BRIEFING



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# Electrification of heavy-duty vehicles in emerging markets

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## INTRODUCTION

Heavy-duty vehicles (HDVs)[1] comprise a relatively small share of vehicle fleets in most countries, but they contribute a disproportionate share of emissions that destabilize the climate and jeopardize human health. On-road diesel vehicles, which are primarily HDVs, are responsible for 78% of black carbon emissions and 86% of nitrogen oxides globally.[2] The global HDV fleet is projected to contribute more greenhouse gas emissions than the light-duty vehicle fleet by 2025.[3] Zero-emission vehicle (ZEV) technology for HDVs, including battery electric vehicles and fuel-cell electric vehicles, has the potential to reduce significantly climate and air quality impacts, including in emerging markets and developing economies (EMDEs)[4].

Without additional ZEV policies beyond 2020, well-to-wheel $CO_2$ emissions from HDVs in the EMDEs are projected to surpass levels in the world's ZEV-leading countries, including ZEV Transition Council (ZEVTC)[5] countries and China, by 2050.[6] However, under an accelerated global ZEV transition scenario leading to 100% zero-emission HDV sales by 2050, $CO_2$ emissions for HDVs in the EMDEs could fall 44% below 2020 levels by 2050. With half of global new vehicle sales, and home to the world's largest

1 Definitions and types of HDVs vary across countries and regions. In this paper, we define HDVs as buses, trucks, vans, and other vehicles with a gross vehicle weight greater than 3.5 tonnes.

2 Dale Hall, et al. (2021), *Decarbonizing road transport by 2050: Effective policies to accelerate the transition to zero-emission vehicles*, (ICCT: Washington, DC, 2021), https://theicct.org/publications/zevtc-effective-policies-dec2021.

3 Drew Kodjak and Dan Meszler, *Prospects for fuel efficiency, electrification, and fleet decarbonization*, (Global Fuel Economy Initiative: London, 2019), https://www.globalfueleconomy.org/media/708302/gfei-working-paper-20.pdf.

4 EMDEs refer to low-or-middle-income countries that are eligible for official development assistance and are outside of ZEV leading countries.

5 ZEVTC members: California, Canada, Denmark, European Commission, France, Germany, India, Italy, Japan, Mexico, Netherlands, Norway, South Korea, Spain, Sweden, the UK, and the US.

6 ICCT Roadmap model, (2021), https://github.com/theicct/roadmap-doc.

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automotive companies, the ZEVTC countries are well-positioned to influence the global market to support a ZEV transition for EMDEs.

Similar to the HDV electrification trend in major vehicle markets, EMDEs are prioritizing public transport for electrification. This includes buses, which have great potential for electrification because they typically have consistent trip schedules and can be charged overnight at depots, reducing the need for a dense network of en route charging points. Moreover, electric buses are shown to be cost-effective (in terms of total cost of ownership) compared to internal combustion engine (ICE) technology in selected markets such as California, USA and Santiago, Chile,[7] considering the typical functional lifetime of buses, which can range from 8 to 15 years depending on the market. Bus electrification can also advance decarbonization efforts because buses are a popular and affordable public transport mode and account for more than one-third of the HDV fleet,[8] on average, in EMDEs. Therefore, this briefing focuses primarily on public transport, including bus electrification in EMDEs, while recognizing the opportunities to electrify other HDV segments with operational profiles similar to buses. Characteristics of those profiles, including predictable daily range, return-to-base operation, and long dwell time, are suited to depot charging, the charging practice commonly used by urban delivery vans, sanitation trucks, postal trucks, box trucks, and drayage trucks.

The objectives of this paper are to assess the status of zero-emission HDV deployment and policies in EMDEs, evaluate the major policy levers for HDV electrification, and identify policy barriers and key recommendations for HDV electrification in the EMDEs.

This briefing was originally produced and used to inform the Regional Dialogue meetings held in March and April, 2022 regarding HDV electrification. The findings from the regional dialogues and the follow-on International Assistance Taskforce meeting were summarized in a separate readout paper (see Annex A). The executive summary of this readout paper was submitted to the ZEVTC ministerial meeting held in May 2022. The readout paper reflects further barriers and recommendations for HDV electrification in EMDEs informed by the EMDE representatives and regional experts; it also includes a list of proposed next steps for the ZEVTC to support a zero-emission HDV transition in EMDEs.

## ZERO-EMISSION HDV TRANSITION STATUS

EMDEs are home to various types of buses, including minibuses, midi buses, and large urban transit buses, that vary by country or region. Electric buses are typically 9 to 18 meters in length in EMDEs to match market demand and functionality requirements.[9] Figure 1 illustrates the roughly 30-fold growth in the on-road fleet of battery-electric buses in selected EMDEs over the four years between 2017 and 2020, with the upward trend continuing for the projected data for 2021. However, this growth is concentrated among a modest number of EMDEs: only 23 of more than 100 EMDEs[10] had deployed battery-electric buses as of 2020. Latin American countries lead in adopting electric buses in emerging markets; Chile and Colombia had the highest overall fleet of more than 800 and 500 electric buses, respectively, in 2020.

7 Hall et al., (2021), *Decarbonizing road transport by 2050*; Sebastián Galarza, "From pilots to scale: Lessons from electric bus deployments in Santiago de Chile," https://www.c40knowledgehub.org/s/article/From-Pilots-to-Scale-Lessons-from-Electric-Bus-Deployments-in-Santiago-de-Chile?language=en_US.

8 ICCT Roadmap model.

9 EV-volumes.com, *The Electric Vehicle World Sales Database*, (2020), https://www.evvolumes.com/.

10 Tanzila Khan, et al., *A critical review of ZEV deployment in emerging markets*, (ICCT: Washington, DC, 2022), https://theicct.org/publication/zev-market-review-global-feb22/.

