Developing Scalable and Bankable Electric Bus Programs

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IFC International Finance Corporation WORLD BANK GROUP

Creating Markets, Creating Opportunities

Global Climate Action Partnership

regional leadership, global change

Session design

Part 1: Overview

- Introductions
- Why do we need a systematic approach to e-bus program design?
- The “E-bus Toolkit” approach

Part 2: Designing the framework

- How different countries have approached e-bus adoption?
- Group discussion on applicability of models, experiences, issues and learnings
- Regroup and share learnings

Part 3: Designing the solution

- How to plan for e-bus programs?
- Group discussion on experiences, issues, learnings
- Regroup and share learnings

Part 1: Introductions

Introduction to the World Bank

IBRD and IFC are two of the five international organizations that constitute the World Bank

IBRD	IDA	IFC	MIGA	ICSID
International Bank for Reconstruction and Development	International Development Association	International Finance Corporation	Multilateral Investment Guarantee Agency	International Centre for Settlement of Investment Disputes
Loans to middle-income and creditworthy low-income country governments	Interest-free loans and grants to governments of poorest countries	Solutions in private-sector development	Guarantees for foreign direct investment's non-commercial risks	Conciliation and arbitration of investment disputes

THE WORLD BANK
IBRD • IDA

IFC

MIGA

ICSID

IFC's FY24 investments >$50 Bn

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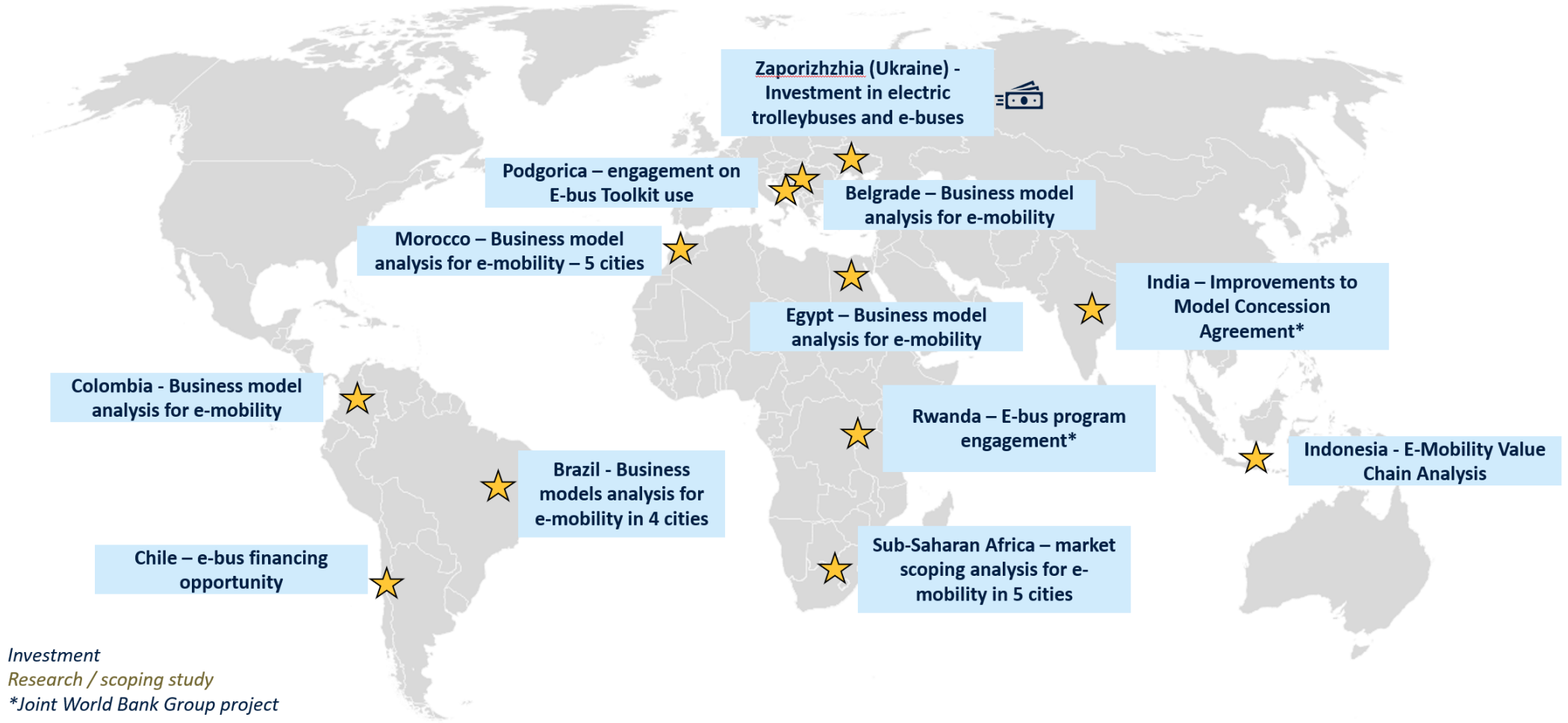
We are working with municipalities and the private sector globally to enable e-bus adoption



