Market Assessment for Intercity Electric Buses in India

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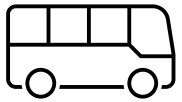
Need for electrification of intercity buses in India

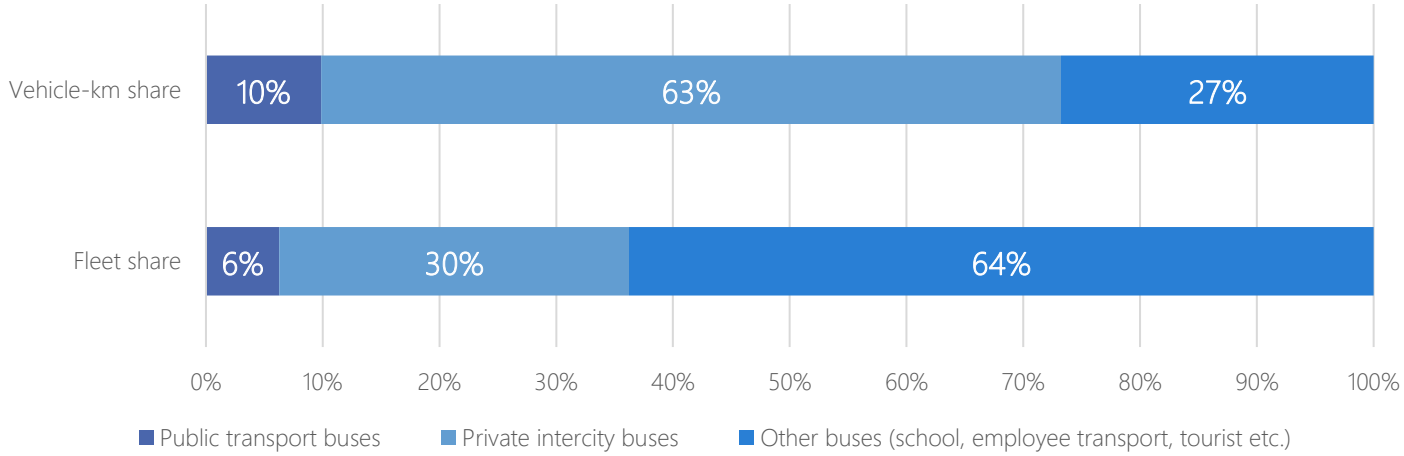


- Private intercity buses carry 22 Cr passenger everyday-57% of all bus trips in India.
- Form 30% of buses and 63% of vehicle-km operated by buses

- Road transport accounts for 12% of India's energy-related CO_2 emissions and is among the fastest growing end-use sectors in terms of Green House Gas (GHG) emissions (IEA, 2023)
- Inducing mode-shift to buses and transitioning to electric buses (e-buses) offers the maximum GHG mitigation potential for India's passenger transport (ITF, 2023)
- Each intercity e-bus can offer ~1,000 tCO_2e of lower life cycle GHG emissions, compared to diesel/ CNG buses.

Type of bus	No. of buses (in '000s)	Annual veh-km operated (in Cr-km)	Share of annual-km operated	Daily ridership (in lakhs)
PTA*- Urban	33	174	1%	210
PTA- Non-Urban	112	1,220	9%	456
Private- Stage Carriage	**400**	**4,900**	**35%**	**1,726**
Private- Contract Carriage	**290**	**4,060**	**29%**	**556**
School/ Education	280	560	4%	153
Omni	210	693	5%	190
Omni for private use	600	1,200	8%	329
Others	380	1,330	9%	364
Total Buses	2,305	14,137	100%	3,985

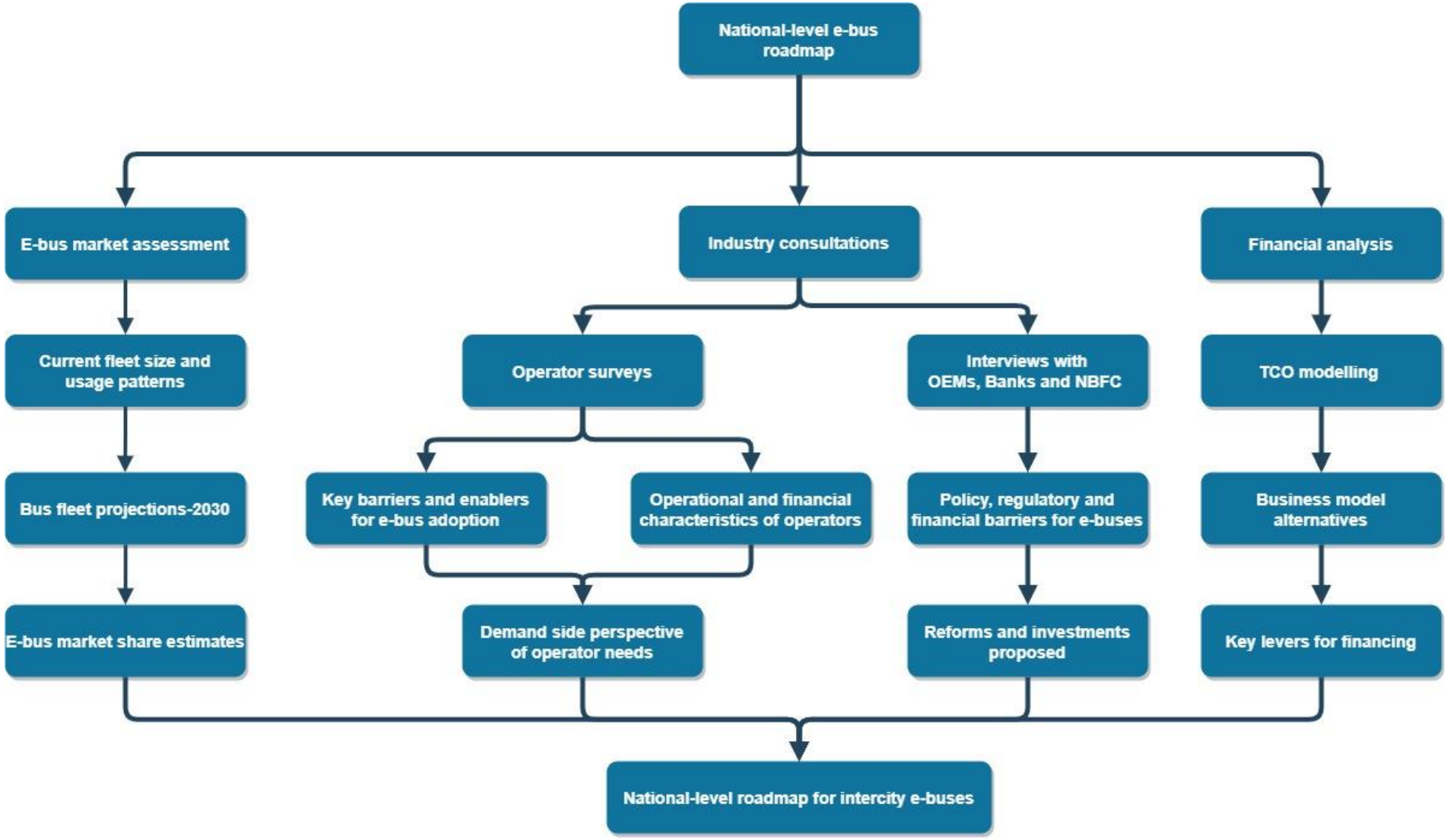
Overview of bus market in India (2020)