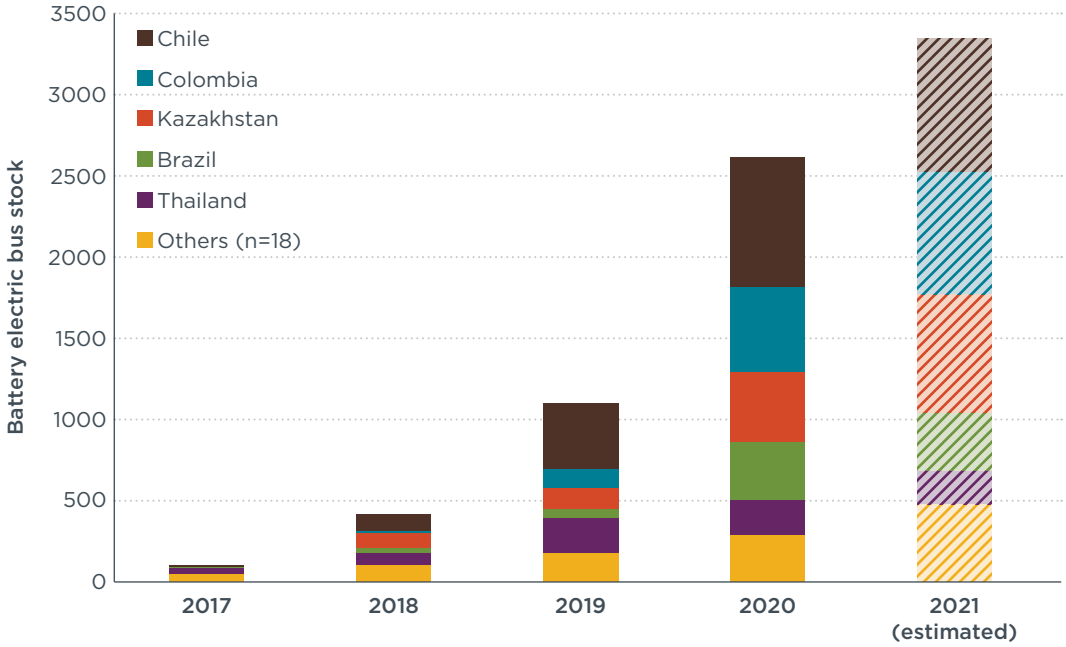


**Figure 1.** Stock of on-road battery-electric bus fleets for emerging markets and developing economies, 2017 to 2021.[11]

*Kazakhstan* and *Thailand* are the two Asian EMDEs with sizeable bus fleets, at more than 400 and 200 electric buses, respectively, in 2020. Several other EMDEs are in an early phase of the transition including *Argentina, Barbados, Egypt, Malaysia, Nepal, Philippines, South Africa, Turkey,* and *Ukraine,* with fleets ranging in size from 5 to 65 electric buses. Some EMDEs that do not yet have sizeable electric bus fleets on-road have ongoing bus rapid transit (BRT) projects and pilot electric bus projects that anticipate scaled-up deployment of electric buses in the near future. *Jakarta, Indonesia* is electrifying its Transjakarta BRT fleet and aims to become 100% electric by 2030.[12] Many African countries have active electric bus projects including *Côte d'Ivoire, Kenya, Mauritius, Morocco, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Tanzania, Tunisia*, and *Uganda*.[13]

EMDEs are generally lagging in electrification of the truck segment of HDVs. As of 2020, Brazil had the largest on-road fleet of battery-electric trucks, with a total of 73.[14] Other Latin American countries such as Colombia, Ecuador, and Uruguay had fleets of 1 to 39 electric trucks, and Philippines had 19 electric trucks. Beyond these few countries, no data for truck electrification exists for EMDEs.

## CASE STUDIES IN EMERGING MARKETS

In this section, we focus on case studies from emerging market cities that lead in electric bus deployment, selected EMDEs to evaluate their policy directions, and regional and global partnerships that are actively supporting EMDEs in advancing the transition to electric buses.

11 EV-volumes.com, *The Electric Vehicle World Sales Database*; E-BUS RADAR "Latin America," https://www.ebusradar.org/en/.

12 C40 Cities Finance Facility, *Electric buses for Jakarta's sustainable urban mobility*. https://www.c40cff.org/projects/jakarta-electric-bus.

13 Global Environment Facility, *Global project to support countries with the shift to electric mobility*. https://www.thegef.org/sites/default/files/documents/10270_CEO_Endorsement_Request_1.pdf.

14 EV-volumes.com, *The Electric Vehicle World Sales Database*.

## SANTIAGO, CHILE

With an on-road fleet of about 800 electric buses, *Santiago,* the capital of Chile, has made the country a global leader in electric buses, second only to China. The city's significant shift to electric buses was made possible through target setting, regulatory planning, policy initiatives, pilot projects, an innovative business model, and incentive provisions in bus contracts. Chile's National Electromobility Strategy set comprehensive targets for HDV electrification,[15] including 100% new sales of urban buses by 2035, and of freight transportation and intercity buses by 2045. To address air pollution in the metropolitan region, in 2017, Santiago authorities published a detailed plan of policies designed to upgrade vehicle emission control technology, retrofit old vehicles, introduce low-emission zones, and provide incentives for public transit modal shifts.[16] Euro VI emission standards were implemented as the minimum requirement for buses.

Santiago conducted a series of pilot projects to study the technical and economic feasibility of introducing electric buses into the fleet.[17] The pilot projects helped in evaluating the operational costs of electric buses compared to ICE buses, and in understanding charging technology and standards, route planning, and needs for technical skills. In general, Santiago has been used as a national proving ground to concentrate resources for the pilot and demonstration projects; now other cities in the country are following in Santiago's footsteps and adopting electric buses.

The new business model for the operation of electric buses is based on a public-private-partnership (PPP), known as a concession model, with the government as the regulatory authority and the fleet providers, fleet operators, utility company, financial institutions, and bus manufacturers as key private sector participants.[18] The chief advantage of this business model is that it separates the framework of regulatory authority from fleet providers and operators, and that other market players such as manufacturers, utility companies, and third parties with greater financing capability than operators can invest in and procure electric buses, essentially playing the role of fleet providers. As a result, the respective expertise and financing capabilities of the public and private sectors help address the high upfront cost of electric buses, and the financial burden on government and operators is reduced. Under this PPP model, the fleet provider purchases the electric bus fleet and holds a leasing contract with the bus operator. Government provides and manages the bus depots for operators, thereby incentivizing the electric bus technology. Government also bears the responsibility of managing financial risk for the fleet providers.

Under the business model, Santiago offers incentives for electric bus fleet providers and operators by granting contracts with longer periods of operation, and longer contract extensions, for electric buses than for ICE buses. The longer contract term reduces the total cost of ownership for electric buses compared to ICE buses, which makes the investment and operation of electric buses lucrative for the fleet providers and operators.

## BOGOTÁ, COLOMBIA

*Bogotá*, the capital of Colombia, has one of the largest electric bus deployments in the EMDEs with an on-road fleet of 655 electric buses as of 2022.[19] This large-scale

15 Ministry of Energy, Government of Chile, "National strategy of electromobility 2021," October 2021, https://energia.gob.cl/sites/default/files/estrategia-nacional-electromovilidad_ministerio-de-energia.pdf.

16 MMA (Ministry of Environment), "Metropolitan Region Plan," 2017, https://ppda.mma.gob.cl/ region-metropolitana/ppda-region-metropolitana/.

17 Galarza, "From pilots to scale".

18 Galarza, "From pilots to scale".

19 E-BUS RADAR, "Latin America."

transition to electric buses is the result of a national mandate for fleet purchases, a ban on ICE buses in tendering processes, a PPP-based business model that has evolved over time, and a tendering incentive for electric buses. Colombia requires that at least 10% of new bus purchases be electric starting in 2025, the purchase share gradually increasing every two years to reach 100% by 2035.[20] The city of Bogotá aims to build a zero-emission bus fleet by 2035[21] and has implemented a law that bans ICE buses in public transport contract processes, effective January 1, 2022.[22]

Similar to Santiago, Bogotá established a PPP-based concession business model for transit operation that distributes regulatory, technological, financial, and operational responsibilities among the various sectors involved, public and private.[23] The distribution of roles in the business model ensures quality of service and fiscal viability of the electric buses. In contrast to Santiago, where the role of providing and managing bus depots is fixed with the government, Bogotá is adjusting the roles of the parties involved. This iterative effort is evidence of the city's responsiveness and flexibility in optimizing the effectiveness of the process and in reducing costs, for example for land acquisition and the cost of converting existing bus depots to charging stations for electric bus deployment.

