ZEBRA
ZERO EMISSION BUS
RAPID-DEPLOYMENT ACCELERATOR

Planning for
the Implementation of
Electric Buses

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REALIZAÇÃO C40 CITIES icct CONSELHO INTERNACIONAL DE TRANSPORTE LIMPO

APOIO Drive Electric CAMPAIGN iCS

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Electric Buses vs. Diesel Buses

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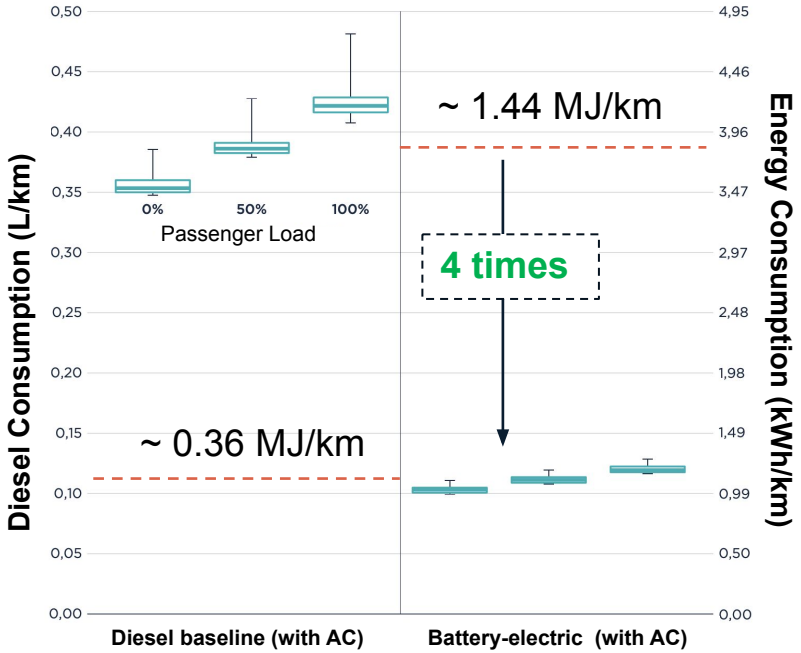
Energy performance

Energy Efficiency

The **diesel bus** consumes about **four times the energy per kilometer** compared to the **BEB**.

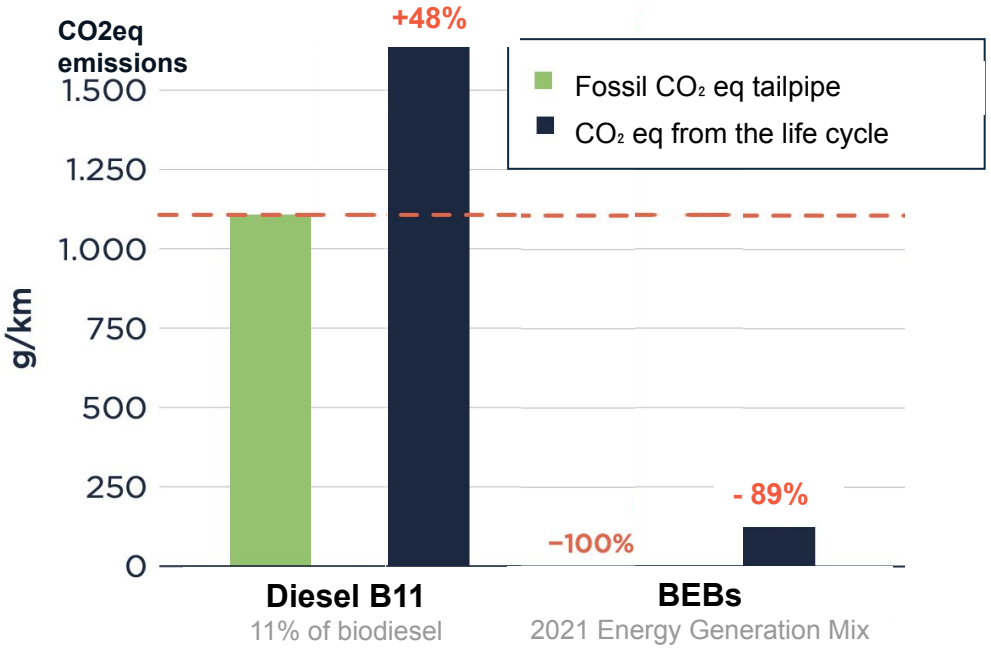


Source: ICCT, 2022

Environmental Performance

Environmental

The **electric bus** promotes a reduction of approximately **90%** in **CO2eq emissions** (over the life cycle).