E-bus adoption among intercity buses offers dual benefits of sustainability mobility and GHG mitigation

Source: Analysis built on Road Transport Year book, 2020

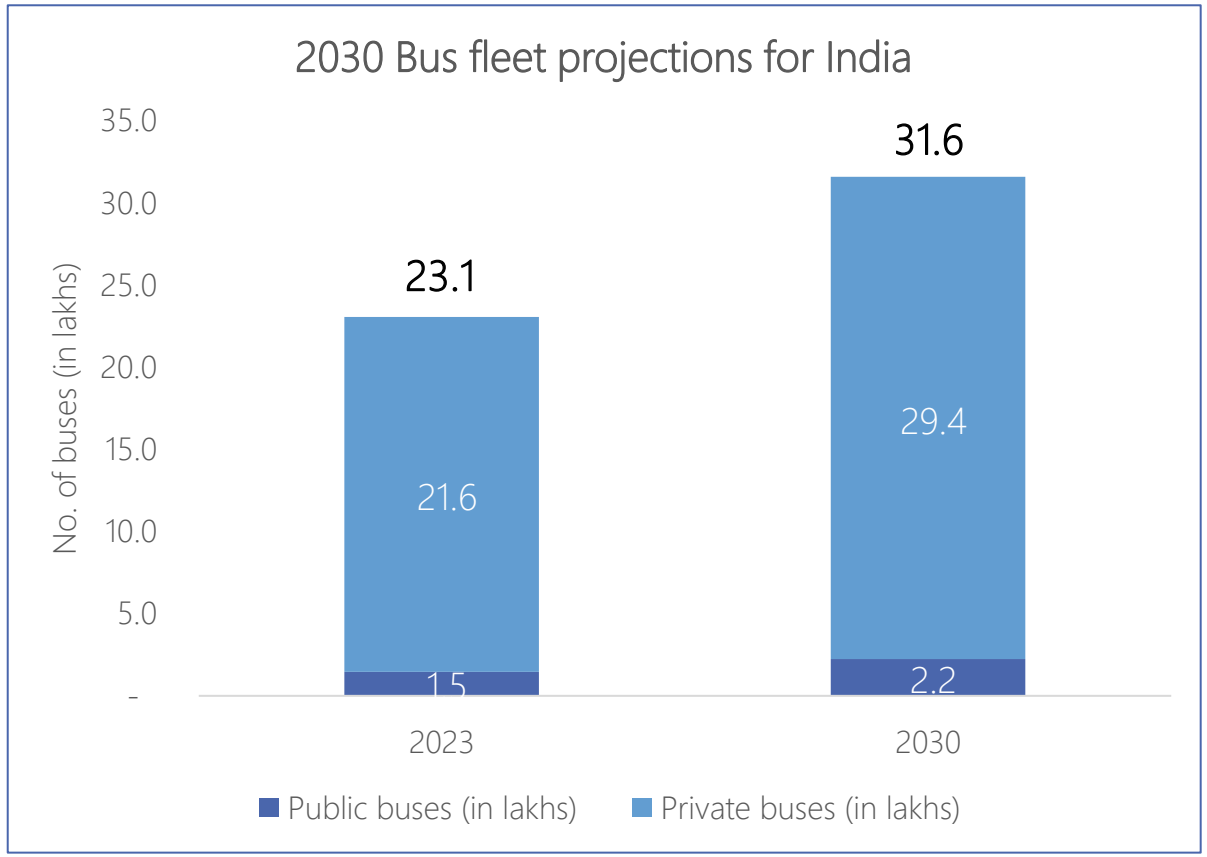
Approach to develop a 'Roadmap for intercity e-buses'



A combination of long-term market projections, stakeholder consultations and financial analysis is carried out to develop a National-level roadmap for e-bus adoption among private intercity buses

Bus fleet projections for 2030

- India's bus fleet projected to increase from 23.1 lakhs in 2023 to 31.6 lakhs by 2030: 2.2 lakh public buses and 29.4 lakh private buses.
- About 20 lakh (2 million) new buses are likely to be procured between 2024 and 2030 for fleet augmentation and replacement needs
    - 18 lakh by private and 2 lakh by public bus operators
    - 3.15 lakhs out of private buses to be electric-80% on intercity
- A market size of 2.52 lakh buses (0.252 million) is estimated for the private intercity e-bus market until 2030.
- Capital investments worth about INR 3.02 lakh Cr (~USD 37.8 billion) needed to meet this target, assuming INR 1.2 Cr (~USD 150,000) per bus