As in Santiago, the tendering process in Bogotá offers longer contract period incentives for electric buses than for conventional ICE buses. Additionally, Bogotá reduced the requirement for average daily bus trip distance in the tendering process to match the typical range of the electric buses.

## OTHER SELECTED EMDEs

Other EMDEs prioritize support for domestic production industries and for fleet purchases through collaboration with international companies and international financing.[24]

*Kazakhstan* is transitioning to electric buses by establishing local manufacturing and assembly capacity, producing electric buses and minibuses, and purchasing hundreds of electric buses in partnership with international manufacturers. The country is developing a roadmap for manufacturing clean fuel vehicles, including ZEVs.

*Thailand* has set production targets for electric vehicles, including setting goals of producing 3,000 electric buses by 2025 and achieving a 30% electric share of all produced vehicles, including urban buses, by 2030. The country is promoting the domestic production industry and investments in electric vehicles, including electric buses and trucks, by offering a variety of incentives such as corporate income tax exemptions, and significantly reduced import duties for raw materials used to produce batteries. In Bangkok, the city transit's electric buses project was launched through a PPP initiative for producing new electric buses and retrofitting old buses to become electric. Thailand is partnering with an international company to establish battery production plants for electric vehicles.

*Ukraine* is manufacturing electric buses and trucks and purchasing a fleet of electric buses through PPP efforts. The government has signed an agreement with an international manufacturing company to build 5,000 electric buses and install 7,800 charging stations.

20 Khan, et al., *A critical review of ZEV deployment in emerging markets*.

21 Yihao Xie, Oscar Delgado, *Decarbonizing bus fleets: How subnational targets can aid in phasing out combustion engines*, (ICCT: Washington, DC, 2022), https://theicct.org/bus-fleets-targets-jan22/.

22 Council of Bogotá D.C., Acuerdo 790 de 2020, (Regimen Legal de Bogotá D.C.: 2020), https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?i=103745.

23 Dalberg, (2020), *Investing in electric bus deployment in Latin America Overview of opportunity and market readiness*, https://theicct.org/sites/default/files/publications/ZEBRA-market-readiness-pitch-sept2020.pdf.

24 Khan, et al., *A critical review of ZEV deployment in emerging markets*.

*Nepal* is at an early phase of transition but has actively supported bus electrification for several years. The country has set electrification targets for various vehicle segments including a goal that 60% of purchases for public transportation be electric vehicles by 2030. Nepal is spearheading various policy initiatives for deployment of electric buses, including fleet purchases using government funding and international loans from the Asian Development Bank; incentivizing the assembly industry through government grants of free land; establishing assembly plants in partnership with international manufacturers to produce electric vehicles, including buses; and importing and distributing electric vehicles in the mini-bus and large bus segments.

*Cape Verde* established an Electric Mobility Policy Charter in 2019 that serves as the national electromobility strategy, including guidelines for timeframes and corresponding measures to gradually transition to ZEVs.[25] The country has set targets of 100% new sales for electric buses and medium and heavy-duty trucks by 2035, which they intend to achieve through international support, the use of incentives, and fleet purchase requirements. The government is mobilizing resources to subsidize the overhead cost of electrification of public transportation and necessary charging infrastructure. Cape Verde has a 5-year (2020–2025) internationally supported project through the Nationally Appropriate Mitigation Action support project (NSP), which provides a rebate through an Electric Mobility Facility to substantially reduce the high upfront cost of electric cars and buses for first-mover individuals, companies, and institutions.[26] The country has introduced a fleet purchase requirement for urban public transportation companies that at least 50% of the new purchases be electric starting from 2025, which will increase by 5% every year until reaching 100% of new purchases by 2035.

## REGIONAL AND GLOBAL PARTNERSHIPS

The **Zero Emission Bus Rapid-deployment Accelerator (ZEBRA)** is a regional partnership for Latin American countries established to accelerate electric bus adoption, with a particular focus in selected Latin American cities.[27] The partnership is financed and facilitated by Partnering for Green Growth and the Global Goals and co-led by the C40 cities and the ICCT. In December 2020, ZEBRA secured commitments from more than 10 bus manufacturers and distributors to make electric buses available in Latin America. During the COP26 in November 2021, ZEBRA announced receipt of $US1 billion in funding from a coalition of investors for deployment of electric buses. The major areas of work for the ZEBRA partnership include (i) sharing knowledge, best practices, and technical skills among the cities for bus electrification through a regional working group; (ii) introducing new technology for electric buses by securing commitments from bus manufacturers and industry partners; (iii) providing support through fleet deployment strategies and innovative business models to procure 3,600 electric buses in the region; and (iv) providing support via financial mechanisms to maintain an active pipeline of investable projects.

The **United Nations Environment Programme's (UNEP) Global Electric Mobility Programme** provides support to more than 50 EMDEs for accelerating the ZEV transition.[28] The programme is primarily funded through the Global Environment Facility (GEF) and the SOLUTIONSplus project, among others. The support for HDV electrification is offered through a global working group that focuses on bus

25 Ministry of Industry, Commerce, and Energy, "Resolution no. 13/2019," February 1, 2019, http://tda-mobility.org/wp-content/uploads/2019/04/Cabo-Verde-Electric-Mobility-Policy-Chapter.pdf.

26 NAMA Facility, "Cabo Verde – Promotion of Electric Mobility," (n.d.), https://www.nama-facility.org/projects/cabo-verde-promotion-of-electric-mobility/.

27 ICCT, *ZEBRA Zero Emission Bus Rapid-deployment Accelerator*. https://theicct.org/initiatives-partnerships/zebra/.

28 "Supporting the global shift to electric mobility," United Nations Environment Programme, accessed July 19, 2022, https://www.unep.org/explore-topics/transport/what-we-do/electric-mobility/supporting-global-shift-electric-mobility.

electrification, with the following major objectives: (i) establishing a global platform to support an electric mobility technology and policy framework; and (ii) building capacity through developing and sharing knowledge products and providing technical support and training. UNEP is leading a support and investment platform in Africa to mobilize supply, investment, and financing in electric mobility by bringing together electric bus manufacturers, financing institutions, industries, cities, and countries. UNEP has developed a clean bus fleet programme for 20 cities in Africa, Asia, and Latin America and the Caribbean to support development of roadmaps and pilot projects for low-emission public transport, including electric buses.

The **GEF Electric Mobility Programme** is a UNEP-led partnership with the International Energy Agency, the European Bank for Reconstruction and Development, and the Asian Development Bank.[29] The program provides financial and technical support for accelerated deployment of ZEVs including electric buses and trucks for 27 developing countries in three regional platforms focused on Africa, Asia and the Pacific, and Latin America and the Caribbean. The program's major areas of support include developing national electrification roadmaps and targets, policy frameworks, business models, and financing schemes in developing countries to support the ZEV transition.