Investment
Research / scoping study
**Joint World Bank Group project*

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INVESTMENT CASE STUDY

Chile: Project finance for >900 e-buses in Chile

- Innovative business model
  - Assets owned and managed by Kauffmann
  - Operated by a third-party entity
  - Leased to and regulated by the local public transport regulator
- Risk elimination approach
  - Payments to Kauffmann do not depend on # of passengers – no demand risk
  - Long-tenors – fully depreciates assets – no residual value risk

Demonstrates role of regulations, contracting and structuring in enabling bankable projects

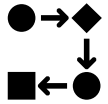
Overview of the “E-bus Toolkit”

Introducing electric buses into public transport operations can come with multiple challenges

- High up-front costs
- TCO is challenging to estimate

Selecting suitable buses & chargers for given operations not straightforward

Operational challenges of optimal routing and scheduling



ICE bus business models may not be appropriate for electric buses

Lack of awareness of how to develop bankable programs

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These challenges span questions to be addressed across a wide range of topics*

Local context

a) Aspirations and targets for e-bus adoption?
b) Current public transport context and regulations?
c) Key stakeholders?
d) Future pathways?

Regulatory and business model

a) 'Ideal' model for e-bus adoption?
b) Nature and feasibility of changes needed?
c) Roles & responsibilities of stakeholders?
d) Support for change?

Operational feasibility

a) Which routes & schedules to electrify?
b) Specifications to meet operating needs of routes and schedules?
    - Battery size & charging solution
c) Supporting infrastructure needs?

Financial viability

a) Current & future costs and revenues of existing solution?
b) Viability of e-buses and other options?
c) Viability gap funding?
d) Availability of financing?

*questions listed are not exhaustive – indicative list

...and more questions to be addressed

'Infrastructure' readiness

a) Infrastructure status & upgrades needed?
b) Operational capabilities & training needs?
c) Repairs & maintenance?
d) Data collection, analysis, reporting?
e) Incident management?

Procurement process

a) Selection methodology for provision of assets & services?
b) Types of contracts and clauses needed?
c) Evaluation criteria?

Financial closure

a) Role of public bodies (e.g. for guarantees)?
b) Source and terms of financing?

Pilot & scale-up

a) Tendering
b) Preparations (e.g. infra upgrades, capacity)
c) Pilots
d) Scale-up
e) Monitoring, feedback & learning

*questions listed are not exhaustive – indicative list

A systematic approach is needed to address these questions to de-risk e-bus adoption programs

The E-bus Toolkit describes the best practices with detailed steps to develop and scale e-bus adoption programs

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 8
Stage	Preliminary Assessment	Business Model	Technical & Financial Feasibility	Operational Readiness	Procurement Guidance	Investment	Project implementation support
Tasks	Broad assessment of potential & feasibility; go/no-go decision to proceed	Create appropriate and regulatory framework & bankable business models	Determine optimal e-bus & charging solutions, estimate TCO and financial viability	Assess and, if needed, improve infrastructure, operating plans, processes & capabilities	Guidance on structuring contracts and conducting tenders	Provide tailored and attractive investment solutions	Support on other key aspects of e-bus and transport system management




Value-Added Services (Optional)


Pilot (Optional Step 7)

- Steps can be selectively applied, depending on client needs, context and budget

Key takeaways so far

- Risk mitigation mindset in program design
- Program design precedes financial design
- E-bus programs require consideration of a wide variety of issues
- Need to engage a wide range of stakeholders early on