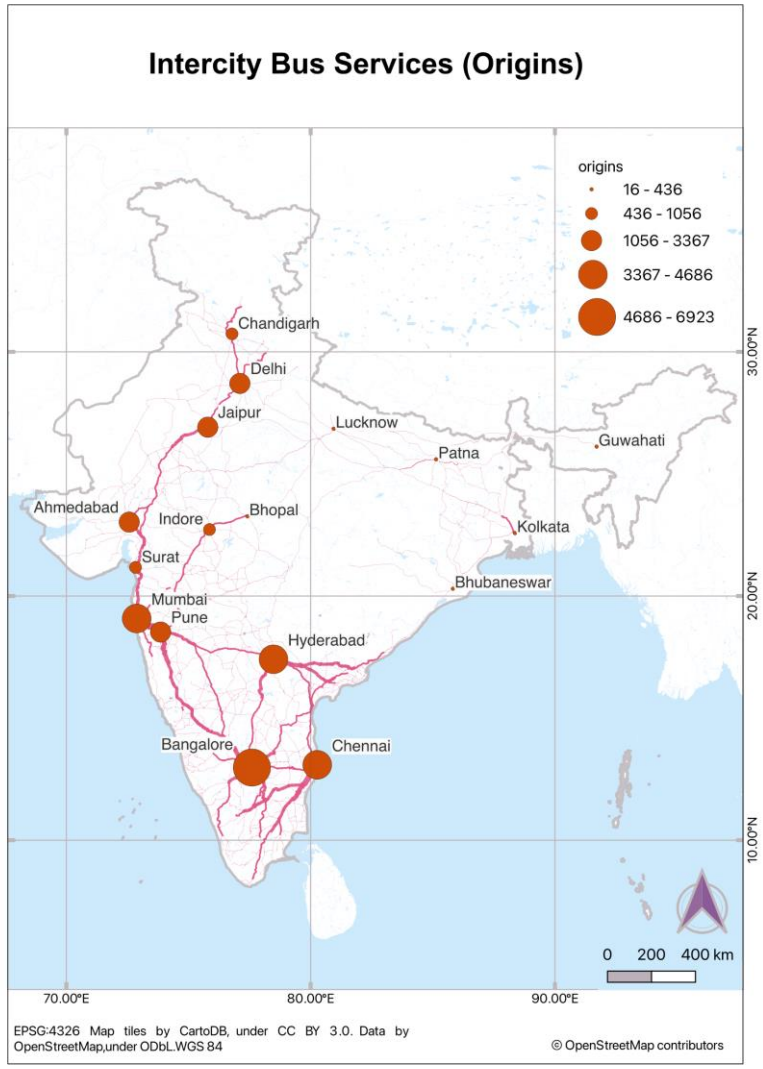


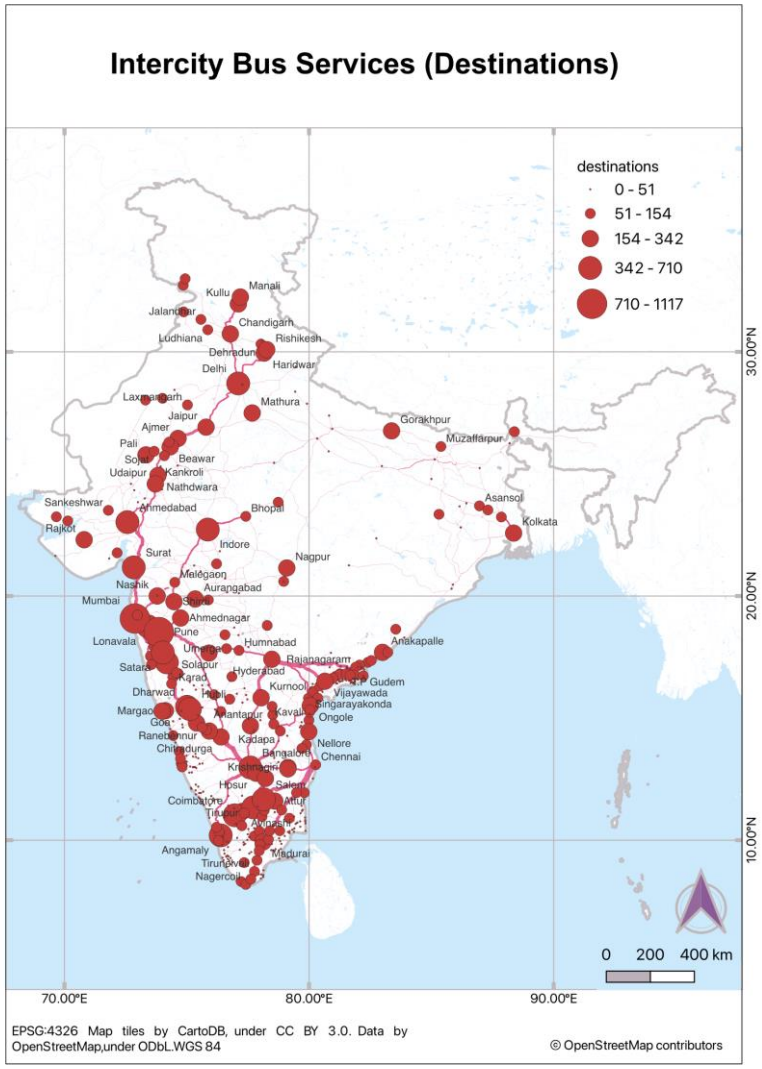
India can potentially introduce 2.5 lakh private intercity e-buses by 2030

Will require investments of over ~3 lakh Cr (~USD 38 billion)

Demand centres for Intercity Buses in India

- The intercity bus market was assessed through mapping existing bus services
- 32,654 Services operating from the top 17 demand centres in India were analysed
- Key characteristics analysed
  - Top O-D pairs
  - Top operators across cities
  - Types of services (AC, Non-AC, Sleeper, Seater etc.)
  - Fares by service type
- The top demand centres and key corridors of operation of e-buses were identified through the mapping exercise.