The **Transformative Urban Mobility Initiative (TUMI) E-Bus Mission** is a regional initiative to support deployment of electric buses in 20 selected cities of the Global South.[30] The efforts and experiences will be replicated for other cities to procure and deploy 100,000 electric buses in 500 cities by 2025. The mission is funded by the German Ministry for Economic Cooperation and Development, with technical support provided by a core group of global organizations. The major functions of the mission include (i) forming global and city-level coalitions of private- and public-sector actors to accelerate mass adoption of electric buses; (ii) developing electrification roadmaps and targets and providing technical assistance to the 20 cities; and (iii) sharing knowledge of the 20 cities with the mentee cities through training and workshops on planning, procurement, and operation of electric buses.

**SOLUTIONSplus** is a global platform that supports innovative and integrated electric mobility solutions across shared, public, and commercial transport modes including electric buses in Africa, Asia, Europe, and Latin America.[31] The project has received funding from the European Union's Horizon 2020 research and innovation programme and is comprised of highly committed cities, industry, research and implementing organizations, and finance partners. The project's major areas of support include conducting city-level demonstrations and assessing adaptability; building capacity through exchange of knowledge and ideas between the public and private sectors, and through training and workshops; developing and implementing appropriate business models; and facilitating funding and financing mechanisms.

## POLICY LEVERS FOR HDV ELECTRIFICATION

Hall et al., (2021)[32] identified six major policy levers for an accelerated zero-emission HDV transition in ZEV-leading markets, including ICEV phase-out targets, regulations, incentives, infrastructure development, fleet purchase requirements, and zero-emission zones. These policy levers could serve as best practice guidelines for countries, including EMDEs, that can be adapted to their contexts and priorities. A few of these policies are already observed in some EMDEs. Countries do not necessarily need to

29 "Donors boost Global Environment Facility contributions to $5.33 billion," GEF, accessed July 19, 2022, https://www.thegef.org/.

30 "TUMI E-Bus Mission," Transformative Urban Mobility Initiative, accessed March 10, 2022, https://www.transformative-mobility.org/campaigns/tumi-e-bus-mission.

31 "About SOLUTIONSplus," SOLUTIONSplus, accessed March 10, 2022, http://www.solutionsplus.eu/solutionsplus.html.

32 Hall et al., *Decarbonizing road transport by 2050*.

implement all six policies discussed below to start deploying zero-emission HDVs; instead, they can determine their own policy mixes and design for ZEV deployment according to their circumstances and priorities.

**ICEV phase-out targets** for HDVs imply a government-announced target to introduce 100% new sales for zero-emission HDVs and, hence, to phase out new ICE HDV sales by a target year. Phase-out targets serve as guidance for industry and businesses in planning ZEV production and imports and infrastructure deployment, and they help fleet operators and other industries to plan and make investments with sufficient lead time. EMDE countries with 100% new sales targets for zero-emission HDVs include *Cape Verde* (for buses and medium- and heavy-duty trucks by 2035), *Chile* (urban buses by 2035, and freight transportation and intercity buses by 2045), *Colombia* (urban buses by 2035), and *Ecuador* (all vehicles incorporated into the public transport system from 2025).[33] EMDE governments can begin with bus electrification targets in selected large cities, which can trigger the market and build momentum for other cities in the country.

**Regulations** are legally binding rules that lead the automotive industry to transition to zero-emission HDV production and imports and hence, to increase product availability. Regulations include (i) ZEV regulations and (ii) fuel economy and emission standards. ZEV regulations require manufacturers to continually increase the annual share of zero-emission HDV sales, with the share requirements varying across HDV segments and taking into account the variation in cost of production and other factors. Fuel economy and emission standards help to reduce the market advantage of lower-cost, higher-emitting technologies and increase the cost of compliance for ICE HDVs. Regulations usually become more stringent over time to accelerate the transition toward ZEVs. The Advanced Clean Trucks (ACT) regulation in *California, USA*, requires at least 30% zero-emission HDV sales in certain HDV segments by 2030, rising to as high as 75% by 2035. For import-reliant EMDEs, regulations can be applied to imported vehicles with a particular focus on fuel economy and emission standards to control market penetration of cheap, high-emitting ICE technology. For instance, the Economic Community of West African States (ECOWAS) is imposing regional emission (Euro IV) standards on imported vehicles.[34]

**Incentives** are supplemental measures that help achieve cost parity with ICE technology, particularly in the early phase of the transition to zero-emission HDVs. Fiscal incentives refer to purchase subsidies, tax and fee benefits to lower the high upfront cost of zero-emission HDVs, in-use benefits such as reduced ownership and usage taxes, and discounted road tolls to lower the total cost of ownership compared to ICE HDVs. To avoid a financial burden on the government, fiscal incentives can be funded through revenue-neutral mechanisms that make high emitters pay (e.g., feebates or bonus-malus system) or through international finance. *California, USA* has several zero-emission HDV incentive programs that are funded through a bonus-malus system. *Cape Verde* is incentivizing bus purchases through the 5-year-long internationally supported NSP. Furthermore, specific HDV segments should be prioritized for incentives depending on need, such as where the price gap with ICE technology is the largest. Fiscal incentives are typically temporary measures put in place until cost parity with existing ICE technology is reached. Non-fiscal incentives can include incentives in bus tendering processes to increase cost-competitiveness with ICE buses, such as the longer contract periods and contract extensions offered in *Santiago, Chile* and *Bogota, Colombia*.

33 Khan, et al., *A critical review of ZEV deployment in emerging markets*.

34 Africa Times, *ECOWAS sets new standards for fuel, used vehicle imports*. https://africatimes.com/2020/02/11/ecowas-sets-new-standards-for-fuel-used-vehicle-imports/.

**Infrastructure** is needed to ensure that sufficient charging capacity is in place to increase the utility of zero-emission HDVs, especially for electric trucks. A key operational advantage of HDV electrification is that nearly all battery-electric HDVs, including electric buses, can be charged overnight at depots at low power, with the exception of a few segments that require high-power and publicly accessible en route charging. Governments can promote private sector engagement for the growth of HDV public charging infrastructure. Policies for charging infrastructure include tax benefits and subsidies for importing charging-related equipment and parts and infrastructure investment, public or private investment or PPP efforts for installing charging stations, collaborations with international manufacturers and/or charging providers, and mandates or national strategy for establishing charging networks along key transportation corridors and at urban centers. *France* recently introduced subsidies for investments in HDV charging infrastructure, which vary by power level at the charging point. *Argentina* offers reduced import tariffs for charging stations with a power level of 50 kW or higher.[35] To facilitate intra-regional travel, regionwide charging infrastructure and technical specifications must be standardized while accounting for infrastructure supply availability and cost.

**Fleet purchase requirements** induce demand for zero-emission HDVs through mandates that fleets be composed of a minimum share of ZEVs. Fleet purchase requirements are typically applied to transit buses and government-owned fleets. *Colombia* and *Cape Verde* have fleet purchase requirements to make 100% of bus purchases electric by 2035. A mandate in *Costa Rica* requires that at least 5% of the bus fleet be replaced with electric buses biennially.[36] For import-reliant EMDEs, this policy could translate into requirements for bus replacement and retrofitting. EMDEs can seek international financing for fleet purchases or to incentivize replacement and retrofitting programs, and collaborations with international manufacturers to provide zero-emission technology. Such requirements across multiple countries under a framework of regional commitment could create a sizeable regional demand for electric buses, and therefore, attract investment in the electric bus sector, and increase the supply of electric buses to the region.

