 'pull' based on value derived by PTAs.

- Establishing e-Buses specialised

Training Institutes identified as stakeholder and over time develop them into **Centres of Excellence (CoE)**

- Conducting **off-site Training** at established training institutes equipped with an e-Bus workshop and unit cut-outs etc. and enabling peer sharing of experiences amongst participating PTAs
- Formalising **Training of Trainers (ToTs) and their certification** and developing more Trainers within PTAs and also outside to grow the industry
- Conducting **on-site e-Bus training** for PTAs **with certification** to cater to large PTAs at reduced logistics and building internal capacity of their team and **PTAs' training centres**

This report further suggests a rollout of a two-year pilot training programme through an institutional structure to develop training pre-requisites and engage potential industry stakeholders. The proposed two-years pilot training programme is expected to set the foundation for training and capacity building of PTAs and other stakeholders in e-Bus sector. This would create a self-sustained e-Bus training ecosystem by involving these stakeholders to further commence the training programmes in the future across the country.

Volume III of this project would focus on the resource requirements for delivering a National Capacity Building Training Programme. An in-depth demarcation of roles and responsibilities at various levels and essential changes in organisational structure shall also be reviewed as part of Volume III.

Notes

As part of the Indo-German bilateral cooperation, both countries have agreed upon a strategic partnership - **Green Urban Mobility Partnership (GUMP)** between Ministry of Housing and Urban Affairs (MoHUA) and Federal Ministry for Economic Cooperation and Development (BMZ). Within the framework of the partnership of technical and financial cooperation, the German government will support improvements of green urban mobility infrastructure and services, strengthen capacities of national, state, and local institutions to design and implement sustainable, inclusive, and smart mobility solutions in Indian cities. As part of the GUMP partnership, Germany will also be supporting in expanding the public transport infrastructure, multimodal integration, using low-emission or zero-emission technologies, and promoting non-motorised transport in India. Through this strategic partnership, India and Germany intend to jointly achieve effective international contributions to fight climate change.