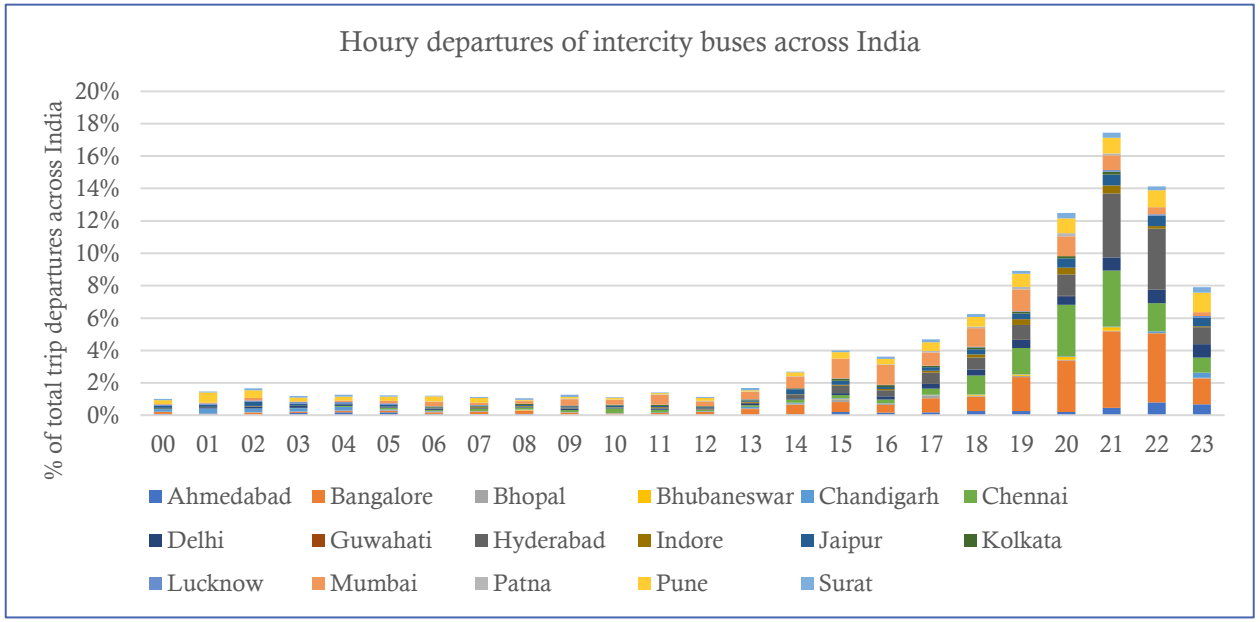


The mapping exercise provides key insights for charging infrastructure needs of e-buses and revenue potential for financiers.

Departure and Arrival time trends

- Air Conditioned (AC) services which form 70% of all the trips while Non-AC services form the remaining 30%.
- 57% of the services are exclusively Sleeper services while 28% services have a mix of seater and sleeper seats
  - Sleeper services are preferred on routes longer than 400 km
  - Semi sleeper services are preferred on routes in the 300-400 km category
  - Seater services typically operate on routes shorter than 300 km.
- 61% trips depart during the 5 hours between 7 PM till midnight
  - 17% of departures are in the peak hour of 9-10 PM

Type of service	% of trips	Average route length (in km)	Fare per km (INR/km)	Average travel time (hrs:min)
AC Sleeper	44%	432	5.8	08:54
Non AC Sleeper	13%	417	4.0	09:00
AC Seater + Sleeper	15%	440	4.7	05:43
Non AC Seater + Sleeper	13%	408	3.6	08:53
AC Semi Sleeper	6%	355	4.1	07:04
Non AC Semi Sleeper	1%	394	2.7	08:05
AC Seater	5%	210	4.5	05:13
Non AC Seater	3%	282	4.9	07:47
AC Seater (Electric)	0.5%	215	1.7	04:21
Total/ Average	100%	407	4.9	08:06



Service and fare characteristics provide insights to OEMs and financiers in planning their products

Stakeholder-wise barriers for e-bus adoption

Extensive consultations were conducted to understand barriers for e-bus adoption, financing and manufacturing

Operators	Financing Entities	OEMs	Cross-cutting barriers
Lack of infrastructure (depot and charging) and technology readiness (range, cabin space)	Lack of understanding of operations and fragmented nature of market.	Lack of long-term visibility for demand and lack of consolidated procurement	Trust deficit between stakeholders
Change in the nature of business from low-CAPEX, high-OPEX to high-CAPEX and low-OPEX	Poor credit worthiness of operators, post Covid-19	Difficulty with long-term commitment to contracts	Lack of data on existing operations
Unfavourable unit economics (financial viability per bus and uncertainty of returns compared to ICE)	Bankability of individual projects/ deals unclear	Lease model economics unfavourable	Product quality and safety unclear
OEMs outpricing the bus compared to specs offered	Lack of financial de-risking products	Variability in battery pricing	Policy issues concerning permits, infrastructure and financing
Lack of access to finance	Lack of visibility and access to ticketing revenue	Supply chain challenges of EVs due to import dependence.	Lack of clarity on timeline for GST benefits
Need for new business models for e-buses: Leasing and revenue sharing	Lack of price benchmarks compared to ICE buses and limited resale value of e-buses		
Loss of jobs for people employed for diesel bus maintenance.	OEMs unwilling to underwrite product performance		
Limited resale value of buses and rigidity in route deployment due to charging constraints	Operators' unwilling to pay for risk premium of e-buses		
Leasing companies including high risk-premium and restricting operating conditions			

Barriers identified provide specific pointers to policy recommendations needed to unlock the market

Operator Surveys: Findings

- 365 operators interviewed
  - 306 samples used for detailed analysis

- Fleet ownership characteristics
  - 99% of the fleet is owned by the operators,
  - 0.7% on lease
  - 0.4% is owned by the operator but is operated under a bigger brand name

- Average age and life of fleet
  - 69% first-hand vehicles, 31% second-hand vehicles
  - Average age of fleet: 5.2 years, Maximum: 15 years

- Service hours and location for parking
  - Buses are operational for 12-14 hours in a day on average

Fleet operated	No. of operators (in %)	Total fleet (AC + Non-AC) (in %)
<=5	78%	10%
>5 and <= 50	17%	29%
>50	4%	61%
Total	100%	100%

Legal entity owning buses	Number of operators (in %)
Individual	62%
Partnership	14%
LLP	11%
Private Ltd.	10%
Others	0%
Section 8 Company	2%
Total	100%

Type of parking location	Number of operators (in %)
Private Parking	51%
On-road	48%
Government bus stand/ depot	1%
Others (Own space/ shared parking/ schools etc.)	1%
Total	100%

Large fleet (>50 buses) owners control 61% of fleet; ~50% of fleet doesn't have organised parking

Operator Surveys: Findings

- Demand patterns
  - Bus occupancy is more than 60% even during off-season
  - Average days of off-peak: 153 days per year
  - Occupancy during peak days- >80% for 98% services

Occupancy ratio (in %)	Peak season	Off-peak season
<=60	1%	32%
60-70	0%	49%
70-80	1%	16%
80-90	80%	3%
>90	18%	0%
Total	100%	100%

- Cost structure
  - Cost of diesel contributes 58% of total cost
  - Loan EMI is the second biggest cost at 14%
  - Staff cost (6%) much lower than STU buses where staff cost is typically the highest cost (~40%)-due to lower salaries, higher-km and self-operated buses
  - Cost structure will flip to lesser energy cost and higher EMI for electric buses. Need to understand the difference to make the case for e-buses

Cost head	% of total cost of operations
Diesel cost	63%
EMI on loan	10%
Maintenance cost	9%
Staff cost	4%
Toll-road fees	4%
Motor-Vehicle Tax	3%
Permit fees	3%
Administrative expenses	1%
Parking fees	2%
Other costs	2%
Total	100%

Revenue risk of private operators isn't as high as perceived; Cost structure of pvt. buses dominated by fuel.