**Zero-emission zones** are city-level policies that set a geographic boundary within which operation of ZEVs is required. Vehicles other than ZEVs are either fully restricted or allowed to enter the zero-emission zones through payment of an access charge. This is a demand-based policy to promote zero-emission HDVs in the form of an in-use incentive for free circulation. Zero-emission zones typically apply to certain HDV fleets such as buses or freight vehicles. The national government could help identify cities in need of such policies and evaluate the benefit of implementation. *Rotterdam, Netherlands* introduced a zero-emission zone that allows trucks of greater than 3.5 tonnes gross weight only if they are zero-emission. For EMDEs, these zones could take the form of dedicated traffic lanes, stops, or parking for electric HDVs.

## POLICY GAPS AND BARRIERS TO HDV ELECTRIFICATION

Phase-out targets, incentives, and fleet purchase requirements are the major missing pieces in the electric bus policy framework of EMDEs. Only a few EMDEs have set 100% new sales targets and offer incentives for electric buses. These policy levers have been critical in ZEV leading countries to drive the supply of electric buses. Fleet purchase

35 Gustavo Máñez Gomis, Esteban Bermúdez Forn, Juan Luis Pardo González, and Jone Orbea Otazua, "Electric mobility: Status in Latin America and the Caribbean 2019," (United Nations Environment Programme, 2019). https://movelatam.org/wp-content/uploads/2020/09/Report-of-Electric-Mobility-in-Latin-America-and-the-Caribbean-2019-LQ.pdf.

36 Khan, et al., (2022). *A critical review of ZEV deployment in emerging markets*.

requirements are a critical demand-based policy adopted in a few EMDEs that have deployed significant numbers of electric buses. However, most EMDEs have not introduced such requirements.

The following specific barriers to electrification of HDVs, including buses, are observed in EMDEs.

(i) **Lack of an electrification roadmap and regulatory framework** results in limited adoption of, and investment in, zero-emission HDVs. Clear phase-out targets and national electromobility strategies, even if non-binding, convey to manufacturers, industry, and fleet operators a clear government commitment to electrification. Delays in adopting and enforcing stringent emission and fuel economy standards allow old, high-emitting and cheaper ICE technology to prevail in the market. Hence, the price gap with ZEV technology remains significant, and would be hard to address with ZEV incentives alone. The implementation of regulations for HDV fleets are especially challenging in many EMDEs because buses and freight are run by multiple informal private operators that are hard to regulate, which calls for a reform of operating authority.

(ii) **Inadequate financing mechanisms** result from the challenge of identifying and implementing a proper business model for the public transit sector and as a result, the large price differential between electric buses and ICE technology is often unaddressed. Business models could vary across EMDEs depending on their specific political and socio-economic circumstances. However, the case studies suggest that a PPP-based model can be successful in the electrification of buses in public transit. Financing mechanisms also govern infrastructure deployment, incentive programs, and fleet purchases for promoting the supply and operation of electric buses.

(iii) **Lack of interest from international manufacturers** in supplying zero-emission HDVs to individual EMDEs is evident, due to weak market demand for the latest electric mobility technology. One solution could be for multiple EMDEs in a region to expand market demand by working together to create regional markets that attract investment from manufacturers and increase the supply of ZEVs.

(iv) **Lack of technical expertise** leads to challenges in establishing regionwide uniform technical standards for electric HDVs and charging infrastructure, and impedes development of a domestic supply chain capability for electric buses including manufacturing, retrofitting, repairing, recycling, reusing, material recovery, and material disposal. Regionally coordinated working groups could address such issues by setting up regional technical standards, providing technical assistance and training, and sharing knowledge and practices.

## RECOMMENDATIONS FOR ACCELERATING ELECTRIC BUS DEPLOYMENT

Our policy recommendations fall into two broad areas: international support and collaboration activities. These broad areas were identified at the regional dialogues held in 2021 and emphasized by EMDE representatives.[37] The recommendations are applicable for electric buses and other HDV segments with operational profiles similar to that of electric buses.

37 Khan, et al., *A critical review of ZEV deployment in emerging markets*.

### International support

The following are key actions through which international finance and/or technical support could be most effective in accelerating the transition to zero-emission HDVs in EMDEs:

- Conduct pilot projects to test and introduce tailored business models with proper monitoring, for production and procurement of zero-emission HDVs, establishing charging infrastructure, and converting existing diesel HDV depots to electric HDV depots with charging stations.
- Prioritize support for popular HDV segments in EMDEs, such as bus rapid transit, minibuses, and midi buses.
- Explore effective incentive program designs to support the early phase of the transition, including a combination of fiscal and non-fiscal incentives such as tax exemptions for investors and purchase subsidies or rebates and promotional incentives in bus tendering processes for fleet operators or fleet providers.
- Form trade agreements to facilitate the importation of materials, equipment, and parts for production of zero-emission HDVs, and for setting up charging infrastructure, including by waiving or reducing import duties.
- Facilitate the setting of appropriate fleet purchase requirements for electric bus fleet procurement and/or retrofitting.

Some EMDEs have already received international grants, loans, and technical support in the areas outlined above from international organizations, banks, and philanthropic institutions.[38] However, support should be extended to a larger number of EMDEs along with established criteria of market readiness to determine support eligibility and priority for the EMDEs. Furthermore, new and existing programs and initiatives for international support should be coordinated among organizations to ensure cost-effective utilization of financial assistance.

### Collaboration

Key actions for regional and international collaboration that can support leapfrogging to zero-emission HDVs across various segments include the following:

- Establish regional working groups and facilitate knowledge sharing and capacity building for developing electrification roadmaps and regulatory and fiscal policy frameworks, procuring electric HDVs, and identifying and implementing appropriate business and finance models.
- Work to integrate target-setting for multiple cities or countries to create regional demand greater than the demand found across individual small markets, thereby attracting manufacturers and other industries to invest in ZEV technology in the region.
- Share technology and provide technical assistance through regional workshops and training for local production and retrofitting; develop local supply chain capability, technical standards, and compliance test procedures; demonstrate technical, economical, and operational viability; and provide means of financing for zero-emission HDV projects.
- Coordinate across regions to unify technical standards for zero-emission HDVs and charging infrastructure across countries to reduce technical gaps, ensure interoperability for HDV segments, and improve economies of scale for investors and suppliers in the region.
- Collaborate with international manufacturers and other industries to establish manufacturing or assembly plants for zero-emission HDVs and batteries, retrofitting facilities, charging infrastructure, and R&D centers.