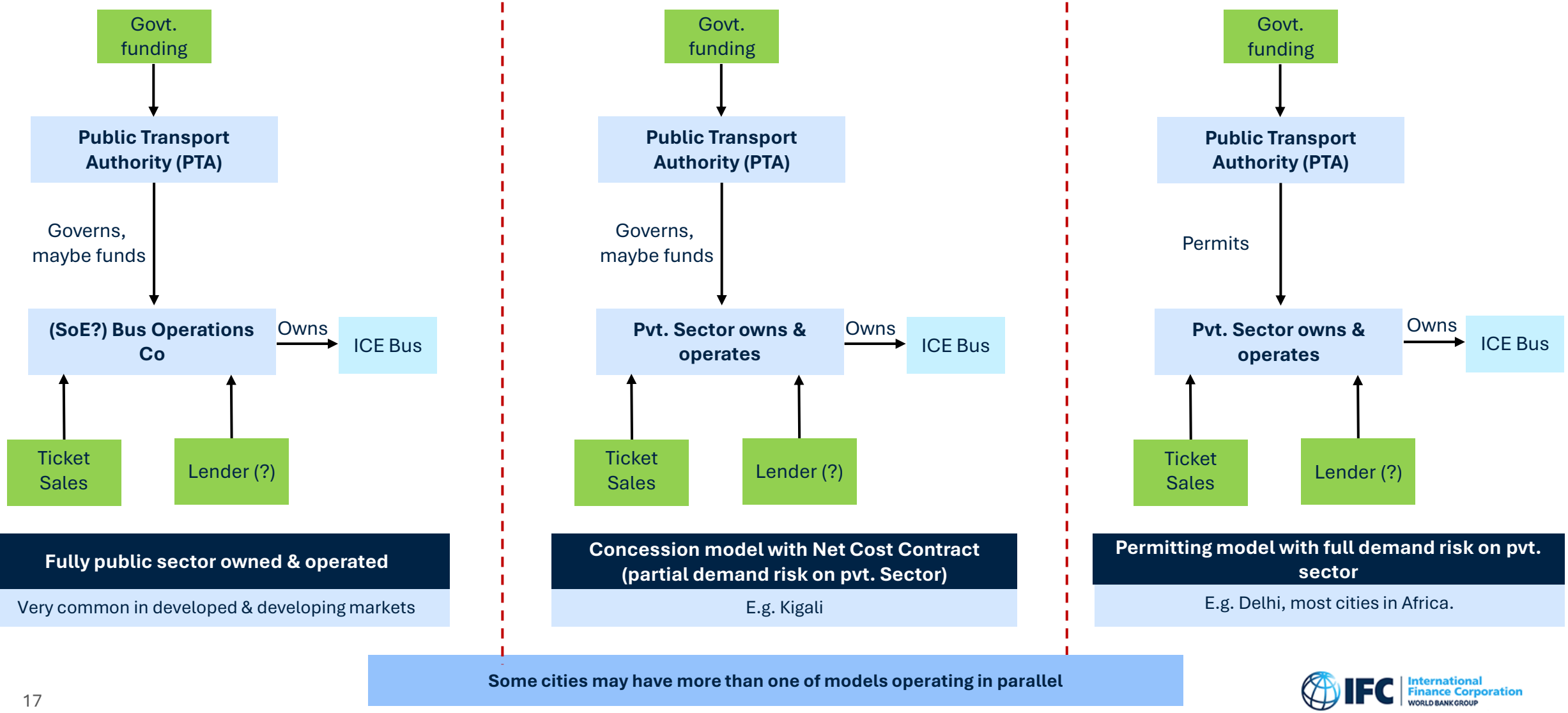
End of Part 1

Part 2: Regulatory frameworks

Regulatory frameworks play a critical role in public transportation

- Globally cities have moved towards well-structured and regulated bus public transport systems
  - In many emerging markets, these may still be unregulated / less regulated
- Traditionally run as a public service by state-owned-entities
- PPP models increasingly prevalent enable scale, competition, efficiency.
- With e-buses, new regulatory frameworks have emerged.
- Focus of this module

Some public transit biz models common in ICE buses but not with e-buses



Fully public sector owned & operated

Very common in developed & developing markets

Concession model with Net Cost Contract (partial demand risk on pvt. Sector)

E.g. Kigali

Permitting model with full demand risk on pvt. sector

E.g. Delhi, most cities in Africa.

Some cities may have more than one of models operating in parallel

Challenges faced by some traditional ‘bundled’ PPP models in emerging markets

- Several countries implemented ‘bundled’ PPP models in 2000 – 2010
  - Chile, Colombia, Peru, India
- Operator – a private sector entity – responsible for fleet ownership, maintenance, operations
- Could be net cost or gross cost contracts
- *All material risks on operator*
- Key challenges faced –
  - Implementation delays
  - Lower passengers than projected
  - Lack of timely payments to operator
- Led to weakening of private sector operators’ financials, disputes, etc.
- Then Covid happened

E-buses create added challenges for the traditional models

1. Viability gaps
2. High capex & lack of capital with private operators
3. Capability gaps in right asset selection and operations
4. Technology risks
5. New ecosystem partnerships needed – utilities, charging solutions, etc.