Source: ICCT, 2022

Total Cost of Ownership (TCO)

Capital Expenditures (CapEx)

Infrastructure

Vehicles

Operating Expenses (OpEx)

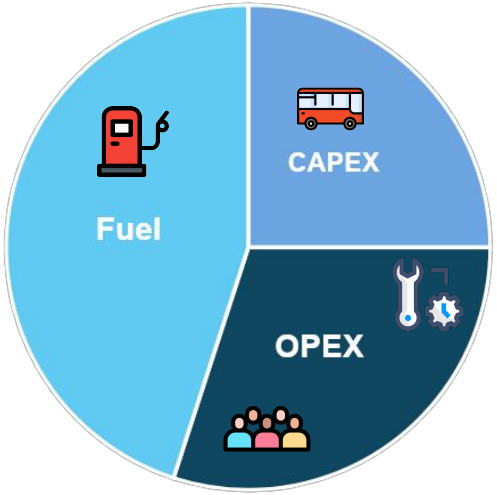
Electric Energy / Fuel

Other operating expenses:

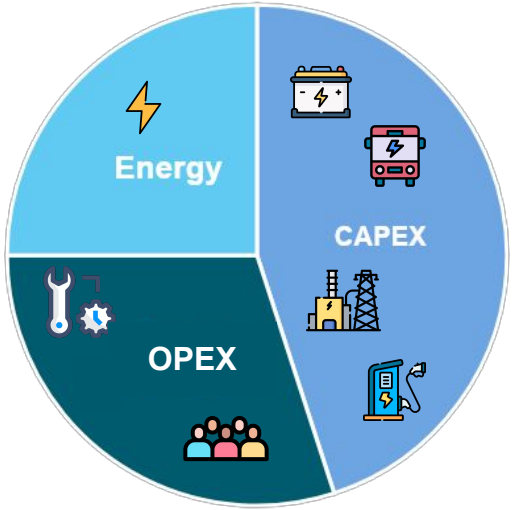
Maintenance (vehicles/infrastructure)

Personnel costs

Diesel Bus



Electric Bus

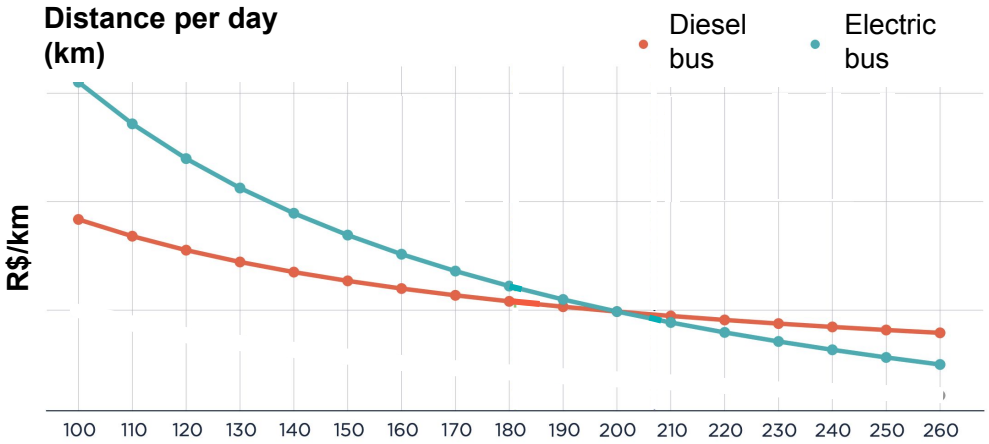


Source: Analysis of the deployment of zero-emission buses in the fleet of a bus operator in the city of São Paulo. ZEBRA, ICCT

Total Cost of Ownership (TCO)

Cost

From around **200 km** per day, the **electric bus** would reach TCO parity with **diesel bus**.