38 Khan, et al., *A critical review of ZEV deployment in emerging markets*.

# ANNEX A: HDV REGIONAL DIALOGUES SUMMARY READOUT PAPER

This summary readout paper is an output of the HDV regional dialogues, and is based on the findings of the briefing and feedback from the regional dialogues and the IAT meeting. The executive summary of this readout paper was submitted to and presented at the ZEVTC Ministerial meeting held in May 2022.

## EXECUTIVE SUMMARY

1. **Heavy-duty vehicles (HDVs)[39] represent** a relatively small share of vehicle fleets in most countries but **a disproportionately large share of transport emissions and climate/health impacts** in Emerging Markets and Developing Economies (EMDEs).[40]

2. **Zero-emission vehicle (ZEV) technology for HDVs, including battery electric vehicles and fuel-cell electric vehicles, can reduce these impacts significantly**—without additional ZEV policies beyond 2020, well-to-wheel $CO_2$ emissions from HDVs in the EMDEs are projected to surpass levels in the ZEV Transition Council (ZEVTC)[41] countries and China in 2050. Widespread adoption of zero-emission HDVs could see $CO_2$ emissions in EMDEs fall 44% below 2020 levels by 2050. With half of global new vehicle sales, and home to the world's largest automotive companies, the ZEVTC countries are well-positioned to influence the global market to support a ZEV transition for EMDEs.

3. This paper summarizes findings for how to accelerate the HDV ZEV transition in EMDE countries and the discussions that took place at the Regional Dialogues and the International Assistance Taskforce (IAT) in March and April.[42] It also sets out proposed next steps for the IAT to develop its recommendations by the CEM-MI Ministerials in September 2022 for ZEVTC Ministers to review, so that the ZEVTC and its partners can launch plans for a **strengthened and coordinated offer of international financial and technical assistance by COP27**.

## STATUS OF THE TRANSITION TO ZERO-EMISSION HDVS

4. **EMDEs working to electrify HDVs are prioritizing public transport.** The on-road fleet of electric buses (e-buses) increased about 30-fold in selected EMDEs between 2017 and 2020. But this growth was concentrated in only 23 of more than 100 EMDEs.

5. **Readiness for zero-emission HDV deployment varies widely by region and/or country.** Some EMDEs are relatively "less-ready" to adopt ZEV technology because they lack adequate government strategies, market deployment, and public awareness, and because of major barriers to getting electrification off the ground. Others are relatively "more-ready": they have sizeable on-road e-bus fleets, or strategies/ongoing projects for scaled-up e-bus deployment. For example, Latin America has several "more-ready" markets, Africa has relatively few, and other EMDEs are at a mix of readiness levels.

39 Definitions & types of HDVs vary. We define HDVs as buses, trucks, vans & other vehicles with a gross vehicle weight greater than 3.5 tonnes.

40 EMDEs: low-or-middle-income countries that are eligible for official development assistance and are outside of ZEV leading countries.

41 ZEVTC members: California, Canada, Denmark, European Commission, France, Germany, India, Italy, Japan, Mexico, Netherlands, Norway, South Korea, Spain, Sweden, the UK and the US.

42 As set out in the ZEVTC 2022 Action Plan and also supporting the Road Transport Breakthrough launched at COP26.

## KEY BARRIERS TO HDV ELECTRIFICATION

6. **For less-ready markets, a variety of barriers may impede HDV electrification,** including:
   - » Inconsistent priorities among stakeholders, and lack of electrification targets or strategies.
   - » High costs from import duties on e-buses, cheap imports of used vehicles, inadequate fiscal/financing mechanisms to invest in e-buses, and lack of knowledge for accessing finance or creating viable projects.
   - » Lack of infrastructure and utility support, especially with the challenge of expensive and unreliable electricity and, in some countries, fossil fuel prices made competitive by subsidies.
   - » Lack of awareness of ZEV benefits among stakeholders and the public.
7. **The more-ready markets have tackled some of these barriers but face others,** including:
   - » Minimal interest among international manufacturers in investing in small markets.
   - » Lack of technical expertise for building capacity for local production and handling supply chains, and for developing charging infrastructure and technical standards.
   - » Gaps in knowledge/communication preventing replication of successful cases and business models.
   - » Inexperience in managing grid integration and scaling up renewable energy as ZEV uptake advances.

## HIGH-LEVEL RECOMMENDATIONS FOR ACCELERATING HDV ELECTRIFICATION

8. In addition to reducing global costs and increasing the availability and accessibility of ZEV technology through ambitious commitments, two broad recommendations were identified for how the ZEVTC can accelerate a ZE-HDV transition in EMDEs:
   - a) **Develop more effective sharing of knowledge and technology by reinforcing, consolidating, and plugging gaps in current collaboration efforts.**
     - (i) In less-ready markets, develop electrification roadmaps, targets, and regulatory/fiscal/policy frameworks; better signal ways to access finance and technical assistance, including through use of best practice guidelines and case studies; ensure reliable energy supply and integrate renewable energy into the ZEV transition; procure electric HDVs; identify tailored business models and award contracts; and create public awareness campaigns.
     - (ii) In more-ready markets, share technology knowledge, and establish training hubs and R&D centers for developing technical skills, which can help build local supply chains, infrastructure, and energy integration.
   - b) **Make technology for effective ZEV deployment affordable by coordinating existing and new programs and by facilitating regional and international collaborations.**
     - (i) In less-ready markets, prioritize support for the most popular country- or city-specific HDV segments; explore effective temporary

fiscal incentive programs in coordination with existing programs and initiatives, to support the early-phase transition and ensure readiness; and form coalitions of ZEV experts and communications experts to accurately communicate ZEV benefits to stakeholders and the public.

(ii) In more-ready markets, establish public/private ecosystems committed to the ZEV transition; build regional markets to attract investment via joint target-setting/procurement across cities/countries; facilitate collaborations with ZEV manufacturers and other industries for investment and domestic supply chain development; and navigate grants, financing and technical assistance programmes for pilot project design and delivery, including feasibility assessments for e-buses, retrofitting technology, and wider rollouts.

## NEXT STEPS

9. By July, building on the above, the IAT will share with ZEVTC Senior Officials emerging priorities for:

   - **Bolstering existing initiatives and/or resources**—identifying opportunities to: strengthen coordination among existing initiatives; increase resources to existing key initiatives; and/or reinforce links between the ZEVTC's agenda and broader activities already underway (such as the G7 Clean Green Initiative country platforms work).
   - **Identifying and plugging gaps in the financial/technical assistance landscape by launching new initiatives and/or pooling additional resources**—ensuring any new activities subsequently agreed and launched complements existing work/ initiatives and provides tailored support, as and where appropriate, recognizing the unique needs and requirements of different geographies.

10. **By September, a formal proposal will be shared with ZEVTC Ministers** at their meeting during the CEM-MI Ministerials in Pittsburgh, with **the goal of pulling this together into a single, strengthened support offer for EMDEs** that could be launched by the ZEVTC and its partners at the COP27 Summit.

## REGIONAL DIALOGUE SUMMARY: AFRICA

The fast-paced urbanization characteristic of many African cities presents large socio-economic opportunities but also challenges. Among the challenges is the need to revamp its transport sector to address growing concerns about traffic congestion, air pollution, and the ongoing climate crisis. Effectively, many African governments are considering bus rapid transit systems in their cities. An unprecedented opportunity, therefore, presents itself to leapfrog towards electric buses. Electric buses have the potential to operate at a lesser cost when compared to diesel buses and will provide further relief from air pollution and climate change.

