

SECTION 3

IDENTIFYING ASEAN'S TIPPING POINTS BY SECTOR

This section presents analyses on the six prioritized sectors in ASEAN discussed in Section 2. In each sector analysis, the report seeks to answer the following questions:

Global sector context

- What is the **global context** of how this sector will decarbonize?
 - What are the **core low-carbon solutions** that will drive decarbonization?
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Geographic sector context

- How is the **sectoral transition progressing** at **ASEAN level**?
 - Are there **opportunities or challenges** specific to the region?
-

Solution status

- What is the **current status** of the core solution being adopted at ASEAN level?
 - Is it only **in development**, or being adopted in **niche markets**, or starting to break into **mass market**?
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Tipping point status

- How close are we to a **tipping point**, to help the solution break into mass market?
 - What are the **key gaps** to be addressed to trigger one?
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Tipping point calculation & levers

- What is the **comparison** of the **current** and **potential future costs** of the **low-carbon solution** versus **the incumbent**?
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Target conditions progress to trigger tipping point

- What is the **current** and **potential future** status of the **tipping point conditions** (affordability, attractiveness, and accessibility)?

TRANSPORT: ELECTRIC BUSES

2% OF TOTAL ASEAN GHG
EMISSIONS 2020

GLOBAL SECTOR CONTEXT

- **Electrifying road public transportation is important in reducing 5–7% of global emissions.**¹ Hence, switching to electric buses will help accelerate the decarbonization of road public transportation.
- **E-buses upfront capital are still costly compared to internal combustion engine (ICE) buses, but total cost of ownership (TCO) is comparable.** E-bus upfront cost, which includes vehicle cost and charging systems, can be 2.5-4x higher than ICE bus.²
- **Globally, 4.5% of public buses have been electrified** and already represented 38% of all bus sales in 2022, anchored by China's electric vehicle (EV) market. Most electrification is happening in Europe, the United States, and China.^{3,4}

GEOGRAPHIC SECTOR CONTEXT



Across ASEAN

Shifting to public transportation is a universal decarbonization lever. Electrifying buses for public transportation will be relevant for all ASEAN countries.

- **Singapore is consistently ranked top 10 in sustainable public transportation indexes;**⁵ but the rest of ASEAN is still lagging.
- **Thailand (68k), Myanmar (29k), and the Philippines (17k) have the largest bus fleets in ASEAN.**^{6,7} These three countries and Singapore also have the biggest bus-to-road vehicle ratio.
- **ASEAN countries have developed electric bus manufacturing capabilities.**⁸ This is key to lowering bus costs and accelerating the learning curve.
- **Most major cities in ASEAN have Bus Rapid Transit (BRT) model,**⁹ with operators owning their own (relatively young) assets,¹⁰ making it more complex to increase the uptake of e-buses.

SOLUTION STATUS IN ASEAN

Solution status stages: ● Solution development > ● Niche market > ● Mass market



E-buses are in between niche market and mass market stage. E-buses can easily reach mass market if governments receive financing support for new vehicle acquisition.



Penetration rate in ASEAN is still quite low. E-bus penetration estimated to be under 5%.¹¹



Issues span across existing asset fleet age, high start-up/upfront cost, and convenience & reliability. Public authorities or bus operators might have limitations, younger ICE fleet-owners are hesitant to switch, and E-buses need 3–6 hours to charge compared to <1 hour for ICE.



Innovative business/financing models were explored. Some have adopted leasing models and carbon financing (e.g., Thailand with Article 6.2).¹²

TIPPING POINT AND ADOPTION RATE STATUS

Tipping point status

TIPPING POINT 1
TCO of E-Bus < TCO of ICE Bus

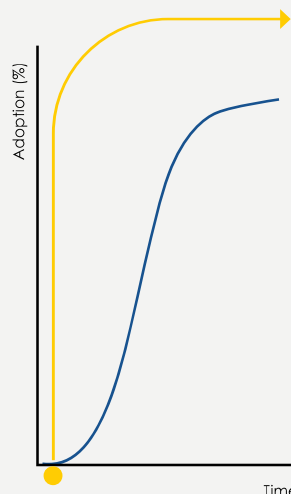
- **The first tipping point has been reached in certain cases/regions,** due to lower fuel cost (electricity vs fossil fuel) and operation & maintenance (O&M) cost.
- **Reliable, affordable, and accessible charging points** (and required power supply) will be key in maintaining TCO and reliability of e-buses.

TIPPING POINT 2
Early retirement of existing ICE Bus fleet

- **Whilst this is not a socio-economic tipping point, younger ICE fleets has been a barrier for increased e-bus adoption.**
- Resolving this issue is an important tipping point for the sector.

Legend: ✓ Mostly reached ○ Reached in certain cases — Not reached

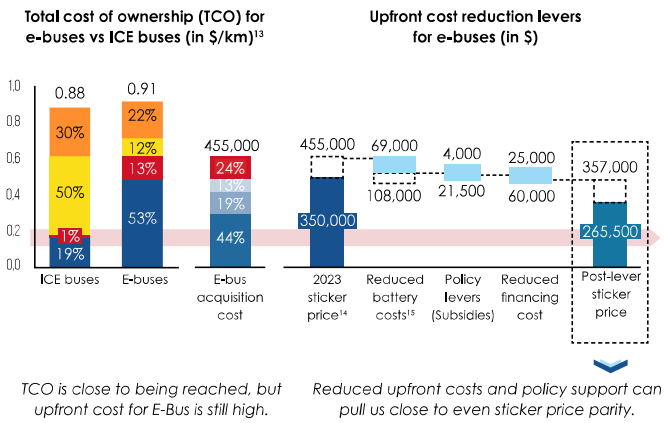
Current adoption status



Even though TCO is competitive, the increase in adoption rate is still very low.