Operator Surveys: Findings

- Financing of vehicles
  - 86% of diesel buses are financed by banks-indicating bankable loans
  - Loan To Value (LTV) ratio of buses is reported at an average of 78% of asset costing with a minimum of 70% and a maximum of up to 100% vehicle cost being financed.
  - The average loan tenure is about 4.2 years with a maximum of 8 years
- The collateral shown for new buses in most cases in the existing bus fleet of the operator.
  - The same scenario is less likely to succeed for e-buses given the significantly high cost per bus which needs many existing buses to be shown as collateral.
- Re-financing is an occasional occurrence for the majority indicating good discipline in payments
  - Post Covid-19 more instances of re-finance occurred and in many cases-up a tenure of 2-4 years

Source of finance	% of operators
Banks	86%
Non-Banking Finance Corporations	6%
Private Financer	5%
Own	3%
Total	100%

Collateral for loans	% of operators
Existing bus fleet	67%
Personal assets to be mortgaged (properties, land, gold etc.)	22%
Company balance sheet and assets to be mortgaged	1%
Grand Total	100%

How often do you refinance buses?	% of operators
Never	46%
Occasionally	47%
Regularly	7%
Grand Total	100%

Typical refinance tenures	% of operators
6 months - 1 year	5%
1 year - 2 years	42%
2 years - 4 years	53%
Grand Total	100%

Majority of private operators financed by banks and re-finance is a trend only after Covid-19

Operator Surveys: Findings

- 80% operators prefer e-buses are their future choice
  - Preference dropped to 43% when current economics are presented
  - 70% want to operate on fixed income basis
- ICE bus issues: Financial sustainability (Diesel cost), parking, staff and taxes
- Top enablers needed for e-buses: **Range, parking and charging, capital cost of e-buses and access to finance**

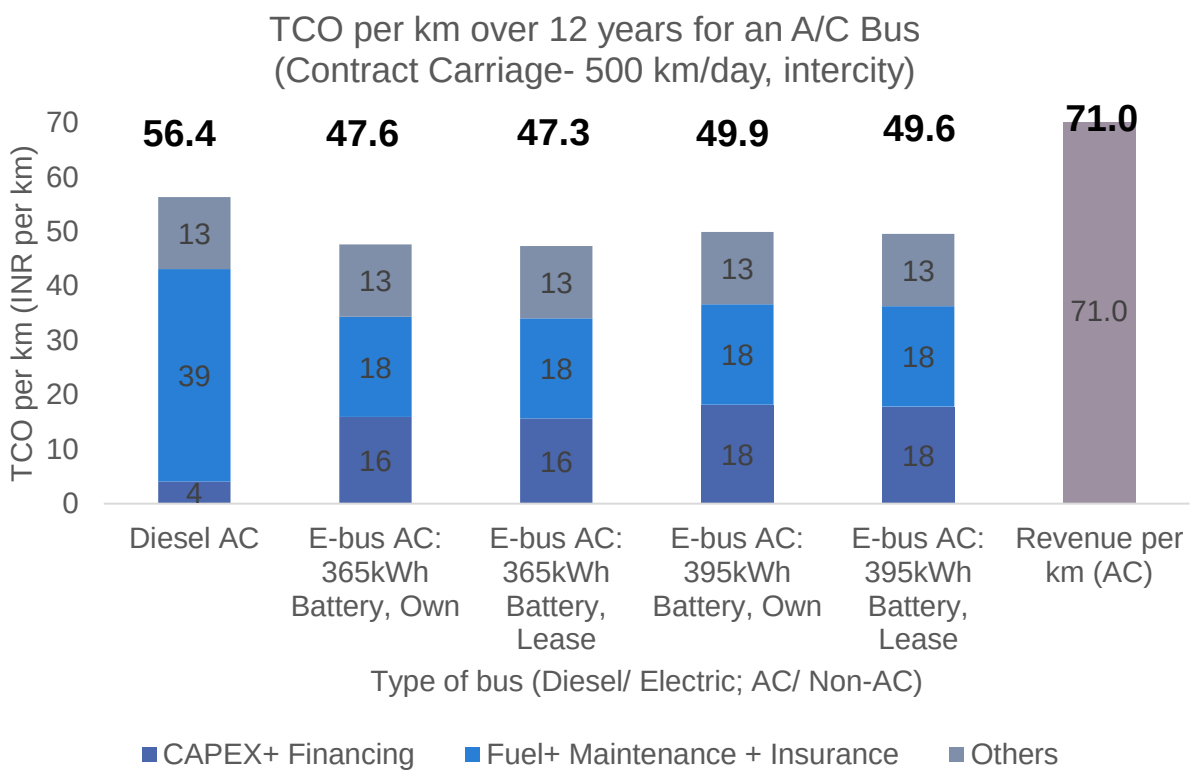
Preferred business model for e-buses	Rank
Operate buses on a fixed income basis (without revenue risk)	70%
Lease/ rent buses from Government	17%
Lease/ rent buses from private entities	7%
Own and operate	6%