### ZERO-EMISSION HDV TRANSITION STATUS

Several African countries have started to put in place policies and programs to support the ZEV transition including:

- Deployment of charging infrastructure (primarily through public-private partnerships).
- Establishment of local electric vehicle manufacturing capacity.
- Launching awareness campaigns on electric vehicles.
- Development of standards for charging infrastructure.
- Development of an electric mobility policy.
- Placing fiscal incentives (e.g., tax exemptions) to support electric vehicles uptake.
- Joining the COP26 Declaration to accelerate the transition to 100% ZEV (focusing on cars and vans) and the Glasgow Breakthrough on Road Transport.

### KEY BARRIERS TO HDV ELECTRIFICATION

Several African countries have started their journey toward the electrification of buses. The transition, however, presents many barriers. The regional dialogue discussion highlighted several of those barriers:

- **Lack of a common and clear strategy**: Bringing together all stakeholders under a common strategy for bus electrification has been a challenge in most African countries. Targets need to be developed for the country's medium to long-term objectives.
- **High import duties**: African countries are heavily reliant on electric bus imports at the early phase of the transition. Yet those vehicles and associated equipment are often subject to high import duties. Furthermore, imports of low-cost, high-emitting used vehicles outcompete electric HDVs. In certain cases, updated directives need to be introduced to propose a formal approach for importing electric vehicles.
- **Lack of charging infrastructure**: The lack of charging infrastructure in most African countries is another significant barrier to ZEV adoption. The situation is further exacerbated by the energy challenge that many African countries are facing.
- **Electricity shortages and high prices**: Many African countries are still battling to provide electricity access to their population, especially in rural areas where populations are disconnected from the grid. In regions where households are connected to the grid, many experience blackouts and are subject to high electricity rates.
- **Lack of incentives:** As electric buses currently present a higher upfront cost when compared to diesel counterparts, governments can put in place incentive programs that will make electric buses more competitive. Lessons learned from leading electric vehicle markets have shown that those programs effectively support the early phase of EV uptake. However, many African markets do not offer incentive

programs and some countries have ZEV disincentives, such as high taxes for electric vehicles, that need to be eliminated.

- **Lack of technical capacity and resources**: The lack of technical capacity to maintain electric buses and their charging infrastructure is a critical concern. From a supply perspective, the current model based on the importation of electric buses makes sense in the short term. However, in the longer term, it could start showing its limitations when the availability of electric buses for exportation decreases (due to an increase in local demand, where they are originally manufactured). The high cost of warehousing for ZEV assembly is another big barrier.
- **Lack of interest in the African market**: African governments are confronted by a lack of interest from international investors. Except for China, many international investors do not yet see the business opportunity that the African market represents.
- **Lack of awareness of electric vehicle benefits:** The lack of public sector awareness of electric buses and their benefits impedes the transition to electric vehicles. On the public side, many do not understand why this transition is necessary and how there are benefits from this transition. In South Africa, many bus operators are still hesitant to adopt electric buses as clear studies supporting their business case are lacking.

## RECOMMENDATIONS FOR ACCELERATING HDV ELECTRIFICATION

The policy recommendations that were discussed at the dialogue include the following areas, which could also be supported through strengthened international and regional collaboration:

- Reduce the cost of ZEV technology to make local ZEV production affordable and bring ZEV cost-parity with conventional vehicles for the same level of service.
- Waive or reduce import duties on electric buses.
- Prioritize support for high-demand HDV segments such as minibuses and midi buses.
- Explore effective fiscal incentive programs, such as subsidies or rebates for purchasing e-buses.
- Bring together all relevant stakeholders of the transition, e.g., governments, the private sector, auto manufacturers, utility and charging providers, financial institutions, and other investors to work in tandem.
- Make information available on details of case studies, e.g., business models and cost comparisons.
- African countries, which individually tend to represent small markets, could strategically aggregate their demand and therefore represent larger markets that are more attractive to international investors. In the West Africa region, the Economic Community of West African States (ECOWAS) is an example of an already existing regional market that could adopt this regionally integrated demand approach.
- Establish training hubs and R&D centers for developing technical skills for domestic production of custom-made e-buses (e.g., solar buses) for Africa, maintenance, and repairing and conducting pilot projects for assessing technical, economic, and operational feasibility of e-buses.
- Facilitate knowledge-sharing for developing electrification roadmaps, strategy, targets, and regulatory and fiscal policy frameworks; ensuring reliable energy supply; identifying tailored business and finance models; financing zero-emission HDV projects; and launching public awareness and information campaigns.

## REGIONAL DIALOGUE SUMMARY: ASIA AND THE PACIFIC

The EMDE countries in the Asia and Pacific region are mostly at an early phase of the transition to zero-emission public transport and are eager to accelerate the pace of change with the aim of reducing $CO_2$ emissions and air pollution. Some countries are in the midst of developing ambitious national electromobility strategies and roadmaps, while others have adopted various policy actions to increase electric public transport accessibility and affordability.

### ZERO-EMISSION HDV TRANSITION STATUS

Some countries in the region are actively supporting the electrification of public transport and developing plans and various policies to accelerate the transition. The key ongoing actions include:

- Developing a national e-mobility strategy and roadmap and setting electrification targets for public transport.
- Developing local supply chain capability for electric buses.
- Introducing incentive schemes to support ZEV manufacturing and reduce the high upfront cost of electric buses.
- Introducing large-scale tenders for the deployment of electric buses.
- Establishing certification testing for electric vehicles.
- Focusing resources on adopting electric buses in selected large cities and planning for other cities to follow the footsteps of mentor cities.
- Developing electric bus rapid transit systems with international finance.

### KEY BARRIERS TO HDV ELECTRIFICATION

The key barriers to the deployment of zero-emission public transport, as discussed at the meeting by country participants, are outlined below:

- **Lack of a clear roadmap and regulations** to guide the transition toward electric vehicles
- **Lack of international support and collaboration** for financing the transition and investment by international manufacturers in the region.
- **Lack of energy and infrastructure** for the manufacturers and operators of electric public transport.
- **Inadequate fiscal incentives** to reduce the high price of electric buses and electricity.
- **Lack of knowledge and expertise** for identifying and implementing appropriate business models, procuring electric buses, and technical skills.

### RECOMMENDATIONS FOR ACCELERATING HDV ELECTRIFICATION

The policy recommendations that were discussed at the dialogue include the following areas, which could also be supported through strengthened international and regional collaboration:

- Provide greater international support than existing for the transition in the form of finance and technical assistance.
- Support the formation of collaborations with international ZEV manufacturers and suppliers to support greater investment flows into electric public transport across the region.