Need for -

1. New sources of private sector capital
2. Players with different capabilities
3. Appropriate regulatory frameworks

On regulations, two key shifts are enabling greater private sector participation in e-bus programs

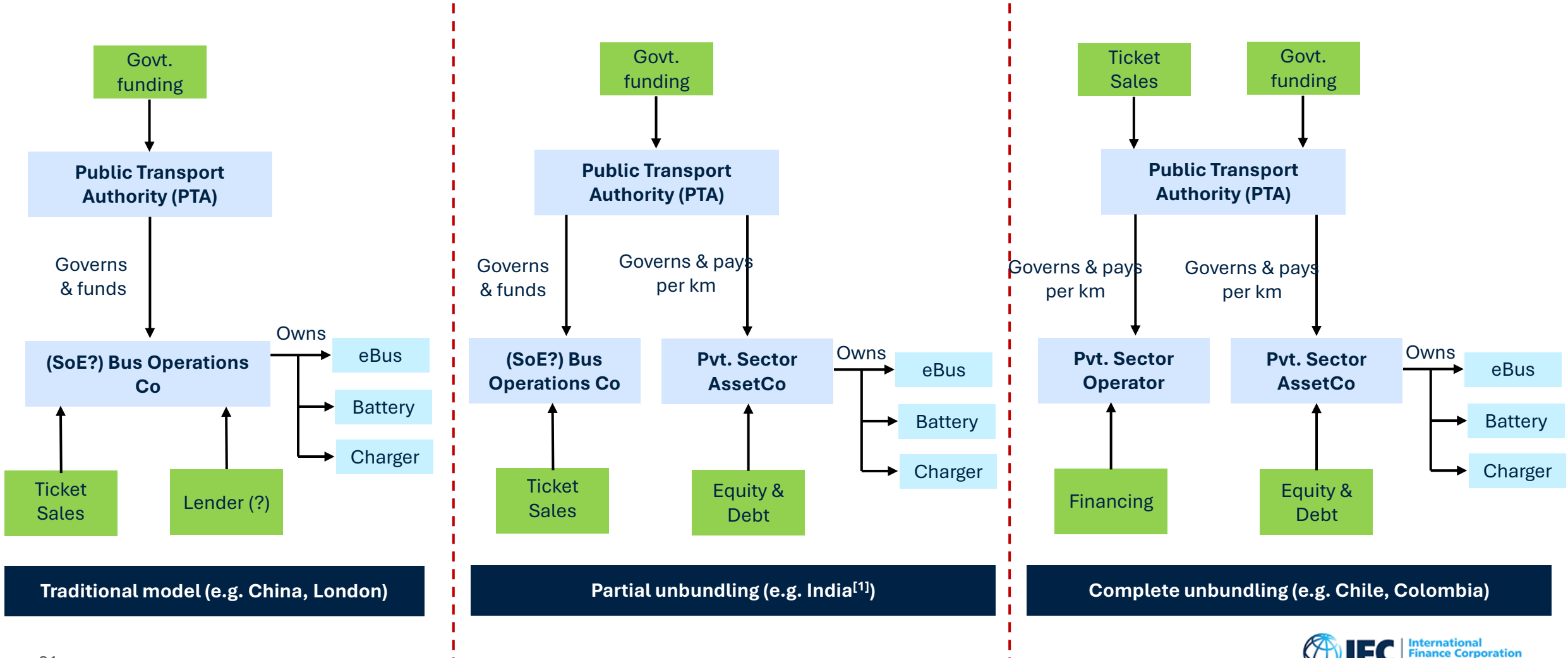
1. *Shift from consolidated ownership + operations to 'unbundled' models*

   - Asset and operations related risks and capabilities distributed across entities specialized in each

2. *Shift from Net Cost Contracts (NCC) to Gross Cost Contracts (GCC) models*

   - Eliminates 'demand risk' for the private players

Archetypes of e-bus biz models globally



*In India, the SoE entity plans and oversees operations and collects fares, but driver, vehicle cleaning, etc. is done by the private sector co.

Key roles & responsibilities in the ‘unbundled’ model

- Fleet Provider
  - Leases assets like e-buses, charging solution
  - Contract with transit authority
  - Responsible for ensuring uptime and asset related SLAs
  - Receives fixed payment per bus/month guaranteed by the transit authority, upon meeting asset SLAs.
- Operators:
  - Operate and maintain the fleet and depots according to set standards
  - May receive for a fixed payment per bus, plus a variable payment per km and per passenger (depending on fleet availability and KPIs).
- For both, the source of remuneration is an availability payment from the transit authority
- Payment quality depends on creditworthiness of the transit authority and the credibility and enforceability of the financial support from the municipality
  - Colombia – contract is with City of Bogota
  - Chile – contract is with Govt. of Chile

India: Cost reductions through aggregation at national scale

WORLD'S LARGEST GREEN MOBILITY DRIVE IS NOW BIGGER & BETTER

*Demand for sustainable mobility has increased to **6,465** e-buses*

CONVERGENCE energy. simplified
Convergence Energy Services Limited

	Lot 1 12m Low Floor AC	Lot 2 12m Low Floor Non-AC	Lot 3 12m Std Floor Non-AC	Lot 4 9 m Low Floor AC	Lot 5 9 m Std Floor AC	Lot 6 7 m Std Floor AC	Lot 7 (Type-III) 12m Std Floor Non-AC	Lot 8 (Type-II) 12m Std Floor Non-AC
Delhi	1900			2080				
Telangana		500					500	
Haryana			375		175			
Gujarat - Surat			150					
Arunachal Pradesh					6	4		
Kerala					125		450	200