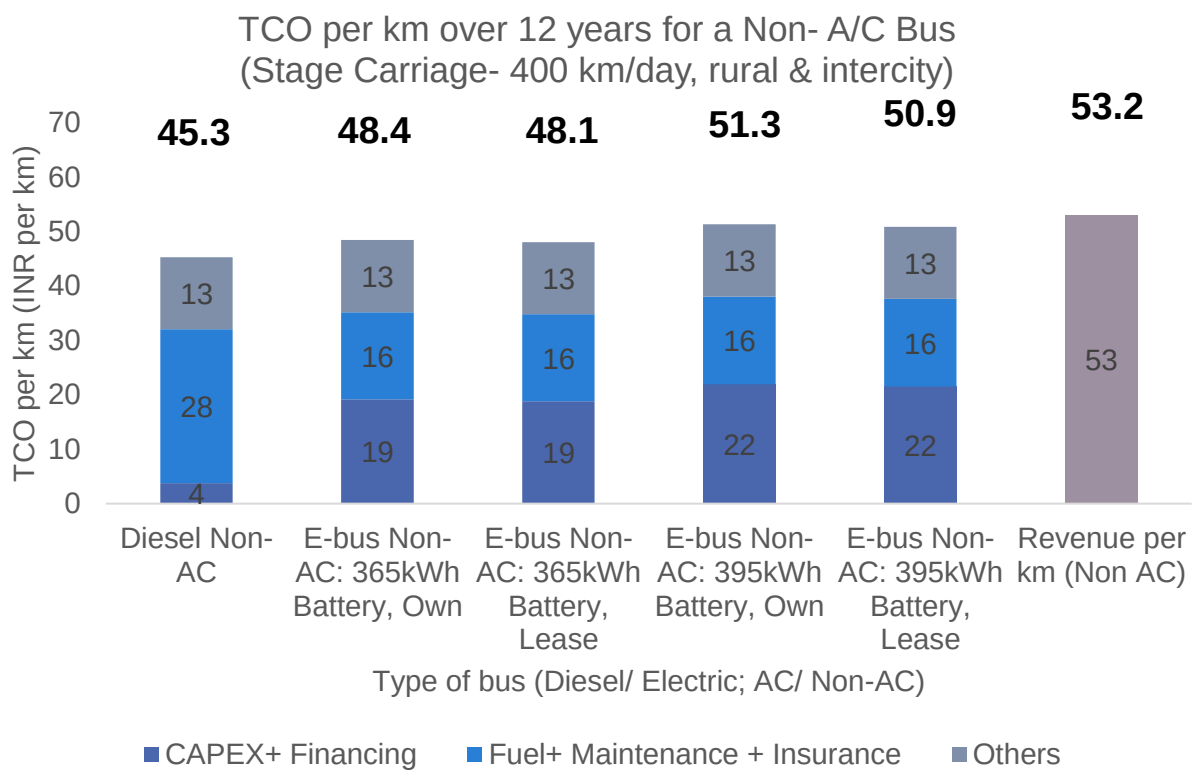
key enablers to adopt e-buses	Average rank
Improve range offered by e-buses	9.67
Increase availability of charging	9.62
Reduce cost of e-buses	9.57
Provide space to park and charge e-buses	9.31
Reduce taxes and permit fees	8.79
Share knowledge on electric buses	8.13
Improve access to finance	8.11
Increase number of vehicle models	7.70

Ranking of challenges faced by operators	Average rank
Cost of fuel (Diesel/CNG)	9.6
Lack of bus parking and maintenance facilities	8.5
Revenue recovery of operations cost	7.2
Hiring and managing staff	7.1
Motor Vehicle Tax	6.6
Irregular payments	5.4
Cost of permit	5.1
Vehicle model availability and quality	4.1
Access to finance	4.2
Availability of permit	3.3

80% operators willing to adopt e-buses; Need to address range, charging and capital cost issues

Total Cost of Ownership (TCO) Analysis





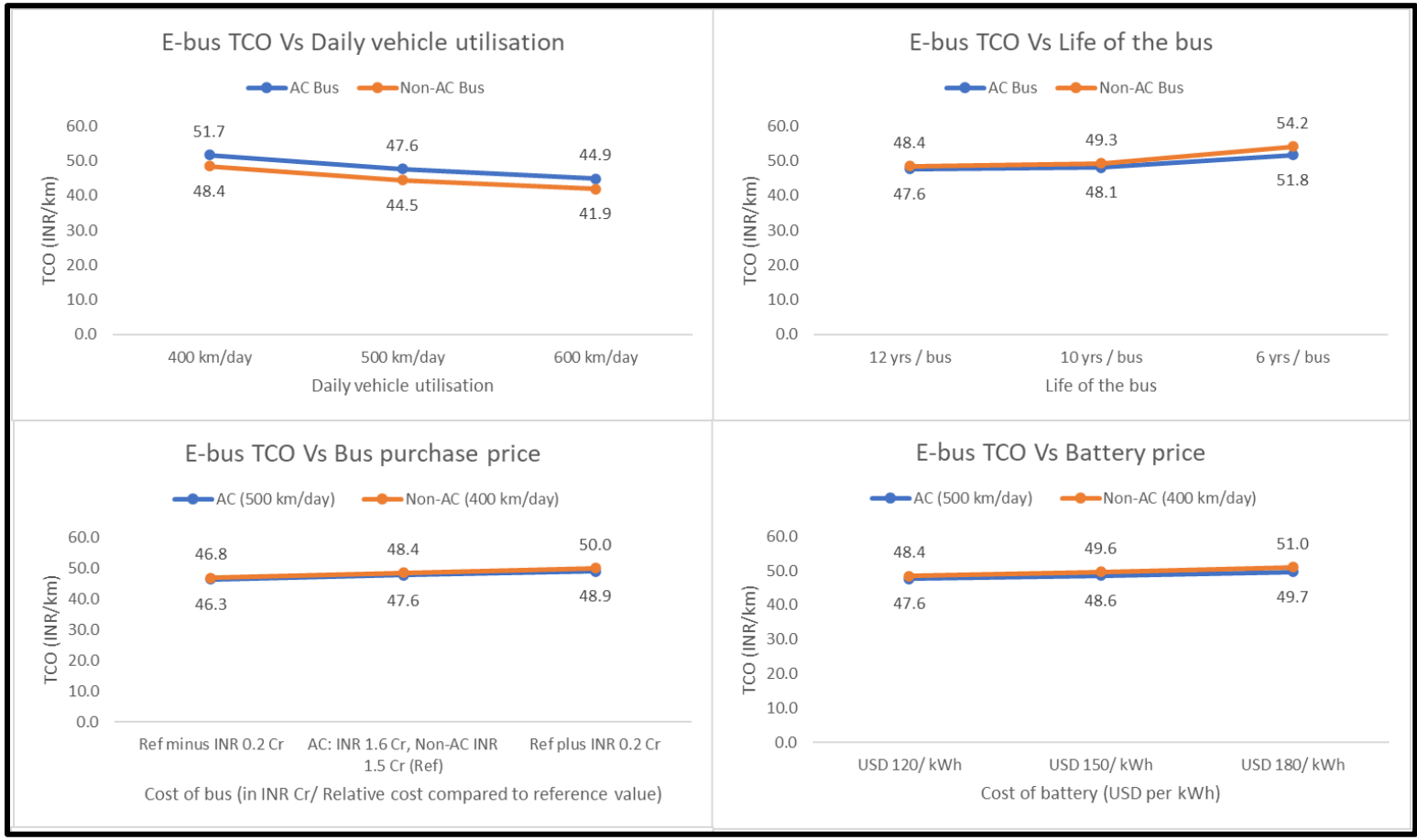
Assumptions: Cost of bus- INR 1.6 Cr (365 kWh battery), INR 1.9 Cr (335 kWh battery); Cost of charging: INR 20 lakhs per bus; Daly-km: 500 km; Annual days of operation: 350; Diesel price: INR 90 per l; Electricity tariff: INR 7.5 per kWh; Annual increase in diesel and electricity: 5%; Cost of finance: 12% for operator, 11% for aggregator, LTV: 75% on bus, battery; Loan tenure: 6yrs/bus, 6yrs/battery; Cost of equity: 20% for operator, 15% for aggregator

