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A CRITICAL REVIEW OF ZEV DEPLOYMENT IN EMERGING MARKETS

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EXECUTIVE SUMMARY

Promotion of zero-emission vehicle (ZEV) technologies is a key global strategy for decarbonizing the transport sector and helping to achieve long-term climate goals. ZEV sales are increasing rapidly in the world's leading passenger vehicle markets, including China and many of the countries represented in the ZEV Transition Council (ZEVTC). However, ZEV uptake has been much slower in emerging markets and developing economies (EMDEs) including low- and middle-income countries. Without additional ZEV policies beyond baseline year 2020, well-to-wheel CO_2 emissions are projected to double in 2050 over the 2020 level, compared to a 5% increase for the ZEVTC countries and China combined. However, with significant ZEV uptake, CO_2 emissions in EMDEs could fall 51% below 2020 levels by 2050. Therefore, to reach the climate goal of limiting global warming to less than 2 degrees Celsius, acceleration of the transition to ZEVs is needed in EMDEs as well as in leading ZEV countries.

Many of the ZEVTC governments are well-positioned to support a ZEV transition in EMDEs and have committed to accelerating the global ZEV transition. In this paper, we make specific recommendations regarding how ZEVTC governments can contribute to a ZEV transition in EMDEs. To arrive at these recommendations, we review and evaluate the status of ZEV uptake and ZEV policies in EMDEs; identify policy gaps and barriers, and strategies for leapfrogging to electrification; and quantify the existing and required level of international financial support to promote early phases of ZEV uptake in EMDEs. We have included in our analyses 117 non-ZEVTC countries from four key EMDE regions: Africa, Latin America, Eurasia (selected countries in Eastern Europe, Middle East, and South and Central Asia), and ASEAN nations.

ZEV UPTAKE AND ZEV POLICIES IN EMDEs

In 2020, a few leading EMDEs posted substantial ZEV shares of vehicle sales, particularly for urban buses (e.g., Chile, 15%) and two-wheelers (e.g., Vietnam, 8.5%). For passenger cars, ZEVs accounted for less than 1% of vehicle sales in EMDEs, with Ukraine (0.9%) and Jordan (0.8%) having the highest sales shares. Most EMDEs reported no ZEV sales as of 2020. And sales of electric trucks, along with policies to promote them, are essentially non-existent in EMDEs.

Some EMDEs have introduced policies to accelerate the ZEV transition that echo one or more of the five major policy levers—including phase-out targets, regulations, incentives, infrastructure, and demand-based policies—that have been identified in the global ZEV leading markets. EMDEs have also taken actions to further develop their domestic ZEV industries and market-based solutions, and to leverage international support. Most of these policies were adopted in 2020 and 2021; it will take time for these changes to influence ZEV market uptake in these countries.

However, the absence of phase-out targets and regulations are major gaps in EMDE ZEV policy frameworks. Phase-out targets refer to long-term planning of the government for 100% of new sales be ZEVs. Regulations include standards for fuel economy and emissions of CO_2 and other conventional pollutants per distance driven, as well as ZEV regulations that require manufacturers to continually increase the annual share of ZEV sales. These rules are critical to ensure sufficient availability of ZEV models for purchase; otherwise even generous incentives may not be effective. Only a few EMDEs have set phase-out targets for internal combustion engine vehicles (ICEVs) in specific vehicle segments. And few EMDEs have stringent CO_2 standards and ZEV regulations, and emission standards for local air pollutants. Meanwhile, infrastructure support remains at an initial development phase in most of EMDEs. And only a few EMDEs (e.g., Cape Verde, Belarus, Thailand) provide strong incentive programs, even though ZEVs are far from being cost-competitive in most EMDEs.

Some EMDEs (e.g., Thailand, Indonesia, Malaysia) are developing local ZEV manufacturing and assembly capacity by incentivizing the domestic production industry and creating collaborations with international manufacturers; prioritizing electrification for major transport modes such as buses in some Latin American countries, and two- and three-wheelers (2&3Ws) in ASEAN countries; introducing electric fleets and expanding purchase options through e-mobility businesses such as in some of the African countries for 2&3Ws; and using international support for financial and technical assistance.

STRATEGIES NEEDED FOR EMDEs TO OVERCOME KEY BARRIERS

In addition to common barriers to ZEV uptake—availability, affordability, convenience, and consumer awareness—EMDEs face specific challenges: nonexistent ZEV regulatory frameworks, inadequate fiscal and financing mechanisms, imports of low-cost used ICEVs, and lack of technical capacity. The magnitude of each of these barriers varies across countries and regions.

To encourage adoption of ZEV technology and investment in it, EMDEs need to develop ZEV transition roadmaps, ZEV regulatory frameworks, and localized ZEV supply chain capabilities. Before ZEVs reach cost parity, EMDEs can reduce ZEV upfront costs through budget-neutral mechanisms that make high-emitters pay (e.g., feebates), or international financing to fund targeted fiscal policies and innovative business models. Import-based EMDEs could form trade agreements with exporting countries to lower or waive import duties for ZEVs or ZEV components and regulate import of used ICEVs while allowing imports of slightly used ZEVs that meet performance and safety standards. EMDEs could prioritize ZEV transitions of highly utilized fleets, such as shared mobility fleets or government-operated vehicles. EMDE governments could mobilize private-sector initiatives through partnerships with international automobile companies and/or through international financing.

BIG GAP IN INTERNATIONAL FUNDING FOR EMDEs

International funding for the ZEV transition has already played an important role in EMDEs. Based on publicly available information, at least 37 EMDEs received approximately US$163 million for ZEVs between 2017 and 2021. However, this support is only 6.5% of the level of funding (US$2.5b) we estimate is needed over the next five years to adequately support the early phase of the ZEV transition in EMDEs.

RECOMMENDATIONS FOR ZEVTC TO SUPPORT ZEV UPTAKE IN EMDEs

ZEVTC governments, along with other relevant international entities, can serve an important role in supporting the global ZEV transition by helping to drive down ZEV technology costs, providing financial and technical assistance, and deepening regional dialogues for knowledge exchanges. Specifically, ZEVTC member countries can:

- Set clear targets to transition to 100% ZEV sales between 2030 and 2040, bring down ZEV technology costs, and increase global availability and affordability.
- Support the creation of dedicated financing facilities for ZEVs via existing and new programs and initiatives to provide effective financial assistance to EMDEs, and act to shift investments in ZEVs abroad.
- Establish a working group on the global ZEV transition as an enduring forum to engage with non-ZEVTC countries, especially EMDEs, and form regional collaborations to reduce disparities in the ZEV transition.

TABLE OF CONTENTS

INTRODUCTION

Promotion of zero-emission vehicle (ZEV) technologies is a key global strategy for decarbonizing the transport sector and helping to achieve long-term climate goals (ICCT, 2020). ZEVs include battery electric vehicles (BEVs) and fuel-cell electric vehicles (FCEVs) that have zero tailpipe emissions during driving. BEVs dominate global ZEV markets and hence, are the leading ZEV technology globally (IEA, 2020).

Widespread adoption of ZEVs offers a broad array of benefits to society. ZEVs have zero tailpipe emissions and, therefore, are associated with substantial public health co-benefits from reduced traffic-related local air pollution. ZEVs reduce global greenhouse gas emissions significantly when coupled with low-carbon or renewable energy sources of electricity production. BEVs are known to be 2 to 4 times more energy efficient than ICEVs (Skowron, 2019) and enhance a nation's energy security by reducing dependency on imports of petroleum fuel. Furthermore, the ZEV transition expands opportunities for employment, and industrial and economic development by promoting the ZEV production industry, cost-competitive ZEV battery technology, ZEV and battery supply chains, ZEV exports, and electric mobility startups and businesses.

ZEV sales are increasing rapidly in the world's leading passenger vehicle markets, including China and many of the countries represented in the ZEV Transition Council (ZEVTC). The ZEVTC is made up of ministers and representatives of some of the world's largest and most progressive car markets including Canada, the European Union, India, Japan, Mexico, Norway, Republic of Korea, the United Kingdom, and the United States. However, ZEV uptake has been much slower outside of the leading countries, particularly in emerging markets and developing economies (EMDEs), including low- and middle-income countries.

As shown in Figure 1, EMDE markets are experiencing the fastest growth in transport-sector emissions. Without additional ZEV policies beyond baseline year 2020, well-to-wheel CO_2 emissions in EMDEs are expected to double by 2050 over the 2020 level, compared to a 5% increase in the ZEVTC countries and China combined (Sen and Miller, forthcoming). Therefore, limiting global warming to 2 degrees requires an accelerated ZEV transition in EMDEs as well as in China and ZEVTC countries. Furthermore, without a ZEV transition, EMDEs would be stranded in a fossil-fuel dominated future with massive energy and economic insecurity and volatility. The need to accelerate the ZEV transition in EMDEs is amplified by the air pollution and health impacts of ICEVs. Given that vehicle regulations in EMDEs tend to be less stringent than in advanced economies, the air pollution benefits of ZEVs are correspondingly greater in EMDEs (Sen et al., 2021).

ZEVTC governments are well-positioned to support a ZEV transition in EMDEs as the ZEVTC has committed to accelerating the global ZEV transition. Moreover, ZEVTC governments include some of the largest donors of development assistance and some of the world's most important centers of automotive design and manufacturing, both of which can directly influence a ZEV transition in EMDEs.

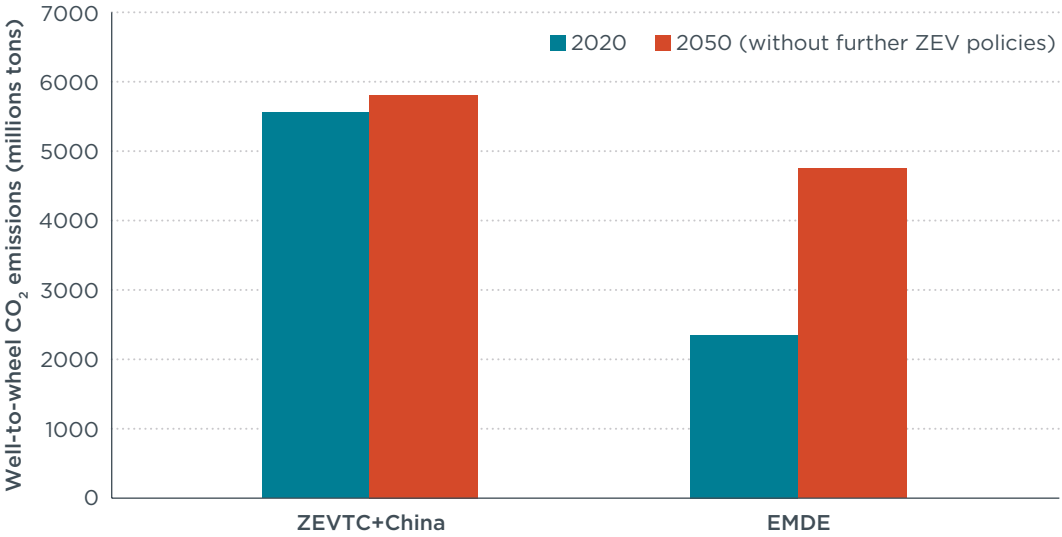


Figure 1. Estimated well-to-wheel CO_2 emissions (million tons per year) from cars, vans, buses, and trucks in the ZEV leading countries (ZEVTC countries and China) versus emerging markets and developing economies (EMDEs), in 2020 and 2050 (without further ZEV policies).