For more details, visit https://www.convergence.co.in/tender

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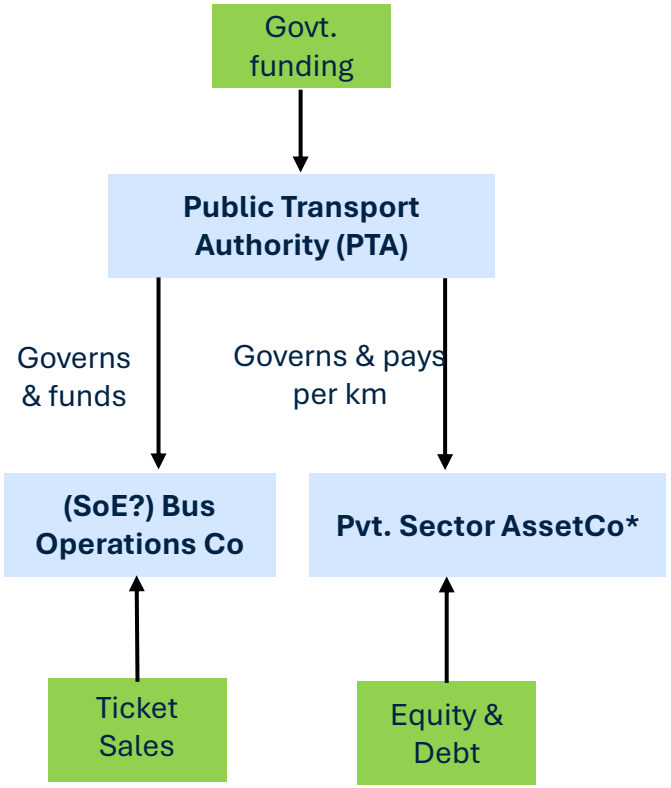
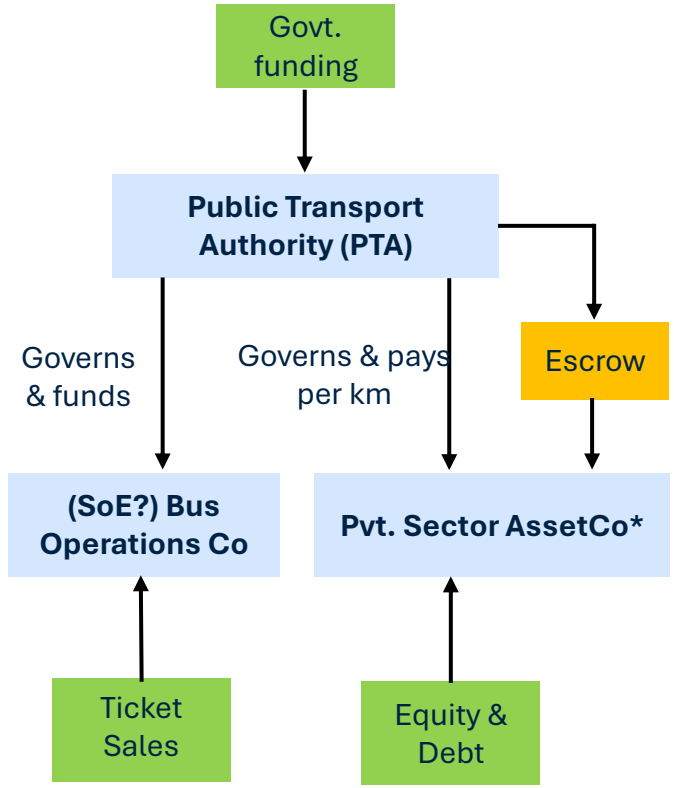
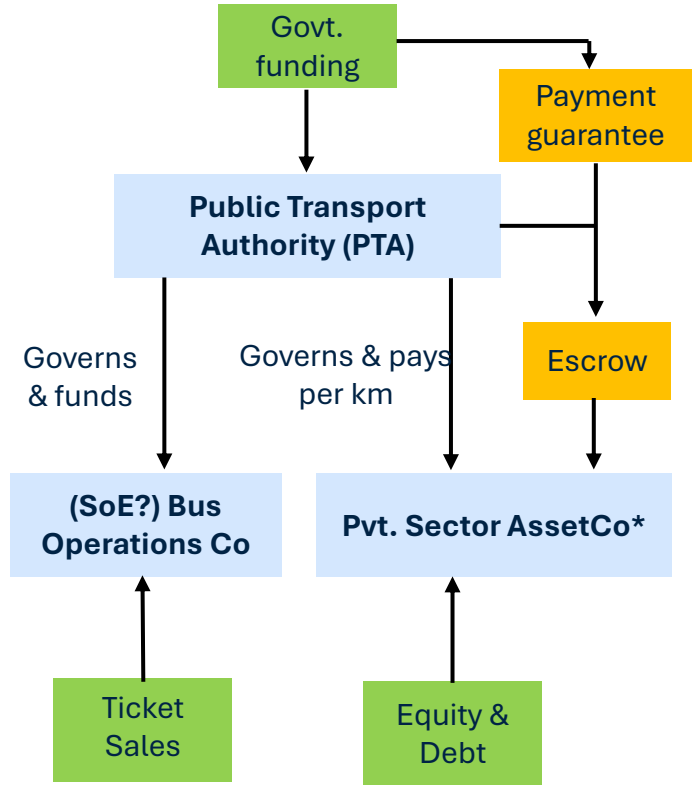
De-risking through payment security mechanisms