Assumptions: Cost of bus- INR 1.5 Cr (365 kWh battery), INR 1.8 Cr (335 kWh battery); Cost of charging: INR 20 lakhs per bus; Daly-km: 500 km; Annual days of operation: 350; Diesel price: INR 90 per l; Electricity tariff: INR 7.5 per kWh; Annual increase in diesel and electricity: 5%; Cost of finance: 12% for operator, 11% for aggregator, LTV: 75% on bus, battery; Loan tenure: 6yrs/bus, 6yrs/battery; Cost of equity: 20% for operator, 15% for aggregator

TCO parity achieved in longer-distance services. Both AC & Non-AC services will still make profits with e-buses.
Lease model of procurement can be potentially cheaper due to lower finance costs.
However, risk attribution within lease payments can outweigh the cost savings.

TCO: Key finings and Sensitivity Analysis

- Key findings from TCO analysis
  - TCO of AC e-buses is 12%-15% lower than AC diesel over its 12 year life
  - Non-AC e-buses can be 6%-13% higher compared to diesel buses
  - Reducing bus cost to INR 1.1 Cr will achive TCO parity for Non-AC buses
  - Lease model is 0.7-0.9% cheaper for AC and Non-AC compared to ownership due to lower cost of financing for the leasing company (9% Vs 15%)
  - Using 395 kWh batteries instead of 365 kWh will add 5-6% to TCO range for AC and Non-AC
- Variables impacting TCO (1/2)
  - Daily-km can impact TCO by 13-14%
  - TCO of AC buses is ~7% higher for e-buses compared to 24-25% in case of ICE buses