Work on a ZEV transition in emerging markets is underway by international development organizations and institutions such as the Global Fuel Economy Initiative (GFEI) (Cazzola et al., 2021), the International Transport Forum (ITF) (Blanco and Jeannière, 2021), the International Energy Agency (IEA) (McBain and Bibra, 2021), the Global Environment Facility (GEF) (Dalkmann and Huizenga, 2010), the United Nations Environment Programme (UNEP, 2020), the World Bank (World Bank, 2018), and the Asian Development Bank (ADB) (Grütter and Kim, 2019). However, more work is needed to assist EMDEs in devising policy strategies and regional and international support for a faster ZEV transition.

The objectives of this paper are to evaluate the current state of ZEV uptake and policies in EMDEs; identify strategies regarding how EMDEs can leapfrog to electrification; and identify how ZEVTC can contribute to a ZEV transition in EMDEs.

SCOPE AND METHODS

In this paper, EMDEs refers to non-ZEVTC countries that have low or medium levels of income per capita, as defined by the International Monetary Fund's World Economic Outlook (IMF, 2021); are eligible for ODA, as determined by the Organization for Economic Co-operation and Development (OECD, 2019); have structural features consistent with limited development and structural transformation; and are insufficiently integrated into the global financial system. This paper reviews ZEV development and policies in 117 countries (see Appendix A for a detailed list of countries) from four key regions—Africa, Latin America,[1] ASEAN nations,[2] and Eurasia.[3] These 117 countries are primarily EMDEs but also include a few high-income countries that are not ZEVTC members but are emerging in the ZEV transition.

The status of ZEV uptake and policies in EMDEs is addressed for on-road vehicles including passenger cars (PCs), buses, two- and three-wheelers (2&3Ws), and trucks. Although a true ZEV transition refers to the transition to vehicles with zero tailpipe emissions (i.e., BEVs and FCEVs), some EMDE data, targets, and policies include plug-in hybrid vehicles (PHEVs), since they are only at the early phase of the transition. PHEVs, which combine an electric and a conventional combustion engine drive train, offer the potential to reduce greenhouse gas emissions and air pollution relative to conventional ICEVs if a higher share of driving is done using the electric motor. Therefore, in this paper, we include such partial zero-emission technologies in our definition of electric vehicles (EVs) such that EVs include BEVs, FCEVs, and PHEVs.

To determine how ZEVTC countries can contribute to a ZEV transition in EMDEs, we first review the status of ZEV sales and policies in EMDEs. We summarize ongoing and planned ZEV policy actions in EMDEs; identify important barriers to ZEV adoption; and make recommendations for strengthening ZEV policy frameworks in EMDEs. We quantify international support in terms of grants and loans provided for each region based on published information (see Appendix D for list of references on international support). We compare financial assistance provided to funding amounts needed to support early ZEV uptake by region. We conclude by identifying actions ZEVTC countries could undertake to support EMDEs in overcoming the barriers to ZEV adoption. Our recommendations are based on the effective policies adopted by advanced economies and EMDEs but are contextualized to the circumstances of EMDEs.

Data on 2020 vehicle sales or stock (where sales data was not available, i.e., for electric buses) in EMDEs were collected from various databases and model predictions including EV Volumes (2021), OICA (2020), MotorCycles Data (2020), and ICCT Roadmap model (ICCT, 2021). A review of EV policies and international support in EMDEs was done based on information published in government policy documents, research publications, and media reports (see Appendix D for a detailed list of references). Information on ongoing ZEV-related actions was also obtained from international development organizations such as UNEP, and from EMDE representatives at the regional roundtable[4] discussions. Effective policies to accelerate the ZEV transition are drawn from a related ICCT paper that systematically evaluated policies for light-duty and heavy-duty vehicles in ZEVTC countries and leading markets (Hall et al., 2021).

1 Latin America includes countries from South & Central America, excluding Mexico, which is a ZEVTC country.

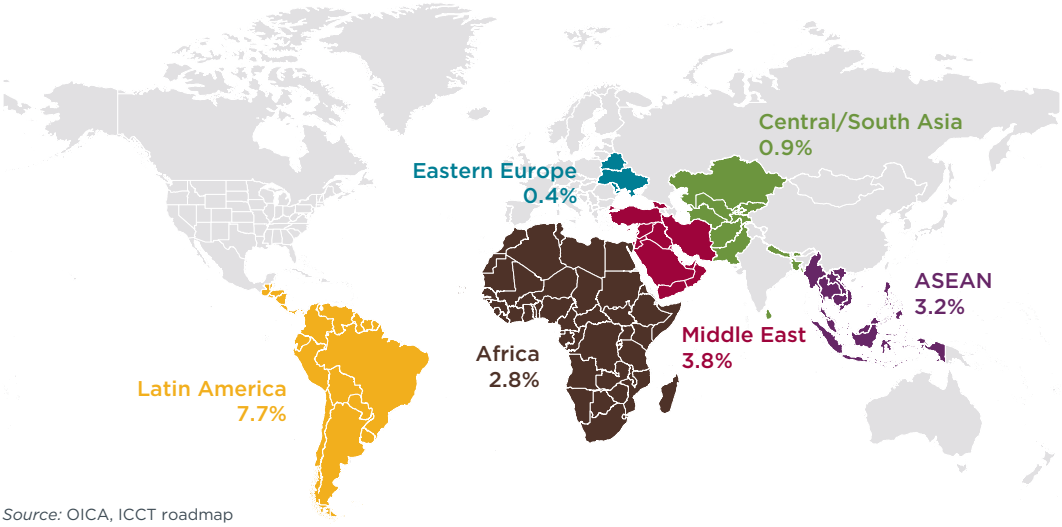
2 Association of Southeast Asian Nations includes Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

3 The Eurasian region includes selected countries from Eastern Europe (excluding EU-27 countries), the Middle East, and Central & South Asia (excluding India).

4 To ensure that ZEVTC Ministers' discussions on the global ZEV transition at COP26 in November 2021 reflect the views and experiences of EMDEs, the UK Government organized four regional roundtable meetings in September 2021—for Africa, the Americas, Eurasia, and Southeast Asia and the Pacific. With Government officials from nearly 40 EMDEs participating, these meetings helped identify some of the key barriers, opportunities, ideas, and areas of regional and international collaboration and support for the ZEV transition in EMDEs.

OVERVIEW OF EMERGING MARKETS

Figure 2 shows the key regions and sub-regions of EMDEs that are analyzed in this paper. EMDEs comprised about 19% of the global new vehicle market in 2020, which includes PCs, vans, buses, and trucks. The 2020 vehicle stock in EMDEs, including light-duty vehicles, buses, trucks, and 2&3Ws, is projected to double in 2050. This rapid growth in the vehicle fleet will exacerbate the adverse climate and air quality impacts of on-road vehicles in these regions.



Source: OICA, ICCT roadmap

Figure 2. EMDE regional shares of the global vehicle market

Figure 3 illustrates the estimated well-to-wheel CO_2 emissions from vehicles (except 2&3Ws)[5] by EMDE region and sub-region for baseline ZEV policy scenarios for 2020 and 2050, and an ambitious ZEV policy scenario for 2050. A baseline scenario includes currently adopted and finalized ZEV policies (Sen and Miller, forthcoming). An ambitious scenario assumes an accelerated global ZEV transition to reduce cumulative CO_2 emissions, and to approach as nearly as possible, zero emissions by 2050. The ambitious scenario is based on strong ZEV policies that drive a technically feasible scale-up of ZEV production and uptake such that ZEVs account for 100% of global vehicle production by 2050 for cars, vans, buses, and trucks. As demonstrated in Figure 3, with currently adopted policies in the baseline scenario, the estimated total well-to-wheel vehicle CO_2 emissions from all regions of EMDEs will reach 4.7 billion tonnes in 2050—more than double the 2020 level. However, in the ambitious scenario, a significant transition to ZEVs in the regions could instead reduce CO_2 emissions to 51% below the 2020 level by 2050. This emissions reduction would be even higher if 2&3Ws were taken into account.

5 Due to data limitations and time constraints, 2&3Ws were outside of the modeling scope of the study by Sen and Miller (forthcoming) that estimated the well-to-wheel vehicle CO_2 emissions for various regions and scenarios.

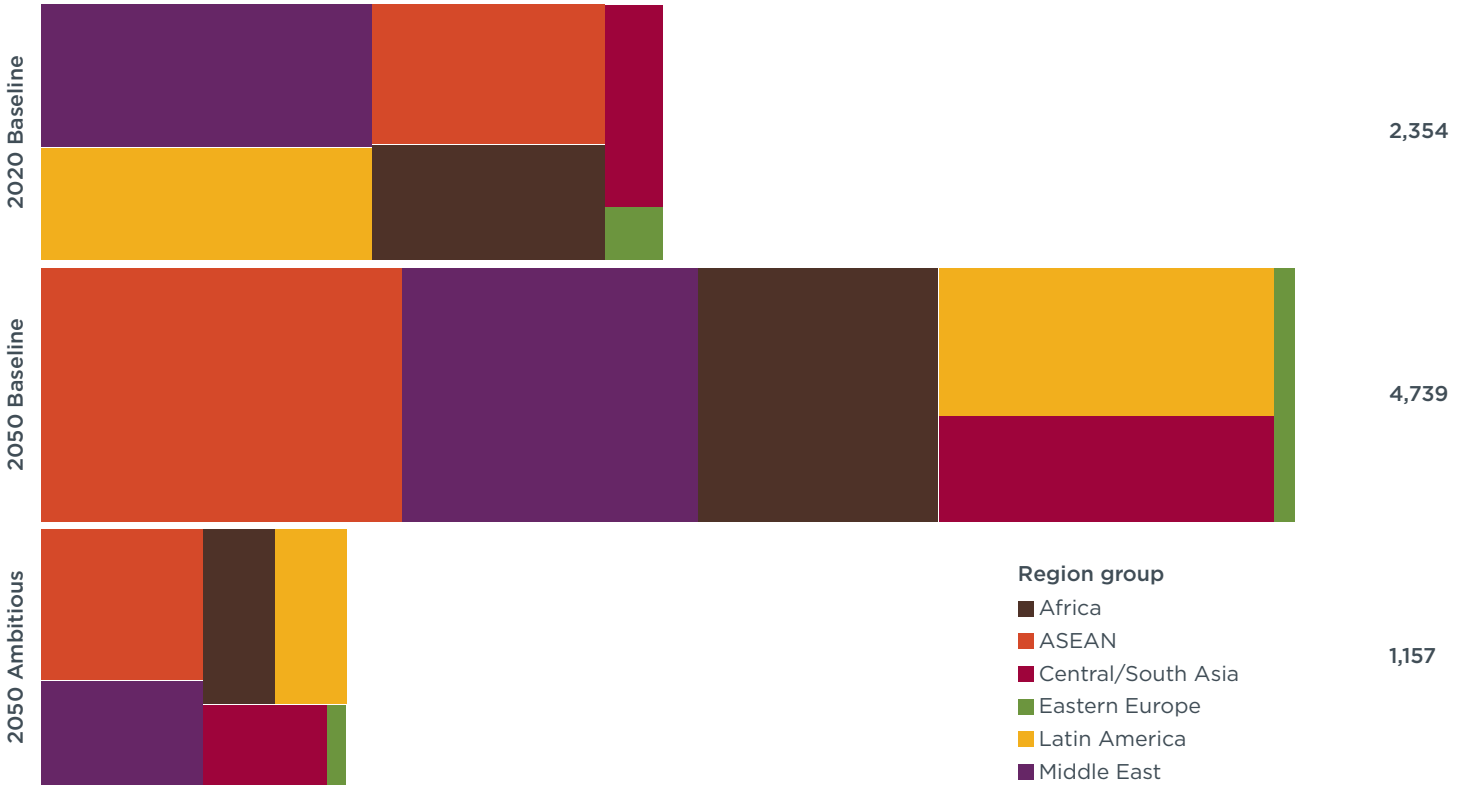


Figure 3. Estimated well-to-wheel CO_2 emissions (million tonnes per year) from cars, vans, buses, and trucks in EMDEs, by region and sub-region

Passenger transportation modes in many EMDEs are dominated by 2&3Ws, particularly in ASEAN and Latin American countries. Based on 2020 estimates, ASEAN countries account for the highest sales share of 2&3Ws among the EMDEs, at 70%, and are third, after China and India, in global sales share for 2&3Ws (ICCT, 2021). Latin American countries are second in sales share among EMDEs, at 15%.