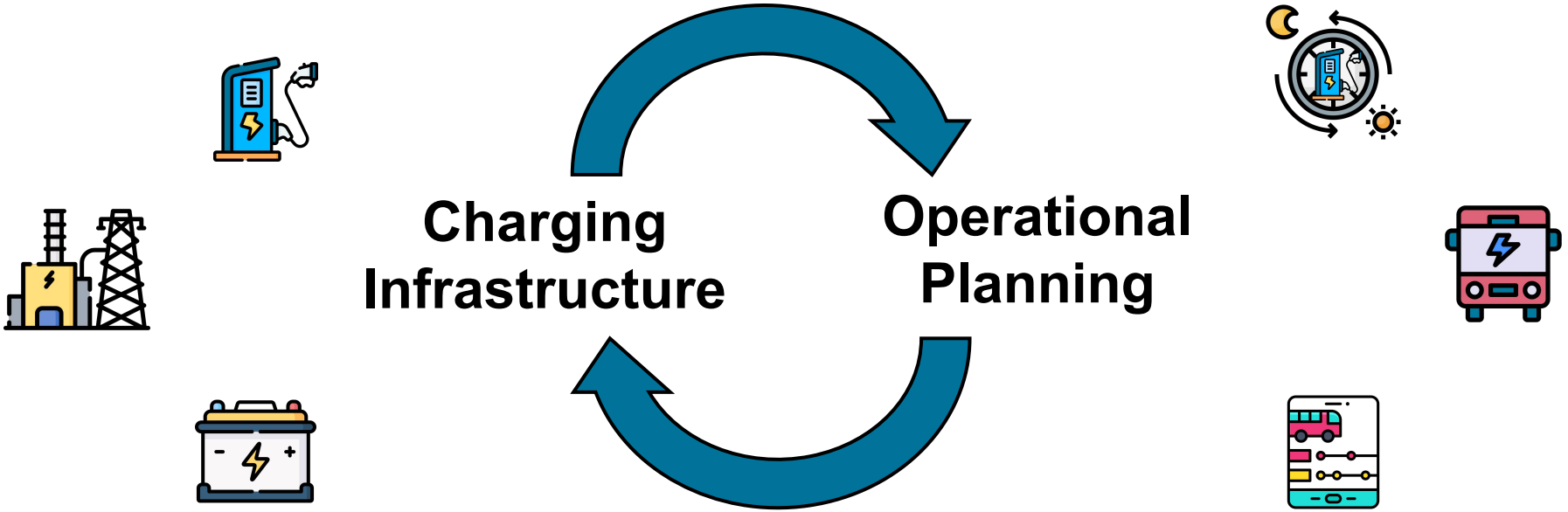
Source: ICCT, 2022

Challenges to Electrification

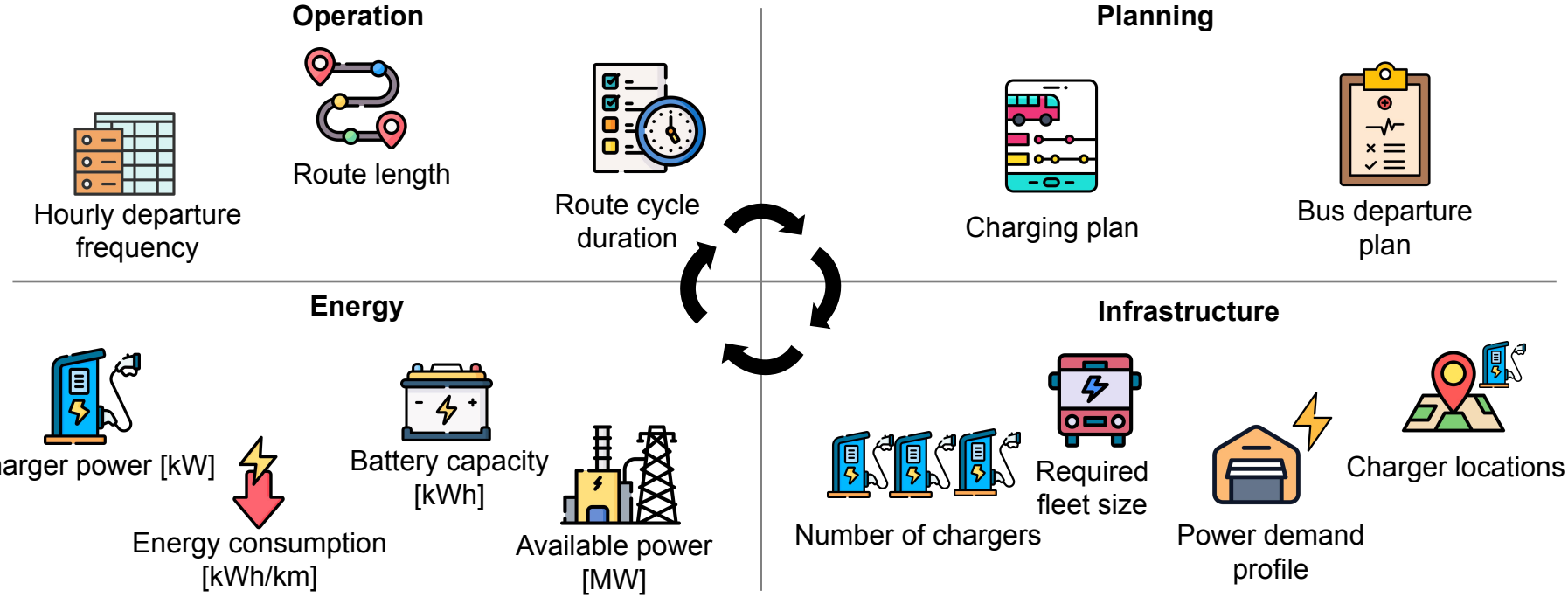
A Transitioning from **diesel to electric** buses in urban transport requires a **shift in operational strategy** due to two main constraints:

(I) Vehicle range
(II) Electrical grid capacity

Interdependent Processes



Charging Strategies and Infrastructure Sizing

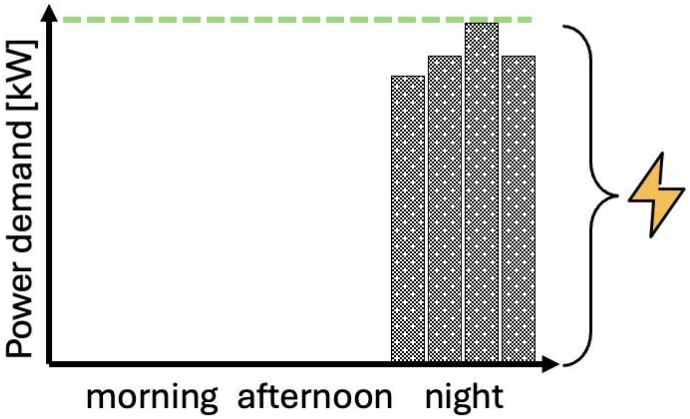


Example

Charging Infrastructure and Operational Planning

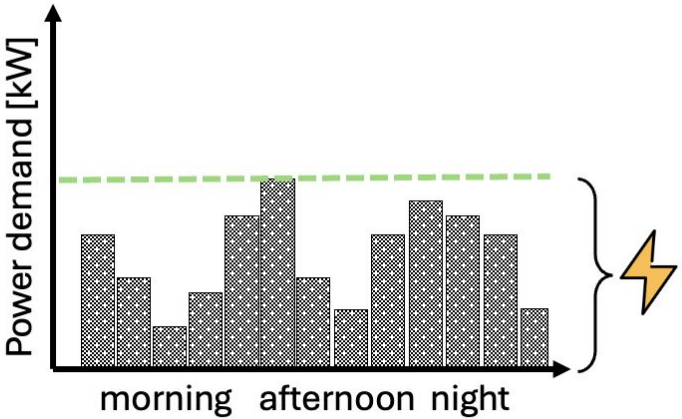
Overnight Charging Strategy

OVERNIGHT Charging:
HIGHER power requirements
LOWER operational range



Integrated Charging Strategy

INTEGRATED Charging:
LOWER power requirements
HIGHER operational range



Requires detailed operational planning

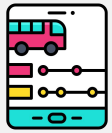
Example: Operational and Energy Characteristics

Route Extension

Case 1: **35 km**

Case 2: **92 km**

Cycle time
3.4 hours



Hourly departure frequency
Peak hour **8 departures/hour**
Between peaks **6 departures/hour**

Battery capacity
324 kWh

energy consumption
1.2 kWh/km

Charger Power
150 kW
(75kW + 75kW)

Case 1

Route length

Case 1: 35 km

Charging Strategy	Overnight	Integrated	
Fleet	**28**	**28**	
Number of Chargers	**7**	**4**	57%
Power Availability at the Depot [MW]	**1**	**0,6**	60%
Average km/bus/day	**131** km (**203 km** Vehicle Range)	**131** km (**203 km** Vehicle Range)	

Case 2

Route length

Case 2: **92** km

Charging Strategy	Overnight	Integrated	
Fleet	53	29	54%
Number of Chargers	16	9	56%
Power Availability at the Depot [MW]	2,4	1,3	54%
Average km/bus/day	182 km (203 km Vehicle Range)	332 km (203 km Vehicle Range)	+82%

Recommendations

Planning Recommendations

Identify locations for **charging stations**, such as garages, terminals and other facilities.

Planning the schedule of departures and charging events for each bus

Plan for **power availability** by establishing cost estimates and a timeline for adapting the electrical grid, including **substations** for voltage conversion.

Monitoring: Store and process data to support planning, including battery state of health (SOH).

Maximize the **utilization rate** for **electric buses**.

Increase supply of **public transport**.