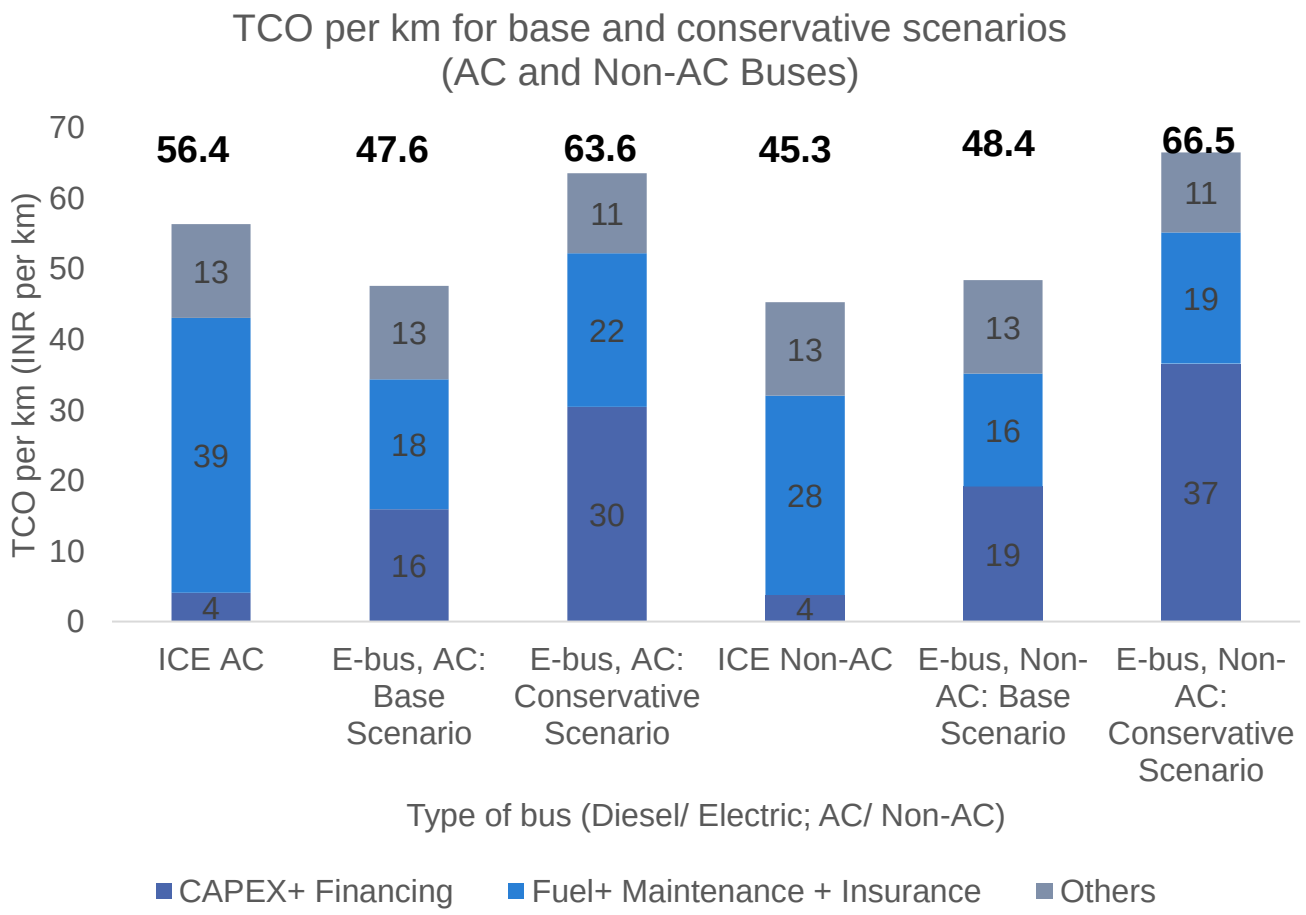


TCO: Key finings and Sensitivity Analysis

- Variables impacting TCO (2/2)
  - Reducing life of bus from 12yr to 6 yrs increases TCO by 9%
  - Electricity tariff can impact TCO by 9-11%
  - Bus costs in India are currently inflated due to limited manufacturing capacity. Addressing that can reduce TCO by up to 5-7%
  - Continuation of tariff subsidies for EVs is crucial for e-bus tariff parity
- Financing terms
  - Loan To Value (LTV), loan tenure and interest rate are the key financing terms impacting TCO
  - LTV impacts the binary choice of procuring e-bus or not. Loan tenure and interest rate determine the relative TCO

TCO: Base case Vs Conservative case

- TCO variables depend on type of operator
  - Larger operators attract better terms on bus cost and financing, have access to infrastructure
  - Intercity operations have better TCO due to higher daily-km
  - Risk attributed to e-buses leads to conservative estimation of life of bus, demand aand payment capability of operator
- Key results: Base case Vs Conservative
  - Conservative scenario TCOs are higher for e-buses across AC and Non-AC, contract and stage carriage services
  - De-risking the investment in e-buses is key to reduce the perceived risks and price the e-bus and financing products better
  - Extended warranties, expanding manufacturing capacities, first and second loss instruments on loans, improved data reporting on existing demand and revenue patterns will help de-risk investments substantially



TCO Analysis: Cashflows

- Operating expenses higher than capital expenses even for electric buses
- EMI/ lease payment for Non-AC buses is more than 400% higher for Non-AC buses
    - This reduces the attractiveness of electric buses for Non-AC segments

Type of bus, battery and ownership	EMI/ Lease payment		Operating expenses		Capital + Operating expense	
	Actual	% difference vs diesel	Actual	% difference vs diesel	Actual	% difference vs diesel
Diesel AC	59,000		5,69,000		6,28,000	
E-bus AC: 365kWh Battery, Own	2,33,000	295%	2,68,000	-53%	5,01,000	-20%
E-bus AC: 365kWh Battery, Lease	2,28,000	286%	2,68,000	-53%	4,96,000	-21%
E-bus AC: 395kWh Battery, Own	2,65,000	349%	2,70,000	-53%	5,35,000	-15%
E-bus AC: 395kWh Battery, Lease	2,60,000	341%	2,69,000	-53%	5,29,000	-16%

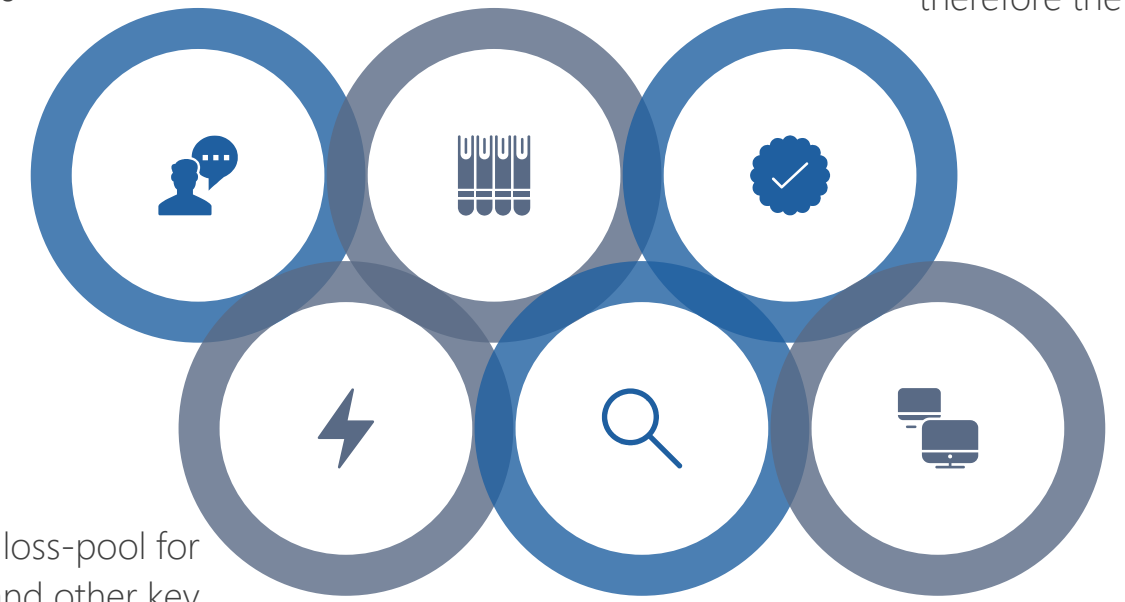
Type of bus, battery and ownership	EMI/ Lease payment		Operating expenses		Capital + Operating expense	
	Actual	% difference vs diesel	Actual	% difference vs diesel	Actual	% difference vs diesel
Diesel Non-AC	55,000		4,12,000		4,67,000	
E-bus Non-AC: 365kWh Battery, Own	2,80,000	409%	2,33,000	-43%	5,13,000	10%
E-bus Non-AC: 365kWh Battery, Lease	2,74,000	398%	2,33,000	-43%	5,07,000	9%
E-bus Non-AC: 395kWh Battery, Own	3,20,000	482%	2,35,000	-43%	5,55,000	19%
E-bus Non-AC: 395kWh Battery, Lease	3,14,000	471%	2,35,000	-43%	5,49,000	18%

Key Recommendations

Transparency in e-bus costs across AC & Non-AC buses is needed to rationalise the prices offered to different operators

Demand Aggregation and lease based procurement across private operators, can achieve economies of scale.

Financial de-risking of loans through first-loss/ second-loss facilities needed to reduce the cost of financing and therefore the total cost of ownership



National-level mandate needed for OEMs to publish product specifications being offered and their operational performance to assuage market concerns.

Creating a loss-pool for batteries and other key components to allow lifecycle based financing for e-buses

Ubiquitous charging infrastructure with priority for high-demand corridors is a pre-condition for e-bus uptake