Initial Gross Cost Contracts (GCC)



Second phase of Gross Cost Contracts (GCC) evolution



PM E-bus Sewa Scheme

Key takeaways

- Well-structured private sector participation can accelerate e-bus adoption

- Three aspects of regulatory restructuring to be considered:
  1. Unbundling
  2. Standardization and aggregation
  3. Payment security mechanisms

End of Part 2

Part 3: Designing the solution

Focus of this session

1. How to derive the optimal specifications of e-buses and charging solutions to deploy?

2. What goes into planning of infrastructure?

3. What goes into planning for operations?

Bus, charger and infra specifications are derived from operational needs

1

1. Which routes?
2. # of e-buses per route?
3. How many trips per day?
4. Planned start & end times?

2

Identify (depot) locations for overnight parking and charging

3

Derive *optimal** e-bus & charger specifications (includes TCO** analysis)

4

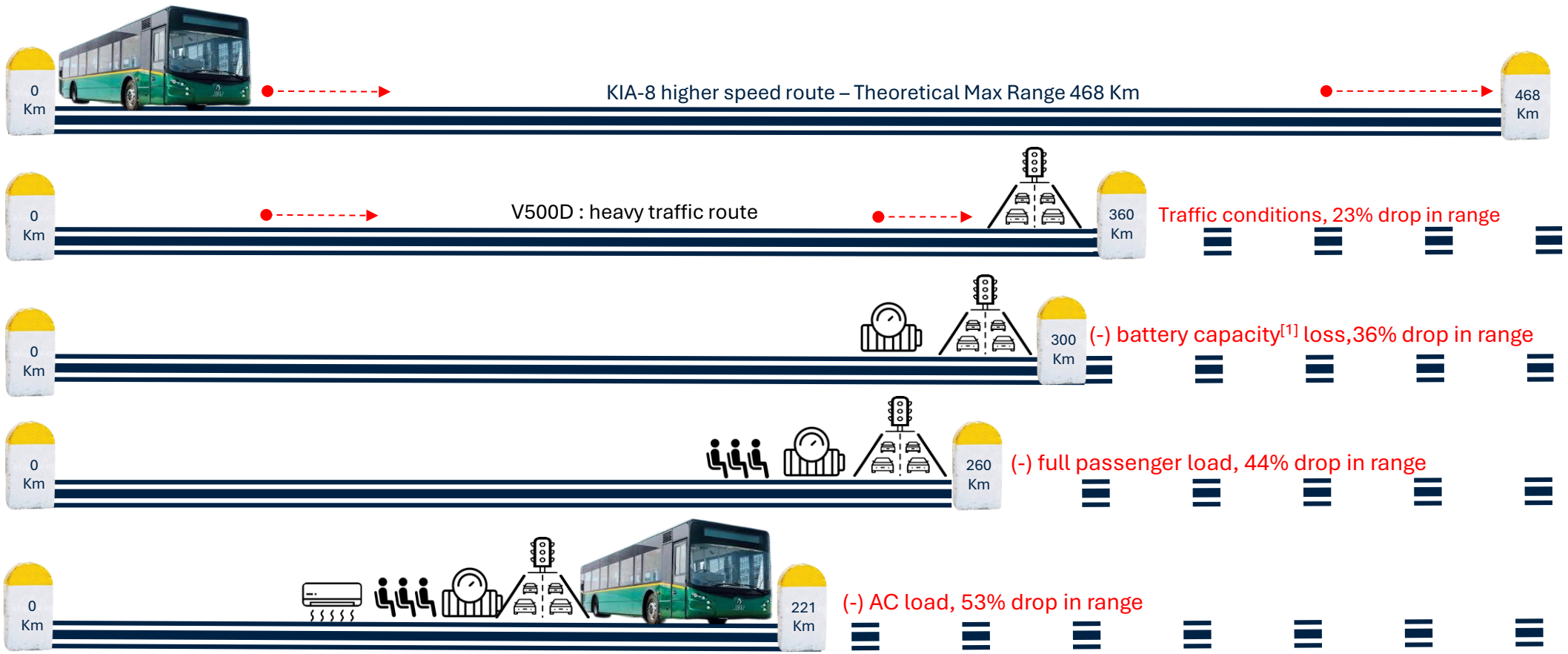
Assess power supply needs at each depot

Optimal specifications = meets operating needs at lowest costs

**TCO = Total Cost of Ownership over the life of the asset

Selecting the right specifications of e-buses and charging solutions requires an in-depth study of the routes and operations