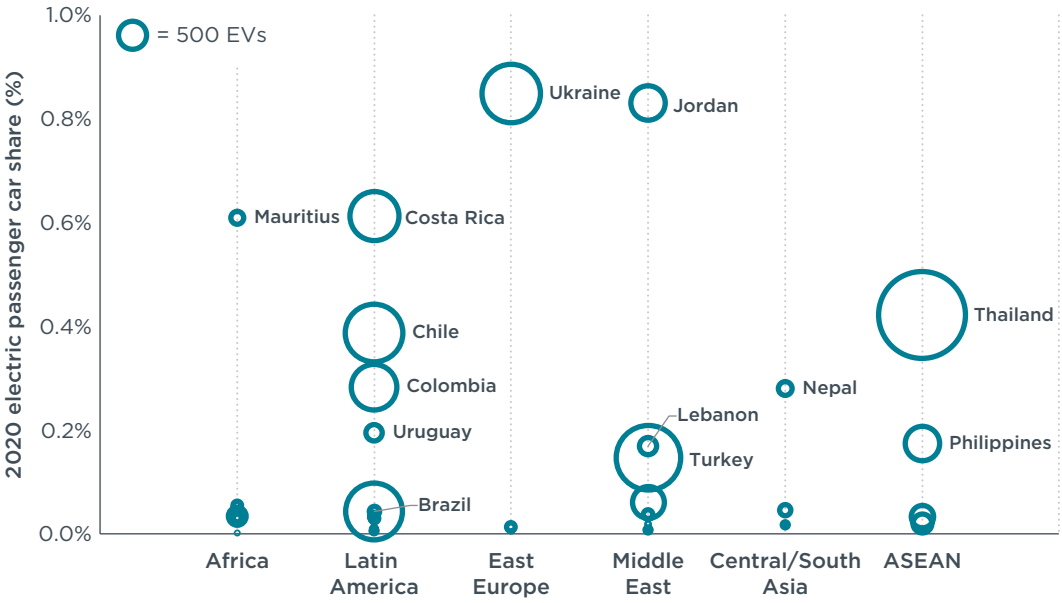
African countries are also a large market for 2&3Ws. Annual 2&3W imports by Africa are approximately 3 to 4 million units, with a current fleet of around 15 to 20 million vehicles.[6] EMDEs are well-positioned to accelerate the ZEV transition through electrification of 2&3Ws, which is amplified by the relative cost-competitiveness of electric 2&3Ws compared to electric PCs (Rokadiya et al., 2021).

The vehicle market in many EMDEs is driven by the low purchase price and high affordability of imported used vehicles, particularly in many African countries. About 1.5 million used vehicles are imported by Africa every year (UNEP, 2020), and African countries account for about 40% of exported used light-duty vehicles worldwide. For some African countries, 80% to 90% of imported vehicles are used (Deloitte, 2018). Such low-cost, imported, used ICEVs help to create a wide price gap with ZEVs, and delay the attainment of cost parity for ZEVs. EMDEs that import used ICEVs could become importers of used ZEVs but may face challenges in ensuring quality and safety of imported used ZEVs.

6 Estimate from United Nations Environment Program (UNEP).

ZEV TRANSITION STATUS

Some EMDEs have sizable sales of ZEV PCs, as of 2020 (Figure 4). All ZEV sales in these markets are BEVs and do not include FCEVs. The 2020 ZEV sales share of PCs in EMDEs is less than 1%. Ukraine and Jordan have higher ZEV market shares than other EMDEs across the regions, at 0.9% and 0.8%, respectively. However, these ZEV shares are still lower than in some high-income countries in similar regions, such as the UAE (1.5%) and Singapore (1.1%). Some EMDEs are scaling up ZEV sales, such as Costa Rica at 0.6%, and Chile and Thailand, each at 0.4%. Compared to Chile and Thailand, Costa Rica has a higher ZEV sales share, however, the overall new vehicle market is smaller in Costa Rica. Similarly, Mauritius has a ZEV share of 0.6%, but the ZEV market share is sensitive to the small size of vehicle market.



Note: Israel, UAE, and Singapore are high-income countries with ZEV sales shares of 0.8%, 1.5%, and 1.1%, respectively

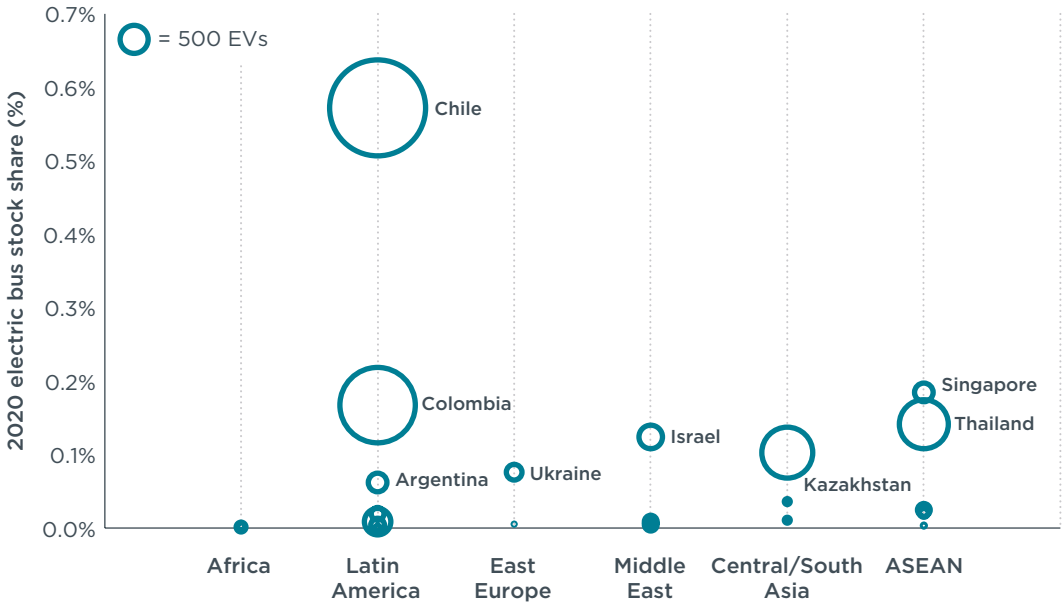
Figure 4. New battery electric cars sales share (%) and relative market size for EMDEs, by key region and sub-region for 2020
Source: EV Volumes (2021); OICA (2020); ICCT Roadmap model (ICCT, 2021)

Early signs of ZEV uptake for PCs are observed in some EMDEs including Colombia, Nepal, Uruguay, Lebanon, and Philippines with ZEV shares of the PC market registering between 0.1% and 0.3%. Brazil has higher ZEV sales yet a relatively lower market share than many EMDEs due to its bigger vehicle market. A few African countries such as South Africa, Morocco, Zimbabwe, and Tunisia are at a very early stage of EV uptake, with ZEV shares of the total vehicle market registering less than 0.1%.

Accounting for EVs including both BEVs and PHEVs for PCs, Ukraine and Jordan have slightly higher market shares, at 1.5% and 1.1%, respectively, than BEV shares alone in these countries. High-income countries such as Israel, Singapore, and UAE have higher EV market shares than the share for EMDEs overall, at 3.1%, 2.5%, and 1.7%, respectively. Selected EMDEs that are scaling up their EV uptake such as Costa Rica, Colombia, and Thailand, each have EV sales shares of 0.6%, while Chile's share stands at 0.5%.

Figure 5 shows the stock (on-road) shares for battery electric buses (i.e., passenger transport with greater than 3.5 tonnes) for EMDEs by region. Chile and Colombia are home to the largest fleet of electric buses after China. As of 2020, Chile's electric bus stock includes more than 800 (IEA, 2021) electric buses with 0.6% stock share and

15% 2020 new bus sales share. Colombia has around 500 electric buses with 0.2% stock share and about 12% 2020 new bus sales share. Chile and Colombia also have about 1000 electric buses on order, which are not reflected in the 2020 electric bus stock numbers. Kazakhstan and Thailand have cumulatively more than 200 electric buses each, which represent minor shares (i.e., about 0.1%) of their respective bus stocks. Several other EMDEs across the regions have electric bus stocks such as South Africa, Egypt, Malaysia, Turkey, Uruguay, Ecuador, Ukraine, Argentina, and Brazil with cumulative totals of 11 to 67 electric buses.



Note: Israel and Singapore are high-income countries

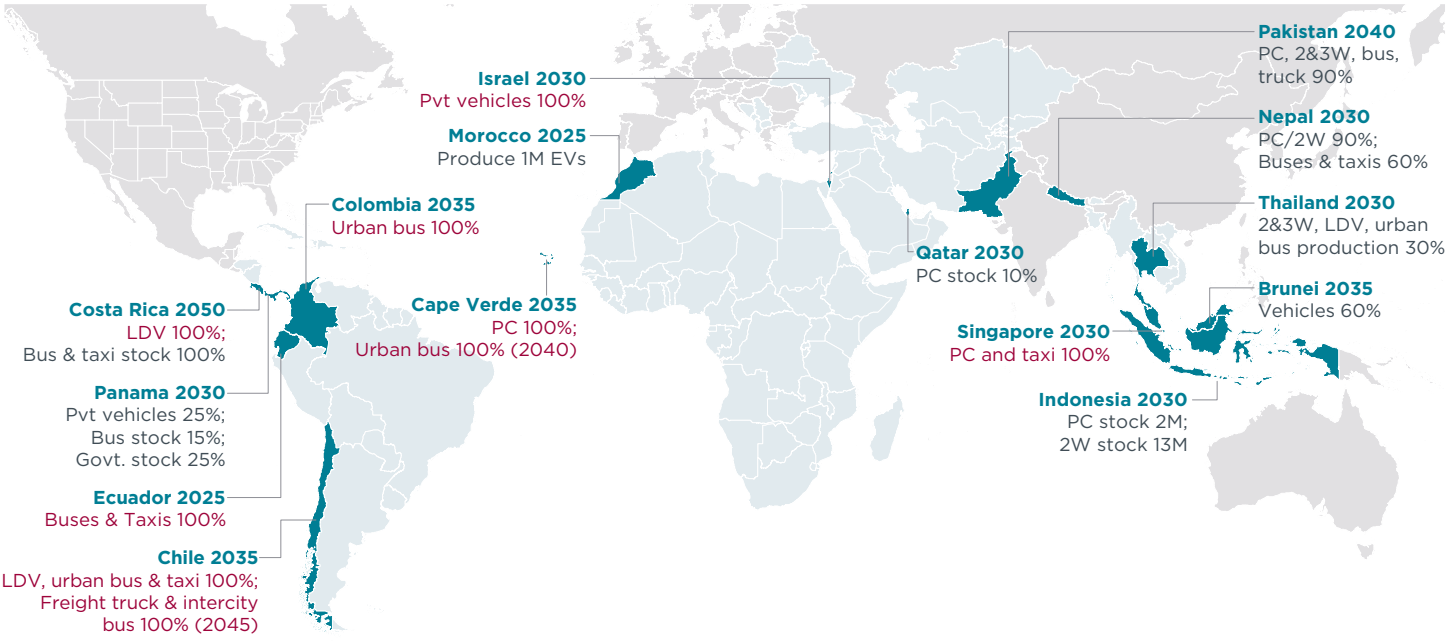
Figure 5. New battery electric buses stock share (%) and relative stock size for emerging markets and developing economies by key region and sub-region for 2020.
Data Source: EV Volumes (2021); ICCT roadmap model (ICCT, 2021).