- **Invest in the battery value chain** to accelerate the learning curve.
- **Targeted policy such as OEM subsidy or mass government procurement.**
- **Retirement mechanism for younger ICE fleets.**
- **Introduce innovative business models** to not only reduce cashflow, but also allow risk-sharing of vehicle components.

Notes: [1] IEA (2019), Transport sector CO2 emissions by mode in the Sustainable Development Scenario, 2000-2030; [2] Arthur D. Little (2020), Electric Buses; [3] IEA (2022), Global EV Outlook 2023; [4] BloombergNEF (2023), Electric Vehicle Outlook 2023; [5] Oliver Wyman (2023), Urban Mobility Readiness Report 2022; [6] ASEANStats (2018), Number of public buses (in thousand); [7] Statista Research Department (2023), Number registered private buses Philippines 2020-2022; [8] BMP-EAGA (2022), ASEAN Gears Up for a Shift to Electric Vehicles, Systemic analysis; [9] T. Sattienam et al. (2006), A study on the introduction of bus rapid transit system in Asian developing cities; [10] Expert and industry interviews; [11] ICCT (n.d.), Zero-emissions vehicle deployment statistics; [12] Quantum Commodity Intelligence (2023), Switzerland, Thailand agree e-bus ITMO scheme under Article 6.



Increased E-Bus adoption will require the ability to implement innovative business model/ financing, to either transform Capex into Opex (via risk-sharing) or reduce upfront cost directly:

- Lease and operate.** Non-bus operator entities (e.g., utility companies) procure E-buses & lease to traditional operators.
- Mobility-as-a-Service.** OEM offer operators vehicles + charging on a pay-to-use basis without asset ownership.
- Special financing facility.** Offering lower-rate financing for e-bus or financial incentive to retire ICE buses earlier.
- Carbon financing.** Voluntary market or bilateral schemes to help with upfront capital or improve operational cashflow.



ENABLING CONDITIONS TO TRIGGER TIPPING POINT

PROGRESS

AFFORDABILITY

- Continued battery learning curve to lower down upfront cost of electric buses, that currently accounts around 50–60% of total TCO.¹³
- Lowered TCO from charging infrastructure cost and charging-related cost (electricity price).
- Implementation of business models to reduce upfront capital such as lease and operate, special financing facility, or carbon financing mechanisms.
- Improved policy/regulatory environment to enable new entities to enter the bus transport ecosystem, seeing several intangible aspects of the current ecosystem is hindering uptake of business models.

- ✓ Investments in battery and e-bus manufacturing (incl. critical mineral supply chain) are in progress across ASEAN.
- ✓ Charging infrastructure and related charging costs may already tip the TCO of e-buses against ICE in specific routes and charging types, as TCO is highly dependent on route.¹³
- ✓ Several case studies of lease-and-operate (e.g., Enel X in Santiago)¹⁶ and Special Financing Facility (e.g., IFC) has been implemented for e-buses in Latin America. Thailand has been able to raise innovative e-bus financing through Article 6.2 mechanism, with Swiss as financier.¹²
- ✗ Barrier to entry remains high, permitting-wise.

Key actions to accelerate progress:

- ❑ Policy adjustment: Regulatory support (e.g., procurement process or permits for non-operators to contract with transport authorities) for innovative business models.
- ❑ Investment for battery: Scaling up battery production to obtain benefit from the economies of scale.
- ❑ Innovative business financing: Continued efforts to access carbon financing or set-up of financing facilities.

ATTRACTIVENESS

- Separation/reduction of cost through either lease-and-operate models or direct reduction through special financing or carbon financing mechanisms.
- Improved charging mechanism and infrastructure to further increase accessibility to non-fixed/longer routes.
- Higher urgency for better air quality in metropolitan cities, to influence public push for e-bus procurement.

- ✓ Innovative business models for e-buses have been used globally but have not become mainstream in ASEAN.
- ✓ Push for better air quality and awareness has increased post-COVID. This is apparent with prevalence of social media creating movements on this matter.
- ✗ Charging infrastructure has not been developed well.

Key actions to accelerate progress:

- ❑ Policy adjustments: Regulatory support for innovative business models to be successfully implemented.
- ❑ Societal push: Further strengthen the push for better air quality in metropolitan cities.

ACCESSIBILITY

- Improved charging mechanism and infrastructure to further increase accessibility to non-fixed/longer routes.

- ✗ Charging infrastructure has not been developed well for non-fixed/longer routes due to the lack of clear deployment plan, although is increasingly improved for BRT routes (mostly via depot charging).

Key actions to accelerate progress:

- ❑ Policy adjustments: <see above>.
- ❑ Innovative business model/financing: <see above>.

Legend: ✓ Progress is moving well ✓ Progress is mixed ✗ Progress is not happening (or happening far too slowly)

Notes: Tipping point enabling condition's rating guide: Affordability: Green – Parity achieved, Amber: Parity could be achieved with the help of levers before 2030, Red: Parity might only be achieved after 2030. Attractiveness & Accessibility: Green – No barrier to tipping point, Amber – Currently impeding tipping point but strong progress underway, Red – Currently impeding tipping point with limited progress to date.

[13] ICCT (2023), Evaluation of factors that affect total cost of ownership in support of Transjakarta's electric bus adoption plans; [14] Systemiq analysis; [15] Using battery price of 275-300 \$/kWh, based on BloombergNEF's 2020 e-bus battery pack numbers in the EU; [16] Morris, C (2020), IEA case study #2: electric buses in Santiago, Chile.