Simulations on a 12m, 322 kWh e-bus on actual routes in Bangalore



Route conditions → impacts range → impacts # trips → impacts revenues

Percentage drop in range is cumulative

[1]Effective range drop due to 20% loss in battery capacity

Use of software tools to derive the optimal e-bus & charger specifications

Step 3

How it works

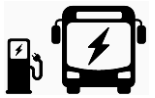
Inputs

1. GPS & operational data, gathered from existing and planned bus operations
2. Curated list of e-bus & charger specifications & prices

Software based mathematical modeling and simulations

Outputs

1. Desired specifications for e-bus & chargers
2. Detailed TCO model / financial viability gap assessment

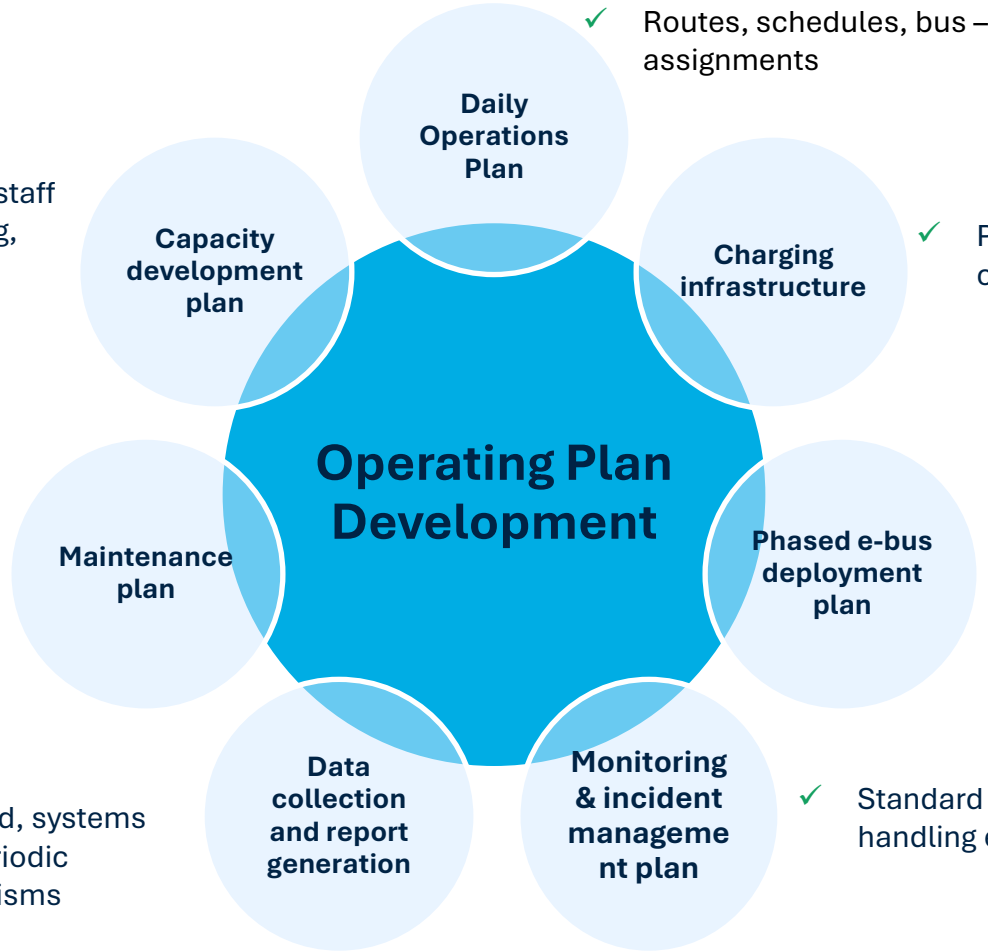


Evaluate wide range of battery size & charging power options to ensure operational feasibility at lowest cost

1. Accurate estimation of optimal specifications
2. Identification of bus routes that are operationally feasible and commercially most viable
3. Plan for charging infrastructure needed
4. Possible to deploy at scale
5. Improved estimate of financial viability and TCO for different scenarios
6. **Lowers risks of program failures**