The ZEV transition in the 2&3W segment is faster in some ASEAN countries compared to other regions. As of 2020, Vietnam had a high sales share of 8.5% (around 262,000 sales) for electric two-wheelers, followed by Philippines at 1.3% (2&3Ws), Indonesia at 1.1% (two-wheelers) and Malaysia at 0.8% (two-wheelers). Thailand and Cambodia have electric 2&3Ws sales share of 0.1%. As of 2019, the Philippines has 3500 e-trikes. Electric 2&3Ws are emerging in Eurasia, particularly in some South Asian countries. Bangladesh has more than 1 million lead-acid battery-operated e-rickshaws (Hasan, 2020) and Kathmandu, Nepal has around 1,200 e-rickshaws (Shrestha, 2018). For Africa, some e-mobility based businesses and startup companies are bringing in electric 2&3Ws as both public and private transportation, such as in Kenya, Liberia, Rwanda, Togo, Zimbabwe, Uganda, Ghana, and South Africa. Latin America is the second largest two-wheeler market among EMDEs after ASEAN region, but two-wheeler electrification there is at the nascent stage.

ZEV uptake lags significantly for the truck segment in EMDEs. A few Latin American countries such as Brazil, Colombia, Ecuador, and Uruguay had sales of only 1 to 31 battery electric trucks in 2020. Other than these few countries, little data exists regarding the uptake of electric trucks in EMDEs.

ZEV TARGETS

Some EMDEs have set official EV targets for specific vehicle segments. Figure 6 depicts where EV targets are officially announced as part of legislation or a country's Nationally Determined Contribution under the Paris Agreement, or which are published in official policy documents such as a national e-mobility strategy, roadmap, climate action plan, decarbonization plan, or budget. This map does not include targets that combine EVs with conventional hybrids or vehicles fueled with CNG/LPG/biofuels. For EMDEs with multiple targets (e.g., new sales, stock, and production) and target years (e.g., interim milestones and long-term targets), we prioritize the targets in the order of 100% new sales (or ICEV phase-out target), stock, and production, and also prioritize the long-term targets (i.e., the longest timeframe).



All targets are new sales targets, unless specified as stock/production targets
Vehicle includes light-duty vehicle (passenger car & light commercial vehicle) and heavy-duty vehicle
Pvt: private; Govt.: government; PC: passenger car; 2&3W: two- and three-wheelers; LDV: light-duty vehicle

Figure 6. Official ZEV targets in EMDEs. Targets in red indicate ICEV phase-out goals of 100% new EV sales

As of October 2021, EMDEs with ICEV phase-out targets of 100% new EV sales include Cape Verde (passenger cars by 2035 and urban buses by 2040), Chile (LDVs and urban buses and taxis by 2035, and freight transportation and intercity buses by 2045), Costa Rica (light-duty vehicles by 2050), Colombia (urban buses by 2035), Ecuador (public transportation by 2025), Israel (private vehicles by 2030), and Singapore (passenger cars and taxis by 2030). Some EMDEs have ZEV stock and production targets. For instance, Chile and Costa Rica have plans for 100% ZEV stock for public transport fleets such as buses and taxis; and Morocco and Thailand have ZEV production targets over specified timeframes. However, most EMDEs do not yet have any ZEV targets (see Appendix B for a complete list of the targets in EMDEs).

ZEV POLICY STATUS

An ICCT paper (Hall et al., 2021) has identified five major ZEV policy levers as key drivers for an accelerated ZEV transition in most ZEVTC countries and leading markets. These five policy levers fall in the domains of phase-out targets, regulations, incentives, infrastructure, and demand-based policies.

- **Phase-out targets**, the elimination from the market of new ICEVs by a target date, are the logical corollary of setting targets for 100% electrification of new sales. Phase-out targets demonstrate the determination and ambition of the government to decarbonize the vehicle fleet and to be consistent with long-term climate goals. The target also serves as a guideline for auto manufacturers to plan their scaling up of ZEV production, building infrastructure, and phasing out sales of ICEVs gradually over a long timeframe.
- **Regulations** include fuel economy and emission standards to lower vehicle fuel consumption, CO_2 emissions, and conventional pollutants per distance driven, and ZEV regulations which require manufacturers to continually increase the annual share of ZEV sales. Regulations are clear policy signals to vehicle manufacturers and the automobile industry for adopting ZEV technology to ensure that a growing share of ZEVs and varieties of ZEV models is available for purchase.
- **Incentives** are inducements that increase the attractiveness of ZEVs compared to ICEVs. Monetary incentives can take the form of subsidies/rebates, tax exemptions/benefits, waived/reduced registration fees to reduce the high upfront cost of ZEVs, and in-use benefits (e.g., waived parking fees and reduced electricity tariffs for charging) to reduce the total cost of ownership compared to ICEVs until cost parity is achieved. In-use incentives can also be non-monetary, including exemption from circulation restrictions and mandatory or designated parking spaces.
- **Infrastructure** is needed to ensure that sufficient charging capacity is in place to service ZEVs, which increases consumer confidence regarding ZEV ownership. Policies for charging infrastructure can include tax exemptions/benefits for importing ZEV charging-related equipment and parts; public or private investment or public-private-partnership (PPP) effort for installing charging stations; mandates or national strategy for establishing countrywide charging networks; or integrating renewable energy for EV charging.
- **Demand-based policies** aim to electrify vehicle fleets, including shared mobility fleets such as buses and taxis, government/public vehicle fleets, and the fleets of dominant transport modes such as 2&3Ws. Policies include mandatory fleet purchases/sales requirements, direct procurement, retrofitting, or replacement. In addition, raising public awareness of ZEV benefits and usage through campaigns and events is also a critical component of demand-based policies.

Some EMDEs have introduced policies that echo one or more of these five major policy levers. In addition, EMDEs are taking actions for **industrial development policies** that promote domestic ZEV manufacturing, assembly, and distribution; research & development (**R&D**) and capacity building related to ZEV uptake and infrastructure; innovative **business models** to develop market-based solutions for affordability and expanding consumer options; and **international support** for financing and technical assistance.

After a systematic review of existing ZEV policies in EMDEs, each EMDE was evaluated using metrics that assess policy stability/reliability, scale/coverage, and significance of implementation. Table 1 demonstrates existing EV policies for selected EMDEs from each region that met the three evaluation criteria and have been active in supporting electrification in the region (see Appendix A for a detailed list of policies for all EMDEs and Appendix D for references). The first five policy categories

are the five major policy levers reviewed above. Policies in the "Others" category are also observed in many EMDEs.

Table 1. Existing EV policies for selected emerging markets and developing economies

Country	Phase-out target	Regulations		Incentives		Infrastructure	Demand		Industrial development		Others		
		CO_2 standard	ZEV regulation	Subsidy/tax	In-use	Strategy/ Support	Special fleet	Shared mobility	Manufacturing	Assembly	R&D and capacity building	Business model	International support
South Africa						●	●	●	●	●	●	●	●
Cape Verde	●			●	●	●	●			●			●
Colombia	●			●	●	●	●	●				●	●
Costa Rica	●			●	●	●	●	●	●	●			●
Ukraine				●	●	●		●	●			●	●
Jordan				●		●		●					●
Kazakhstan				●		●		●	●	●	●		
Nepal				●		●	●	●	●	●	●	●	●
Thailand				●		●		●	●	●	●	●	●
Philippines				●	●	●		●	●	●	●	●	●

The dots in Table 1 indicate that a given EMDE is making at least some effort in a given policy category; however, it does not necessarily mean that the EMDE has made substantial progress in that policy sector. In many cases, these policies were adopted in 2020 and 2021 and will require time to be systematically developed and reflected in ZEV market uptake.

EMDEs active in supporting electrification are working to develop charging infrastructure; promote EVs through incentives; establish EV and battery manufacturing capacity and assembly; target electrification for various fleets such as buses, taxis, 2&3Ws, and government fleets; and leverage international support for ZEV deployment. However, major policy gaps in EMDEs are typically found in the absence of phase-out targets and CO_2 standards and ZEV regulations, the most effective policy mechanisms for ensuring availability of a growing share of ZEVs. As discussed regarding Figure 6, only a few EMDEs (i.e., Cape Verde, Chile, Costa Rica, Colombia, Ecuador, Israel, and Singapore) have set ICEV phase-out targets. Only Brazil and Saudi Arabia have fuel economy standards, and those are not stringent enough to drive ZEV uptake.

Although there are policy gaps and limited policy actions for many EMDEs, the potential for a ZEV transition is real, and many EMDEs are making efforts to increase ZEV uptake. The following section lists such potential action areas and policies that are most prevalent across EMDEs.

ACTION HIGHLIGHTS

This section identifies and evaluates some of the existing potential and ongoing or planned policy actions that could drive ZEV uptake in various EMDEs. Such potentials and opportunities could be explored more extensively by each EMDE according to their individual situations and needs. Most of the policy actions were taken in 2020 and 2021, and it will take time for these recent policies to increase the ZEV uptake in EMDEs. Examples of actions in various policy categories for early adopter EMDEs could be followed by other EMDEs that are eager to develop policy frameworks for transitioning to ZEVs.

a) **Purchase and usage incentives:** Many EMDEs offer consumer-based incentives to improve EV cost-competitiveness and usage benefits. Purchase incentives include waived or reduced duties, taxes, and fees such as customs duties, excise duties, import duties/surcharges, registration taxes, road/circulation taxes, goods and service taxes, carbon taxes, sales taxes, green taxes, and VATs. Example EMDEs across the regions include *Cape Verde, Mauritius, Rwanda, Zambia, Paraguay, Belarus, Moldova, Ukraine, Uzbekistan, Pakistan, Sri Lanka, Bhutan, Maldives, Nepal, Thailand,* and *Malaysia*. Furthermore, *Cape Verde* has a 5-year long (2020–2025) internationally supported project through its Nationally Appropriate Mitigation Action (NAMA) support project (NSP) to assist with the high upfront cost of EVs (NAMA, 2020). The NSP will provide the rebate through an Electric Mobility Facility (EMF) to cover a significant share of the incremental cost of electric cars and buses for first-mover individuals, companies, and institutions. It is expected that the program will encourage consumers to purchase ZEVs and boost the ZEV sales share in Cape Verde. Mauritius has a rebate for low CO_2-emitting vehicles. *Belarus* provides a VAT rebate for consumers who purchase EVs inside the country. *Bhutan* offers an internationally supported subsidy grant and loan facility for taxi drivers covering 90% of the purchase price of electric taxis. *Maldives* provides a reduced interest rate on loans for purchasing battery electric vehicles. *Thailand* has a tax based on CO_2 emissions of PCs and exempted taxes for EVs. *Indonesia* offers a preferred lower interest rate and waived transfer tax.