- Linked to this, strengthen collaboration with international manufacturers and other industries to develop the local manufacturing capacity of electric buses.
- Explore effective fiscal incentives to subsidize the high upfront cost of electric buses and electricity for the fleet operators and manufacturers.
- Prioritize support and adapt business models for country- and/or city-specific HDV segments, such as city buses and short/medium distance buses.
- Facilitate knowledge-sharing and technical training required to support capacity building in different key areas including development of policy framework; identification and implementation of tailored business models; procurement of electric buses; ensuring reliable energy supply; establishing infrastructure; developing technical skills for supply chain capability; and financing projects.

# REGIONAL DIALOGUE SUMMARY: CENTRAL & EASTERN EUROPE, WEST ASIA, AND MIDDLE EAST

Like in many other regions in the world, governments from these regions see transport as a key sector to decarbonize their economy to align with the goals of Paris Agreement. Effectively, many countries in the region are now looking into transitioning towards electric vehicles. However, achieving this transition will require developing a regulatory framework that addresses the technological, financial, and regulatory barriers against electric vehicle adoption.

## ZERO-EMISSION HDV TRANSITION STATUS

Some countries in the region have started on public transport electrification. Key policies, declarations and programs include:

- Public transport electrification targets.
- Import duty exemptions on electric vehicles.
- Value added tax (VAT) exemption on electric vehicles.
- Adoption of Euro V emission standards.
- Development of electric mobility laws through technical advisory groups (including the private sector).
- Joining the COP26 Declaration to accelerate the transition to 100% ZEV (focusing on cars and vans) and the Glasgow Breakthrough on Road Transport.

## KEY BARRIERS TO HDV ELECTRIFICATION

Many countries in the region are at the initial stage of their electric vehicle transition and find themselves confronted with challenges and barriers that prevent them from achieving their transport decarbonization goals. Challenges that were mentioned during the regional dialogue discussion include:

- **Lack of a clear strategy**: Most countries have not yet established a clear strategy/ roadmap on how to transition toward electric vehicles
- **Lack of a national dialogue**: There is a need for a national dialogue to discuss key policies and measures that need to be put in place to support the electrification of the transport sector.
- **Lack of detailed experience sharing:** Details need to be provided when sharing successful experience on electric vehicle uptake. Failure to do so prevents their replicability.
- **Disincentive policies**: Several governments present policies that act as disincentives against electric vehicle adoption. These include subsidies on fossil fuels (e.g., diesel) or tax regimes that are favorable to conventional vehicles.
- **Difficulties with funding**: The lack of financial resources to procure electric vehicles represent a major barrier. Many countries are facing difficulties when it comes to securing financial resources to support electric vehicle uptake.
- **Lack of interest from investors**: The small markets for electric vehicles make it hard to attract investors.

## RECOMMENDATIONS FOR ACCELERATING HDV ELECTRIFICATION

The policy recommendations that were discussed at the dialogue include the following areas, which could also be supported through strengthened international and regional collaboration:

- Provide grants or other financing mechanisms to support ZEV programs, including design and implementation of pilot projects to serve as a role model for replication.
- Facilitate knowledge-sharing regarding incentives and reliable policy framework, electric vehicles procurement, infrastructure, and details of success stories.
- Integrate regional markets to attract ZEV manufacturers and other industries for investment.

# REGIONAL DIALOGUE SUMMARY: LATIN AMERICA AND THE CARIBBEAN

Heavy-duty vehicles represent a small share of the total vehicle fleet in most Latin American cities but contribute significantly to greenhouse gas emissions. Governments are also looking into reducing their dependence on fossil fuels. Within this context, many Latin American cities have started transitioning toward electric vehicles. Up to 2022, this transition has focused on electric buses, where cities like Santiago and Bogota stand as world leaders. Several cities have also started looking into electrifying other heavy-duty vehicle segments (e.g., trucks). Overall, the transition toward an electric heavy-duty fleet still presents many technological and financial barriers that will need to be addressed for countries to be aligned with the Paris Agreement goals.

## ZERO-EMISSION HDV TRANSITION STATUS

Some countries have already introduced several measures to transition toward heavy-duty electric vehicles, many of which were highlighted during the Regional Dialogue meeting:

- Announcement of phase-out targets for combustion engine vehicles.
- Development of Incentive programs to support electric vehicle uptake.
- Adoption of fuel efficiency standards.
- Launched/launching pilot projects on electric buses to learn about the technology.
- Placing tax-exemption/reduction on electric vehicles.
- Setting mandates on energy efficiency for heavy-duty vehicles.
- Development of innovating business models to support fleet electrification.
- Revising import policies to favor penetration of more efficient vehicles.
- Development of local manufacturing capacity for electric vehicles.
- Joining the COP26 Declaration to accelerate the transition to 100% ZEV (focusing on cars and vans) and the Glasgow Breakthrough on Road Transport.
- Joining the Zero Emission Medium- and Heavy-Duty Vehicles MoU that was also launched at COP26.

## KEY BARRIERS TO HDV ELECTRIFICATION

Despite the efforts that many governments in the region have deployed in recent years, much more needs to be done. Several challenges were highlighted during the roundtable discussion:

- **Resistance to change**: Resistance to change is a barrier that exists whenever a significant disruption occurs, such as the transition toward electric vehicles.
- **Lack of motivation to transform the diesel-based heavy-duty market:** The heavy-duty vehicle space is quite dispersed and not well integrated compared to other vehicle markets. Also, the typical lifetime of conventional heavy-duty vehicles is very long (until they completely stop working, which can take up to 30 years), creating another barrier to electric heavy-duty vehicle adoption.
- **Economic feasibility of bus retrofits:** Besides importing or manufacturing electric vehicles, several cities in the region are also looking into retrofitting of diesel buses to electric. Yet, such operations' economic feasibility remains unclear and needs to be studied on a case-by-case basis. In Chile, for example, several start-ups are doing retrofits on commercial vehicles in the mining sector. Still, the regulations they are subject to could compromise their economic feasibility and should therefore be operated with caution.

» **Innovating business model approaches:** The high upfront cost of heavy-duty electric vehicles (compared to their diesel counterparts) is a significant barrier to their adoption. Additionally, the heavy-duty vehicle market comprises a relatively small number of stakeholders, making it hard to attract private financing. Therefore, there is a need to develop innovative business approaches that could facilitate the acquisition of electric vehicles. On that front, there are cities that have already illustrated how a concessional business model that distributes responsibility among bus providers, bus operators, and charging infrastructure owners can be successful.

## RECOMMENDATIONS FOR ACCELERATING HDV ELECTRIFICATION

The policy recommendations that were discussed at the dialogue include the following areas, which could also be supported through strengthened international and regional collaboration:

» Prioritize support and adapt business models for the country- and/or city-specific HDV segments, such as large city buses, minibuses and microbuses for small cities, and freight trucks.

» Develop coalitions of ZEV experts, advocates, communities, and communication experts to accurately communicate ZEV benefits to stakeholders and the public.

» Facilitate knowledge and information sharing for assessing the technical and economic feasibility of retrofitting technology; identifying tailored business models and awarding contracts; financing zero-emission HDV projects; and details of successful case studies.

» Set a regional integrated approach to move away from the on-road old diesel HDVs.

» Share technology and provide training for developing technical skills and local supply chain capability to progressively replace imports with domestic production of ZEVs.