Aspects of operational planning & capability development

Step 4



- ✓ Routes, schedules, bus – driver – charger assignments
- ✓ Plan, design, operate, manage, monitor charging infrastructure
- ✓ Phasing in the e-bus fleet to ensure minimal disruptions to operations
- ✓ Standard operating procedures (SOPs) for event handling e.g. on power failures, trip delays
- ✓ Define KPIs* to be monitored, systems & processes to generate periodic reports, escalation mechanisms
- ✓ Maintenance schedules, infrastructure, people training, tools, SOPs incl. escalation processes, spares availability
- ✓ Develop suitable e-bus specific staff training programs – driver training, fleet management, charging

Many of these aspects can benefit from the use of software based solutions for e-bus fleet planning, monitoring, management

KPI = Key Performance Indicators

Pilots can be conducted to validate analytical estimates & operational readiness

Step 7

Technical performance

Evaluate the real-world performance of e-bus and charging and compare with predictions made during Step 3, considering key factors:

- ✓ Energy consumption and efficiency with varying loads
- ✓ Charging times
- ✓ Speed, acceleration, gradeability, HVAC* performance, etc.
- ✓ Temperature rise of batteries, power train during operations

Operational readiness

Evaluate the operational processes and systems, for example with regards to:

- ✓ Day-to-day scheduling and monitoring
- ✓ Data collection and reporting
- ✓ Event / incident management protocols
- ✓ Repair & maintenance infrastructure readiness

Stakeholder satisfaction

Assess perception of key stakeholders and other qualitative aspects:

- ✓ Riders, including with regards to comfort, noise, image
- ✓ Driver, e.g. on bus performance, overall process

System Impacts

Evaluation of overall benefits / risks of program, e.g. on:

- ✓ Greenhouse gas emission reductions
- ✓ Impact on local air pollution and noise

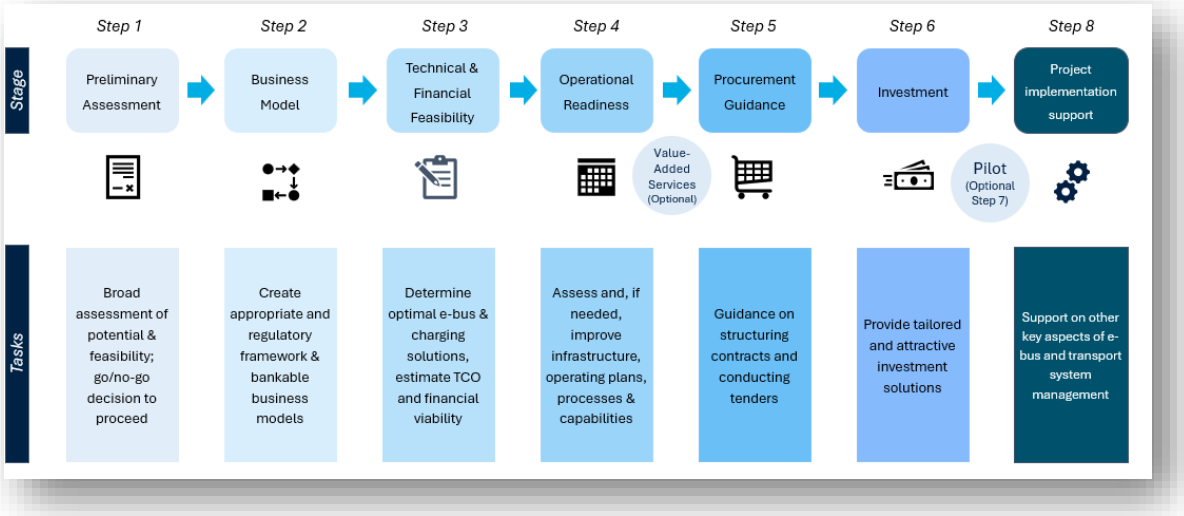
*HVAC – Heating, Ventilation, Air Conditioning

Some key lessons learnt in deployments

1. Clear definition of roles and responsibilities. Examples –
    a) Who will provision power supply for charging – upgrade transformers, switchgears, etc.?
    b) Who will setup (install & commission) charging stations?
2. Post-tender plan and milestones
    a) Validate e-buses and chargers are of the same spec as indicated in the tender
    b) Validate the solution meets operational needs
    c) Schedule of deliveries of e-buses and chargers matches tender declarations
3. A few simple steps can improve battery life, lower operating costs
    a) Driver training – safe driving techniques are also energy saving techniques
    b) Optimal tire pressure
    c) Optimal power and level of charging

Session recap

1. Risk mitigation mindset in program design
2. Program design precedes financial design
3. Need to engage a wide range of stakeholders early on
4. Well-structured private sector participation can accelerate e-bus adoption
5. Three aspects of regulatory restructuring to be considered:
   a) Unbundling
   b) Standardization and aggregation
   c) Payment security mechanisms
6. Technology in project design and operations can lead to significantly lower cost & risks.



Thank you