   EV usage incentives in monetary terms include waived parking fees, as in *Cape Verde*, *Costa Rica*, and *Belarus*; government mandated discounts on vehicle insurance in Colombia; waived toll charges in Ecuador; a waived public roads usage tax in *Belarus*; 50% reduction in motorway tolls in *Pakistan*; lower parking tariffs in *Indonesia*; and a waived motor vehicles user charge in the *Philippines*. Non-monetary EV usage incentives include dedicated parking space in *Colombia*; waived circulation restrictions in the *Philippines*; special lane provision (shared with bicycles) for electric scooters in *Turkey*; and designated EV parking space with constant access to charging facilities and priority parking facilities in *Ukraine*.

b) **Infrastructure:** The EMDE governments are taking various policy actions to support infrastructure development such as establishing national targets and specific plans for installing charging stations; introducing mandates for charging facilities at various establishments, parking lots, and gas stations; partnering with private and international companies; bringing in international funding and technical support; ensuring generation and utilization of renewable energy; and providing incentives to promote investment in establishing charging infrastructure and increase consumers' EV usage benefits.

   A well-developed and region-wide standardized charging infrastructure will facilitate ZEV usage across the border within the region. A few EMDEs have made substantive progress in establishing widespread networks of charging

stations (e.g., *Thailand, Belarus, Kazakhstan*) while many others are in the process of developing charging infrastructure (e.g., *Cape Verde, Morocco, Ghana, South Africa, Rwanda, Jordan, Ukraine, Pakistan, Nepal*). In *Thailand*, a private charging station company has more than 400 charging locations, including normal and fast chargers, and aims to have 1000 charging locations integrated with renewable solar and wind power generation supported by an international loan. A Thai public-private-partnership (PPP) is collaborating with an international company to install more than 1000 new fast chargers and make fast charging facilities available every 50 km along the charging network. The government has given a contract to a private company to install more than 120 fast chargers every 100 km on the main transportation routes across the country. The state-owned energy company has signed contracts with six major international automakers to build a network of charging stations. In *Belarus*, an EV charge point operator has installed about 450 charging stations and has set a goal of installing 639 more by 2022. The government developed a detailed plan for establishing a national network of charging stations at the capital city and along highways in three phases, with a target for 1300 charging stations by 2030, depending on the EV uptake.

Cape Verde has a national target for establishing countrywide charging infrastructure by 2030 and is installing private and commercial charging stations under an internationally funded 5-year long NAMA support project for EV deployment and infrastructure. A PPP project in *Morocco* is building a network of 37 charging stations along an 800 km-long motorway in service areas integrated with solar parking shading structures, to enable renewable energy to power charging stations. A PPP initiative in *Ghana* has set a target of installing 200 chargers at important locations and along major highways. Ghana is also generating solar energy through solar hubs in four major cities for charging EVs. In *Rwanda*, several international auto companies are introducing EVs and installing charging stations at 15 locations in the capital. The government's environment agency is mobilizing EV supplier companies to install more charging stations around the country. *Jordan* has signed an agreement with an international company to install 10,000 charging stations across the country that would allow charging in just 15 minutes. *Ukraine* is collaborating with an international company to manufacture 5,000 e-buses and 7,800 charging stations. *Pakistan* has national targets for installing a minimum number of fast charging stations per 10 sq. km grid (approximately 3x3 km) in all major cities and every 15-30 km on all motorways to ensure an uninterrupted power supply. *Nepal* has received an international loan for import, installation, operation, and maintenance of EV charging stations in 50 locations across the country in collaboration with an international company. Nepal also received an international loan for purchase of a fleet of EVs including e-buses and taxis, construction of a 150-kilowatt solar power plant, and installation of charging stations.

Some EMDEs have introduced mandates governing charging stations in buildings and parking facilities, their incorporation into city/zone planning, and establishment of a minimum frequency of charging stations. These are found in *Kenya* (for all new public buildings); *Rwanda* (for building code and city planning rules); *Turkey* (a zoning regulation for charging stations such as at parking lots and gas stations; parking regulations for mandatory charging facility); and *Costa Rica* (charging stations every 80 km on national roads and every 120 km on county roads).

Some EMDEs are providing incentives to promote investment in establishing charging infrastructure and to improve EV usage benefits. *Rwanda*, *Cape Verde*, *Ecuador*, *Jordan*, *Egypt*, and *Pakistan* have waived or substantially reduced

various types of taxes for importing charging station equipment, related accessories, parts, and/or batteries. *El Salvador* waives income tax on revenues from EV charging services. *Rwanda* offers rent-free land for charging stations on government-owned land. In *Thailand*, the government subsidized public and private sector investment for installing normal and fast chargers across the country under a pilot project. *Indonesia* provides a 75% to 100% discount for upgrading installed power capacity at residences. Lower electricity tariffs than usual consumption rates for EV charging are offered in *Rwanda, Colombia, Argentina, Ecuador, Costa Rica* (temporarily free), and *Pakistan*.

c) **Manufacturing, assembly, and distribution:** Some EMDEs already have major auto manufacturers such as *Thailand*, *Indonesia*, and *Malaysia*, and some have rich reserves of raw materials (e.g., lithium in *Bolivia, Chile, Argentina, Indonesia,* and *Zimbabwe*; manganese and platinum in *South Africa*; nickel and cobalt in *Indonesia*; and copper and cobalt in *Democratic Republic of Congo*). Thus, they have the potential to lead battery and ZEV production and export. Through their domestic production capabilities, EMDEs can reduce ZEV costs compared to imported ZEVs; make varieties of models and options available for consumers; explore and develop technical capabilities for the ZEV supply chain[7]; and develop their economies through global export and employment opportunities. Many EMDEs are developing domestic ZEV production capacity through collaborations with international auto-manufacturers; incentivizing their local auto-manufacturing industry; public or private funding of PPP efforts, and/or taking advantage of international financial and technical support.

   Example EMDEs that have some capacity for EV/battery manufacturing include *Indonesia* (lithium-ion battery), *Brazil* (electric bus chassis and lithium-ion battery), *South Africa* (lithium-ion battery precursor pilot plant), *Belarus* (motorcycles, buses, and the world's biggest electric dump truck), *Pakistan* (solar powered 2&3Ws, PVs, and vans), *Nepal* (2&3Ws and PVs), *Kazakhstan* (buses and minibuses) and *Sri Lanka* (3W taxis). Some EMDEs are building manufacturing plants such as *Morocco* (with a goal of producing 1 million EVs by 2025), *Tunisia* (ZEV components), *Uzbekistan* (EVs), Serbia (electric motors and EV battery components), *Pakistan* (PVs, two-wheelers), and *Bangladesh* (2&3Ws, PVs).

   Some EMDEs offer varieties of incentives to promote an EV manufacturing and assembly industry such as *Thailand, Indonesia, Malaysia, Philippines, Rwanda, Egypt, Pakistan,* and *Nepal*. Examples of these supply-based incentives include waived or reduced corporate income tax and tax holidays for manufacturers over a specified timeframe; investment tax allowances; waived or reduced duties and VAT for imported production-related raw materials, EV/battery components, complete knock-down kits, equipment, and machinery, based on qualification criteria; allowance for greenfield investments involving foreign direct investment (FDI) by international companies for EV manufacturing; reduced-rate financing for EV manufacturers; and government land grants for establishing assembly plants. These incentives may be helpful in the very early stage of market development, but they may need to be gradually replaced by supply-side regulations.

   Some Central and South Asian countries have established EV assembly capacity in partnership with international automobile companies. These are found in *Kazakhstan* (bus); *Sri Lanka* (3Ws); *Pakistan* (EVs); and *Nepal* (3Ws and minibuses). Furthermore, *Sri Lanka* has a United Nations Development

7 ZEV supply chain includes the processes starting from raw material extraction to disposal including manufacturing, sourcing, services, recycling, reusing, and material recovery.

Program (UNDP)-supported project for producing EV components and enhancing local assembling capacity for electric 3Ws; *Bangladesh* is establishing an EV assembly plant.

ZEV import and distribution may still be important and useful for EMDEs that are primarily import-based or do not yet have ZEV manufacturing and/or assembly capacity. Some EMDEs have EV dealership businesses that import and distribute various types of EVs, for example in *Zimbabwe* (used EVs); *Ghana* (EVs); *Sri Lanka* and *Bangladesh* (electric 2&3Ws); and *Nepal* (electric two-wheelers, PVs, minibus, large bus). The dealership companies in these countries are partnering with international manufacturers to import and distribute varieties of EV models; they are also forming strategic domestic and international partnerships to enhance their product offerings.

d) **Shared mobility:** Due to low rates of individual car ownership in many EMDEs, shared mobility such as buses and taxis are popular transport modes. Hence, shared mobility is a transportation segment with great potential for rapid fleet transition to ZEVs. Countries and cities across the regions have introduced or are in the process of launching electric buses, taxis, and car sharing and ride hailing, including in *South Africa* (introduced electric buses, ride hailing taxis, 3W taxis); *Ghana* (solar-powered taxis for ride hailing); *Ukraine* (250 electric buses ordered; hundreds of EVs operating as ride hailing); *Egypt* (various pilot electric bus projects); *Kazakhstan* (100 electric buses purchased; launching electric taxis); *Thailand; Manilla, Philippines* (launched electric buses and minibuses); *Kathmandu, Nepal* (private company operating electric buses; government promotion of more electric buses); and *Pakistan* (introducing electric buses).

   Some EMDEs are aiming for significant electrification of public transportation such as *Ghana, which seeks to* transition to electric buses by 2050; Bogotá, Colombia for purchase of electric buses exclusively starting in 2022; Santiago, Chile for a 100% electric public transportation system by 2040; and *Thailand* and *Malaysia* for acquisition and production of electric buses. Some Latin American countries provide incentives and have adopted mandates and laws for bus electrification such as electric bus promotion incentives in bus tenders in *Santiago, Chile*; subsidies for purchasing electric buses in *Uruguay*; a mandate that 100% of mass transit system purchases be electric by 2035; electrification programs financed with local government and international banks in *Colombia*; and a mandate that at least 5% of the bus fleet be replaced with electric buses biennially in *Costa Rica*.

   Some EMDEs are bringing in electric buses through manufacturing, including buses and trolleybuses now manufactured in *Belarus*; replacement of old diesel buses in *Indonesia*; retrofitting of existing bus fleets in *Iran* and *Ukraine*; and international financing support for purchasing and deployment of electric buses as in *Moldova, Jordan,* and *Nepal*.

e) **Electric 2&3Ws:** 2&3Ws have potential for large-scale electrification because of their low cost and relatively low dependence on extensive charging infrastructure. 2&3Ws are the predominant transport mode in ASEAN countries and these countries are transitioning rapidly toward electrification of the 2&3W segment. In *Vietnam*, electric mopeds and scooters from multiple manufacturers commanded 8% of the market in 2020. In *Indonesia*, 15 2&3Ws manufacturers started to produce electric 2&3Ws as of November 2020. In the *Philippines*, local government programs support adoption of electric 3Ws.

   Electric 2&3Ws also offer great opportunity for low-cost e-mobility in some African and South Asian countries. *Uganda* is manufacturing new electric motorcycles; retrofitting existing ICE motorcycles; and assembling electric

motorcycles and battery packs. *Rwanda* is retrofitting ICE motorcycles to electric. *South Africa* has a startup company that manufactures and operates electric 3-wheeler taxis. *Ghana* is assembling electric 2&3 wheelers. *Kenya* is assembling and manufacturing electric 2&3 wheelers. *Zimbabwe* is assembling electric 3Ws. *Nepal* has many electric 3Ws in use; *Bangladesh* has more than a million electric 3Ws that are used as public transportation.

f) **R&D and capacity building:** R&D and capacity building are important for EMDEs in various respects such as exploring charging methods; conducting field trials and pilot projects to evaluate on-road compatibility and operational viability of ZEV technology; developing technical standards and test procedures for ZEVs, batteries, and charging stations; developing ZEV prototypes; manufacturing ZEVs and batteries; powering EVs with renewable energy, exploring battery recycling and end-of-life usage; and developing ZEV supply chain capabilities.

   South Africa's national uYilo e-mobility program has advanced R&D capabilities including nationally accredited battery and material testing, battery manufacturing, recycling, second-life usage, and Vehicle-to-Grid technology. In *Brazil*, a five-year-long research project was operated and financed by a Chinese energy utility company that involves studying charging behavior, evaluating grid preparedness and installation of charging infrastructure, exploring business models for charging infrastructure, and construction of an electric mobility laboratory. *Thailand* has an EV technology and innovation learning center that provides a platform for developing EV technology, and for learning and awareness-raising by entrepreneurs, government officials, and the public.

g) **Business models:** The e-mobility business is potentially ripe for ZEV uptake through the introduction of electric fleets in ride hailing, car sharing, and delivery services, and expanding purchase options with vehicle leases and battery renting/swapping for electric 2&3Ws. These options provide a strategy to defray the higher upfront cost and leverage the total cost of ownership so that it is closer to parity than the EV purchase price.

   E-mobility startups and businesses are emerging in many African countries, particularly for 2&3Ws. *Zimbabwe* has companies that offer leasing for electric 3W and scooters; electric vans for delivery service; and dealership offering beneficial loan and insurance options for imported used EVs. *Uganda* has companies that are leasing electric motorcycles and renting batteries. *Ghana* has solar-powered 2&3W taxis for leasing. *South Africa* has app-based electric 3W taxis that are cheaper than ICE taxi service. In *Morocco*, private companies are distributing electric 2&3Ws with cheaper insurance policies for EVs than for their ICE counterparts.

h) **International support:** International support is particularly important to help EMDEs overcome economic and technical constraints related to the ZEV transition. International support for the ZEV transition is typically in the form of grants, loans, and technical support from international agencies and philanthropic and financing institutions. Support areas in general include developing policy, regulatory, and fiscal frameworks; building technical capabilities; conducting pilot and demonstration projects and R&D activities; exploring market-based solutions; and providing grants and loans. Details on international support are discussed in a later section.

TOP BARRIERS AND CHALLENGES

In addition to the common barriers to a ZEV transition faced by all countries—including availability, affordability, convenience, and awareness—EMDEs in particular face the following barriers and challenges, which loom larger in some regions than in others.

a) **Lack of regulations** on fuel economy and emissions of greenhouse gases and other pollutants, as well as ZEV sale/purchase mandates, result in limited investment in and production of ZEVs by the industry. For major auto-manufacturing EMDEs such as some ASEAN countries, lack of ZEV regulations fails to convey a strong policy signal to auto manufacturers, which results in product unavailability, despite some significant supply-based incentives.

b) **Higher EV prices compared to low-cost ICEVs** continue to be a barrier to mass uptake of EVs. The lower average cost of ICEVs in most EMDEs would require a combination of regulatory and demand-based polices to bring EVs to cost parity with ICEVs in the long term.

c) **Imports of used ICEVs** enlarges the price gap between ICEVs and ZEVs. Furthermore, importers of used ICEVs are also potential importers of used ZEVs. While imports of slightly used ZEVs can contribute to ZEV uptake in importing countries, imports of overly used ZEVs can bring challenges related to battery degradation, range, performance, and battery recycling (Gaventa, 2021). Such challenges are critical to ZEV uptake in EMDEs since EMDEs generally lack the EV supply chain capability, and developing it will take time. As leading global importers of used vehicles, African countries are particularly affected by these challenges.

d) **Lack of e-mobility-based businesses** in many EMDEs limits options for mass uptake of EVs.

e) **Insufficient charging infrastructure** in many EMDEs means that development of charging infrastructure is often limited to or around the capital city and other major cities, which will delay mass adoption of ZEV technology.

f) **Lack of technical expertise** results in an underdeveloped ZEV supply chain capability, and poor establishment and implementation of technical standards for ZEV and charging infrastructure.

g) **Limited public awareness** of ZEV technology, benefits, and usage results in few examples of ZEV promoting events, campaigns, demonstrations, and learning centers. Raising public awareness is also a challenge in the ZEVTC countries and could be an area of collaboration with EMDEs.

Because EMDEs are at the initial phase of the transition, the stated barriers stand out as priority action areas for EMDEs compared to the developed markets.

POLICY SUGGESTIONS FOR EMDEs

To overcome these barriers and challenges, EMDEs need to develop ZEV regulatory and policy frameworks, along with a commitment to knowledge sharing, capacity building, and financial support. Each country determines its own mix and design of ZEV policies based on its own circumstances, including the opportunities, barriers, and needs that characterize the EV market in each. To help EMDEs leapfrog to electrification, this paper suggests the following policy actions. These suggestions follow from the opportunities, ongoing policy actions, major policy gaps, and barriers in EMDEs; ideas shared by the EMDE representatives at the roundtables (see Appendix E for a summary of the roundtable discussion); and review of best practices exercised in leading ZEV countries. The suggested ideas do not appear in any priority order since each individual EMDE may prioritize the policies according to its own circumstances and needs.

a) **Develop a ZEV roadmap, regulations, and ZEV-focused supply-based incentives to send clear policy signals.** A ZEV roadmap that spells out long-term national targets, interim milestones, and e-mobility strategies; CO_2 emissions or fuel economy standards; mandates for ZEV sales/purchase requirements; and incentives for ZEV production and import will send a strong development signal to the automobile industry for adoption of ZEV technology and investment in ZEV transition. Regulating ICEVs through stringent fuel economy and emission standards could also help bridge the price gap between ICEVs and ZEVs because compliance costs for ICEVs increase as standards get stricter.

b) **Reduce ZEV costs through trade agreements, international financing, and import regulations for used ICEVs.** For import-inclined EMDEs, form trade agreements with exporting countries to lower or waive import duties on new ZEVs or ZEV components. Introduce budget-neutral mechanisms that make high-emitters pay (e.g., feebates), or introduce international financing to reduce ZEV upfront costs through rebates, reduced loan interest, or funding of innovative e-mobility businesses. Regulate import of used ICEVs through regional coordination and stringent emission regulations to reduce the price gap with ZEVs and to restrict import of old high-emitting vehicles.

c) **Integrate infrastructure development with renewable energy and innovative charging solutions.** Develop countrywide charging infrastructure with reliable and low carbon energy supply and introduce innovative charging solutions such as solar carports (ECREEE, 2019), to ensure a full ZEV transition. Unify region-wide infrastructural development and technical standards to facilitate intra-regional travel while considering the infrastructure supply availability versus cost.

d) **Develop technical standards and supply chain capability.** Set technical standards and test procedures for imported and locally manufactured/assembled ZEV and batteries and charging stations. Develop localized ZEV supply chain capability through technical training for ZEV manufacturing/assembly, maintenance, repairing, battery recycling and end-of-life usage, reuse, and material recovery.

e) **Prioritize electrification of specific vehicle segments.** Prioritize the electrification leapfrog of specific fleets such as buses and 2&3Ws, or government fleets through mandates, gradual replacement, and/or retrofitting. Offer direct incentives or financing benefits to production and purchase of the specific segment. Explore low-cost e-mobility options, such as battery swapping and renting solutions for electric 2&3Ws.

f) **Enable innovative e-mobility business and financing models in shared mobility.** Promote and identify appropriate ZEV-based businesses and cooperative finance models with a special focus on electric buses, taxis, and 2&3Ws for ride hailing, delivery services, leasing, battery renting and/or swapping.

g) **Establish ZEV and battery production plants, retrofitting facilities, and R&D centers.** Collaborate with international manufacturers and share knowledge and experiences regionally and internationally to develop ZEV and battery manufacturing/assembly plants, retrofitting facilities, and R&D centers.

h) **Demonstrate ZEV technology and communicate on incentives through exhibitions, experience centers, and pilot projects to raise public awareness.** Collaborate with private sector and international entities on promotion events and demonstrations of ZEVs and charging methods to increase public awareness and familiarity with ZEV technology, operation, and clarity on existing fiscal incentives.

INTERNATIONAL SUPPORT FOR ZEV TRANSITION

Published information shows that EMDEs across several regions are receiving grants, loans, and technical support for the ZEV transition from international agencies and philanthropic institutions (see the detailed list of data sources in Appendix D). International grant agencies active in this space include GEF, the United Nations (UN), the European Union, Internationale Klimaschutzinitiative (IKI), GFEI, the Hewlett Foundation, Tailing Electric Vehicle Co., Ltd (TAILG), and Climate Technology Center and Network (CTCN). International lending banks and other financing agencies include ADB, the National Finance Corporation (CFN), the Central American Bank for Economic Integration, the European Bank for Reconstruction and Development (EBRD), the International Bank for Reconstruction and Development (IBRD), Green Climate Fund under the United Nations Framework Convention on Climate Change (UNFCCC), and the Nordic Environment Finance Corporation (NEFCO).

As Table 2 shows, between 2017 and 2021 these organizations supported 4 to 12 EMDEs with grants of $7.4 million to $16.2 million USD, and 1 to 6 EMDEs with loans of $7.6 million to $68.4 million USD, depending on the region, in their efforts to create a ZEV transition[8]. The funding amount per recipient EMDE varies widely by region. Support areas included shared mobility, charging infrastructure, business models/startups, technical and financial feasibility studies for electric buses, fleet deployment, R&D, and multiple policy interventions and demonstration projects for ZEVs within specific fleet segments and infrastructures. Eurasian countries have received more international financing than other regions. Latin American countries have received the least amount of loan support among the regions that were internationally financed for a ZEV transition.

Table 2. International financial support for a ZEV transition (2017-2021) in EMDEs, by region

Region	Grants (million US$)	No. of fund recipient countries	Loan (million US$)	No. of loan recipient countries	Range of grants per country (US$)	Projected required support (million US$)
Africa	16.2	12	N/A	N/A	$28,500 – $8.4 million	505
Latin America	7.4	6	7.6	1	$40,000 – $2.4 million	1,115
Eurasia	10.6	7	68.4	6	$56,000 – $3.6 million	547
ASEAN	8.0	4	45.1	1	$200,000 – $5.4 million	318
All EMDEs	42.2	29	121.1	8	$28,500 – $8.4 million	2,475

The ongoing international support is far from the level needed to facilitate ZEV leapfrogging in the regions. If the target is to achieve ZEV sales shares of 3% to 4% for each of PCs, bus, and 2&3Ws by 2025,[9] assuming funding at a rate of $30 per kWh[10] (Lutsey and Nicholas, 2019) of battery capacity, the approximate required funding level in the next five years would be $318 million to $1.1 billion per region (see Appendix C for calculation details). These are rough estimates but demonstrate the gap in the level of existing versus required international support. Based on the projected funding amounts, Latin American countries require the greatest support among the four regions due to their higher sales volumes (see Appendix C for detailed data) for each vehicle segment, except for 2&3Ws, for which ASEAN countries have the highest

8 Statistics based on available public information. It is expected that some activities are not captured by this analysis.

9 3% to 4% level of ZEV penetration in the fleet represent an early ZEV development stage that is observed in ZEV leading regions like China, EU, and the US (based on the Marklines database). ZEV sales share of 3% to 4% by 2025 in EMDEs assumes cumulative 2021-2025 ZEV sales that is equal to 10% of 2020 sales.

10 Literature show that the battery pack cost will be $130–$160/kWh by 2020-2022 and further decline to $62/kWh in 2030. The assumed $30/kWh funding level is a rough estimation that mimics the effort to reduce the EV cost through various means before EV reach cost parity with conventional vehicles. https://theicct.org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

volumes. In contrast, ASEAN countries are expected to require the least funding among key regions since 2&3Ws are the predominant travel mode in ASEAN countries and because EV battery size is the smallest for 2&3Ws than for other vehicle segments. Funding could be used for various ZEV policy areas including, but not exclusive to, developing energy and charging infrastructure; providing ZEV incentives and loan services; investing in e-mobility startups and businesses; purchasing and deploying ZEV for various fleets; formulating and implementing ZEV regulatory frameworks, ZEV standards and test procedures; building technical capacity; conducting R&D, and implementing public awareness campaigns and events.

CONCLUSIONS

In this paper, we assessed ZEV uptake and the ZEV policy status for emerging markets and developing economies. Most of the countries analyzed are at the initial stage of developing ZEV markets but some have instituted notable policy advances.

Several emerging markets are leading EV deployment in certain segments.
A few EMDEs have reached substantial EV market shares, particularly in the urban bus and two-wheeler segments. In 2020, ZEV sales shares among EMDEs reached as high as 15% for buses in Chile; 8.5% for two-wheelers in Vietnam; and 1.5% (including plug-in hybrids) for passenger cars in Ukraine. Some EMDEs from each region show early signs of EV uptake, while most other EMDEs had no EV sales as of 2020. Moreover, electrification of trucks is a major gap in ZEV uptake and policies in EMDEs. Further attention is needed to identify ways to close this gap.

Absence of phase-out targets and regulations are major ZEV policy gaps in emerging markets.
Phase-out targets and CO_2 standards and ZEV regulations are major gaps in the ZEV policy frameworks of EMDEs. Some EMDEs have set national ZEV targets and fewer have phase-out targets for internal combustion engine vehicles for specific vehicle segments. Few EMDEs have strong regulatory drivers in terms of stringent emission standards and ZEV regulations. These rules are critical to ensure supply of ZEV models for purchase, which would maximize the impact of demand-base policies.

Some emerging markets are taking major policy levers for ZEV uptake.
Some EMDEs have introduced policies that echo some of the five major policy levers identified in the global ZEV leading markets to accelerate the ZEV transition. EMDEs have also taken actions to further develop their domestic ZEV industry, develop market-based solutions, and leverage international support. It will take time for these recent changes to influence ZEV market uptake.

Infrastructure support remains at an early development phase in most EMDEs. A few—such as Thailand, Belarus, and Kazakhstan—have installed several hundred charging stations and have more under development. EV incentives exist in many EMDEs; however, only a few provide very strong incentive programs (e.g., Cape Verde, Belarus, Thailand) whereas ZEVs are still far from cost-competitive in most EMDEs. Some EMDEs are developing local ZEV manufacturing and assembly capacity through incentivizing the domestic production industry and collaborations with international manufacturers; prioritizing electrification for shared mobility such as buses and taxis for scaled ZEV uptake; introducing electric fleets and expanding purchase options through e-mobility businesses; and using international support for various interventions.

Policies for early ZEV uptake in emerging markets are driven by electrification of dominant transport modes.
Faster ZEV transitions are happening for buses in Latin America and for two- and three-wheelers in the ASEAN countries, which are the predominant modes of passenger transport. EMDEs with important auto manufacturing sectors (Thailand, Indonesia, Malaysia) or significant raw material resources (Indonesia) are offering supply-based incentives to promote local ZEV manufacturing and assembly industries. Many EMDEs are collaborating with international EV manufacturers to establish manufacturing and assembly capacity for EVs, batteries, and other EV components.

For many African countries, e-mobility based startups and dealership businesses are emerging, particularly for 2&3Ws, and some consumer-based purchase incentives have been introduced to improve cost competitiveness of electric passenger cars, which

are typically imported. These policies are expanding EV availability, affordability, and purchasing options for consumers. ZEV policy actions in the Eurasian region favor various combinations of manufacturing and importing, with a focus on buses and 2&3Ws segments, depending on the travel behavior in the sub-regions. Therefore, for accelerating ZEV uptake in EMDEs, the future policy effort and international support should closely align with the local motivations for a ZEV transition in EMDEs, including local travel preferences.

The ZEV transition in emerging markets is challenging and requires strategic policy interventions to overcome challenges.

Specific challenges for EMDEs, in addition to the universal barriers of availability, affordability, convenience, and consumer awareness, consist of nonexistent ZEV regulatory frameworks, inadequate fiscal and financing mechanisms, imports of low-cost used ICEVs, and insufficient technical capacity.

To encourage adoption and investment in ZEV technology, EMDEs need to develop ZEV transition roadmaps, regulatory frameworks, and localized capacity for supply chains. Before ZEVs reach cost parity, EMDEs can reduce ZEV costs without imposing an extensive financial burden on government through budget-neutral mechanisms or international financing to fund targeted fiscal policies and innovative business models. Import-based EMDEs could form trade agreements with exporting countries to lower or waive import duties for ZEVs or ZEV components and tighten standards for imported used ICEVs while allowing imports of slightly used EVs that meet performance and safety standards. EMDEs could prioritize ZEV transitions of highly utilized fleets, such as shared mobility fleets or government-operated vehicles.

Emerging markets need significantly greater international financial support for the ZEV transition.

While EMDEs in all regions are receiving international grants, loans, and technical support for the ZEV transition, there is a significant gap in financial support. Over the past five years, 37 of the 117 EMDEs we analyzed received in total approximately $163 million USD in international support for ZEVs. This amount is only 6.5% of the level of funding ($2.5 billions USD) we estimate is needed over the next five years to adequately support the early phase of the ZEV transition in EMDEs.

RECOMMENDATIONS FOR ZEVTC TO SUPPORT ZEV UPTAKE IN EMDEs

ZEVTC governments, along with other relevant international entities, can serve an important role in supporting the global ZEV transition by helping to drive down ZEV technology costs, providing financial and technical assistance, and deepening regional dialogues for knowledge exchange. Our analysis of ZEV deployment and policies in EMDEs leads to several specific recommendations for how the ZEVTC can contribute to a global transition. These recommendations also include the ideas and suggestions shared in the series of working-level roundtables with EMDE representatives (see Appendix E for a summary of the roundtable discussion). These recommendations are summarized as follows:

- **Set clear targets to fully transition to ZEV sales in the 2030 to 2040 timeframe to bring down technology cost and increase global availability and affordability.**
  - ZEVTC member countries' commitment to full-scale electrification before 2040 will help other countries in setting and achieving their own targets. Large-scale ZEV penetration in leading countries will significantly lower the costs of ZEV technology and increase ZEV model availability and manufacturing capacity. As a result, access to ZEVs and related technologies will become easier for the rest of the world.
- **Support the creation of ZEV-dedicated financing facilities via existing and new programs and initiatives to provide effective financial assistance to EMDEs and act to shift investments in ZEVs abroad.**
  - There is a need to work closely with multilateral international organizations to ensure that relevant funds are spent in a cost-effective way and that the efforts are not duplicated. The funding could be used to: (a) create a ZEV-specific facility dedicated to providing financial and technical support to global ZEV deployment; (b) finance electrification of targeted fleets, such as public transportation and 2&3Ws in EMDEs; (c) identify and support innovative and effective business and finance models to support the e-mobility transition of both light- and heavy-duty vehicles; (d) support development of bankable e-mobility projects to promote investment into ZEV projects.
  - Consider options to ensure that the export of used vehicles to EMDEs supports an accelerated global ZEV transition and is in line with Paris Agreement goals. This could also include offering incentives, in the form of rebates or subsidies, to EMDEs exclusively, for purchasing ZEVs and/or ZEV components for local assembly.
- **Establish a working group on the global ZEV transition as an enduring forum to engage with non-ZEVTC countries, especially EMDEs, and form regional collaborations to reduce disparities in the ZEV transition.**
  - The working group could engage with EMDEs to address key challenges for the ZEV transition and contribute to key priority regional efforts: (a) formulation and implementation of the appropriate measures to accelerate the ZEV transition for EMDEs; (b) establishment of technical standards for safety and quality assurance of new and used ZEVs, batteries, and infrastructure; (c) formation of regional collaborations among EMDEs to regulate imports of used ICEVs and ensure uniformity of region-wide development in charging infrastructure and technical standards; (d) building capability to localize the ZEV supply chain within respective regions and countries; (e) sharing technological know-how and building capacity needed for the ZEV transition; and (f) organizing events and ZEV demonstrations to raise public awareness of ZEV technologies.

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APPENDIX A: EV POLICIES FOR EMERGING MARKETS AND DEVELOPING ECONOMIES

Region	Country	Phase-out targets	Regulations		Incentives		Infrastructure	Demand		Industrial development		Others		
			CO_2 standards	ZEV regulation	Subsidy/tax	In-use	Strategy/Support	Special fleet	Shared mobility	Manufacturing	Assembly	R&D and capacity building	Business model	International support
Africa	Nigeria						●				●	●	●	●
	Ethiopia										●	●		●
	DR Congo						●	●	●					
	Tanzania											●		
	South Africa						●	●	●	●	●	●	●	●
	Kenya				●		●					●		●
	Uganda						●		●	●	●		●	●
	Algeria											●		
	Sudan								●		●			
	Morocco				●		●	●	●	●	●	●		
	Angola						●		●				●	
	Ghana						●		●		●		●	●
	Madagascar													●
	Cameroon						●		●					
	Cote d'Ivoire						●		●					●
	Zambia				●						●			
	Senegal													●
	Zimbabwe						●	●	●		●		●	●
	Rwanda				●	●	●	●	●	●	●		●	●
	Burundi													●
	Tunisia						●	●	●	●	●			●
	Togo						●				●			●
	Sierra Leone						●						●	●
	Namibia						●		●		●		●	●
	Gambia						●		●			●		
	Botswana						●	●			●	●	●	
	Mauritius				●		●		●					●
	Djibouti							●						
	Cape Verde	●			●	●	●	●			●			●
	Seychelles				●		●		●					●

(continued)

EV POLICIES FOR EMERGING MARKETS AND DEVELOPING ECONOMIES

Region	Country	Phase-out targets	Regulations		Incentives		Infrastructure	Demand		Industrial development		Others		
			CO_2 standards	ZEV regulation	Subsidy/tax	In-use	Strategy/Support	Special fleet	Shared mobility	Manufacturing	Assembly	R&D and capacity building	Business model	International support
Latin America	Brazil		●		●	●	●	●	●	●	●	●	●	●
	Colombia	●			●	●	●	●	●				●	●
	Argentina				●	●	●		●				●	
	Peru				●		●		●	●				●
	Chile	●			●	●	●	●	●					
	Ecuador	●			●	●	●	●	●					●
	Bolivia									●				
	Paraguay				●		●		●					
	Uruguay				●		●	●	●					●
	Guyana				●		●							
	Falkland Islands						●						●	
	Belize								●					
	Costa Rica	●			●	●	●	●	●	●	●			●
	El Salvador				●		●							
	Guatemala				●				●					●
	Honduras				●		●							
	Nicaragua						●							
	Cuba								●					●
	Panama							●	●					
Eastern Europe	Belarus				●	●	●			●	●			●
	Moldova				●		●		●				●	●
	Ukraine				●	●	●		●	●			●	●
South Asia	Bangladesh						●		●	●	●			●
	Pakistan				●	●	●		●	●	●			
	Sri Lanka				●		●		●	●	●	●		●
	Bhutan				●		●	●			●			●
	Maldives				●		●		●		●			●
	Nepal				●		●	●	●	●	●	●	●	●
	Afghanistan										●			

(continued)

EV POLICIES FOR EMERGING MARKETS AND DEVELOPING ECONOMIES

Region	Country	Phase-out targets	Regulations		Incentives		Infrastructure	Demand		Industrial development		Others		
			CO_2 standards	ZEV regulation	Subsidy/tax	In-use	Strategy/ Support	Special fleet	Shared mobility	Manufacturing	Assembly	R&D and capacity building	Business model	International support
Central Asia	Serbia				●		●	●	●	●				
	Kazakhstan				●		●		●	●	●	●		
	Kyrgyz Republic				●		●			●				
	Uzbekistan				●		●		●	●				●
Middle East	Bahrain							●						
	Egypt				●		●		●	●	●			●
	Iran				●		●			●				
	Israel	●			●		●		●					
	Jordan				●		●		●					●
	Lebanon				●					●				
	Oman						●							
	Qatar						●			●				
	Saudi Arabia		●				●							
	Turkey					●	●			●				
	UAE				●	●	●	●	●					
ASEAN	Brunei Darussalam						●			●				
	Cambodia						●		●	●	●			●
	Indonesia				●		●	●	●	●		●		●
	Lao PDR				●		●		●			●		●
	Malaysia				●		●		●	●	●			
	Myanmar						●			●				
	Philippines				●	●	●		●	●	●	●		●
	Singapore	●			●		●		●					
	Thailand				●		●		●	●	●	●	●	●
	Vietnam				●		●	●	●	●	●			●

Note: For other EMDEs in Africa, Latin America, Middle East, and Central Asia, no ZEV-related policy actions were found, as of 2020.

APPENDIX B: EV TARGETS FOR EMERGING MARKETS AND DEVELOPING ECONOMIES

Africa

- *Cape Verde*: 100% EV targets of new sales for passenger cars by 2035 and urban buses by 2040. Interim electrification milestones for various fleet segments (e.g., passenger car, urban bus, government vehicles) and countrywide charging infrastructure.
- *Morocco*: EV production target of 1 million by 2025

Latin America

- *Colombia*: 10% of urban bus sales to be zero-emission by 2025 and 100% by 2035.
- *Costa Rica*: 100% of new light vehicles sales and 100% of the buses and taxis to be ZEVs by 2050.
- *Chile*: 100% new sales for light-duty vehicles, urban buses, and taxis be EVs by 2035; 100% new sales for freight transportation and intercity buses by 2045.
- *Ecuador*: All vehicles incorporated into public transport systems must be electric from 2025.
- *Panama*: 25%–40% of private vehicle sales, 10%–20% of private vehicle fleet, 15%–35% of buses; 25%–50% of public fleets to be EVs by 2030.

Eurasia

- *Qatar*: 10% of total car population be electric cars by 2030.
- *Israel*: 100% of new private vehicle sales be EVs by 2030.
- *Kazakhstan*: produce 2000 EVs by 2022.
- *Pakistan*: 90% of new sales be EVs by 2040 for each of passenger vehicles, 2&3Ws, buses, and trucks.
- *Nepal*: 90% of sales for private passenger vehicles (including 2W) and 60% sales of (four-wheeler) public transportation be EVs by 2030.
- The capital cities of some countries set targets for electric buses and taxis within a timeframe, such as Belgrade in Serbia, Doha in Qatar, and Thimphu in Bhutan.

ASEAN

- *Brunei*: 10% of fleet stock and 60% of new vehicle sales are EVs by 2035.
- *Indonesia*: Stock targets for 2 million electric passenger vehicles and 13 millions electric motorcycles by 2030; 600,000 electric passenger vehicles and 2.45 millions electric motorcycles production by 2030.
- *Thailand*: 250,000 EVs, 3,000 electric buses, and 53,000 electric motorcycles production by 2025; 30% of all produced vehicles including 2&3 wheelers, light-duty vehicles, and urban buses, be EVs by 2030.
- *Singapore*: 100% of new car and taxi sales are cleaner energy models (to be defined; however, these presumably are EVs) by 2030; ICEV phase-out target for all vehicles by 2040.

APPENDIX C: ESTIMATING INTERNATIONAL SUPPORT REQUIRED FOR EARLY ZEV UPTAKE IN EMERGING MARKETS AND DEVELOPING ECONOMIES

The required international funding for EMDEs is estimated by region assuming a ZEV sales share of 3% to 4% for each of passenger cars (PCs), buses, and two-wheelers (2Ws) by 2025. The 3% to 4% level of ZEV penetration in the fleet represents early-stage ZEV development as observed in leading ZEV regions like China, the EU, and the US (based on the Marklines database). The ZEV sales share of 3% to 4% by 2025 is cumulative ZEV sales over 2021–2025 timeframe and is equivalent to 10% of 2020 sales. The required amount of international financial support for a given region type is estimated as follows:

$$F_R = \frac{\sum_i (S_{2020,i} \times 0.1 \times B_i \times f)}{10^6}$$

Where,

F_R = required amount of international funding (million USD) for an EMDE region R; R = Africa, Latin America, Eurasia, and ASEAN

$S_{2020,i}$ = predicted sales of new vehicles in 2020 for vehicle type i; i = PC, bus, 2W

B_i = average size of battery (kWh) for a vehicle type i

f = funding needed per unit battery capacity ($ per kWh) for a vehicle type i

The 2020 sales data for each vehicle type is based on the ICCT Roadmap model predictions, as listed in the following Table C.1. According to Mock and Díaz (2021), battery pack sizes for battery electric PCs in 2021 vary between 52 kWh and 85 kWh for electric ranges between 350 km and 550 km.[11] Based on this study, we assumed an average battery size of 50 kWh for PCs.

For electric buses, Dallmann et al., (2017) reported an average energy consumption of 1.00 kWh/km based on a 3-year evaluation of 10 buses operating in China.[12] Assuming 200 km range for small electric buses and 300 km range for large electric buses, we used average battery sizes of 200 kWh for small buses and 300 kWh for large buses and assumed a 50%-50% split for the two sizes in the bus fleet. Based on ongoing ICCT work on electric 2Ws in Vietnam,[13] we used an average battery size of 1.2 kWh for the 2W.

The required level of support needed per battery capacity is assumed to be $30 per kWh. This amount is a rough estimate that accounts for the effort to reduce ZEV costs through various means before ZEV reaches cost parity with conventional ICEVs. Literature shows that the battery pack cost will be $130–$160/kWh by 2020–2022 and further decline to $62/kWh in 2030.[14]

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APPENDIX D: LIST OF REFERENCES FOR POLICY INFORMATION BY COUNTRY

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REGULATIONS—CO_2 STANDARD

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APPENDIX E: SUMMARY OF REGIONAL ROUNDTABLE DISCUSSION

OVERVIEW

In November 2021, Ministers of the Zero Emission Vehicles Transition Council (ZEVTC)—representing the largest automotive markets in the world—met to discuss the global transition for the first time. The key goal was to agree on concrete actions that ensure no country or community is left behind in the transition to Zero Emission Vehicles (ZEVs). To ensure that Ministers' discussions reflected the views and experiences of non-ZEVTC countries, particularly Emerging Markets and Developing Economies (EMDEs), four regional roundtable meetings were organized in September 2021—for Africa, the Americas, Europe and Central Asia as well as Southeast Asia and the Pacific. With nearly 40 countries participating, these meetings helped to identify key barriers and opportunities countries face in the transition to ZEVs. This writeup summarizes the key outputs and recommendations from the four meetings.

CROSS-CUTTING RECOMMENDATIONS FROM THE FOUR ROUNDTABLE DISCUSSIONS

The following summarizes the recommendations and suggestions—such as international support and collaboration—that were consistently raised across all four regions:

International financial support is needed, such as grants, loans, and credit lines dedicated to the ZEV transition.

- Channel a greater share of climate finance toward the transition to electric mobility (e-mobility); ensure funds flow into the e-mobility ecosystem and its proper utilization.
- Identify appropriate financial sources and ensure their appropriate and efficient utilization to fund the transition to e-mobility in a cost-effective way.
- Identify and support innovative and effective business and finance models to support the e-mobility transition of both light- and heavy-duty vehicles.
- Provide innovative green financing instruments, funds at low interest rates to facilitate a cost-effective transition.
- Support the development of bankable e-mobility projects

Regional and international collaborations are needed to form coordinated regional efforts for leapfrogging to electrification, especially in the following respects:

- Knowledge sharing, technical assistance, and investment for regulatory and policy frameworks, including the development of ZEV roadmaps and CO_2 standards; identifying appropriate business and finance models; sharing technology for local manufacturing, assembly, and retrofitting; building awareness and capacity; demonstrating the technical, economical, and operational viability of ZEVs; providing means of financing for ZEV projects; and establishing technical standards for ZEV and charging stations
- International collaboration and financing for establishing ZEV and battery manufacturing and assembly plants, retrofitting facilities, and R&D centers.
- Technical training to localize ZEV supply chain capabilities within respective regions and develop sustainable ZEV pathways including manufacturing/assembly, maintenance, repairing, battery recycling and end-of-life usage, and material recovery and the integration of renewable energy.
- Regionally coordinated efforts for ensuring uniformity of infrastructure

development, technical standards, and regulations across countries. For example, region-wide standardized charging networks to facilitate cross-border travel and regulate the import of used ICE vehicles to reduce the price gap with ZEVs.

- Leverage of the ZEVTC's work with other international organizations' ongoing ZEV related projects to identify gaps and overlaps as well as take actions on specialized topics in line with identified gaps/overlaps.
- Extension of ZEV transition outreach to all countries, especially those that do not have the ZEV transition on their policy agendas yet.