BRIEFING

JANUARY 2023

Charging infrastructure deployment in emerging markets and developing economies

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INTRODUCTION

Facing the threat of climate change and increasing levels of air pollution, governments worldwide are exploring a transition to zero-emission vehicles (ZEVs) to decarbonize their transport sectors. These efforts align with the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (AR6), which highlighted electromobility as a key solution for decarbonizing the transport sector. This is particularly relevant in emerging markets and developing economies (EMDEs)[1], where transport-related greenhouse gas (GHG) emissions are rising quickly and are expected to continue to do so in the coming decades.[2] Figure 1 below maps the key EMDE regions analyzed in this paper and the percentage of the global vehicle market they represented as of 2021.

1 In this paper, emerging markets and developing economies typically refer to countries that have low or medium levels of income per capita, and that are eligible for Official Development Assistance.

2 Intergovernmental Panel on Climate Change, *Climate Change 2011: Mitigation of Climate Change- Sixth Assessment Report*, (2022), retrieved from https://www.ipcc.ch/report/ar6/wg3/.

Acknowledgments: The authors are grateful to Chang Shen, Dall Hall, and Marie Rajon Bernard for their reviews of earlier versions of the paper.

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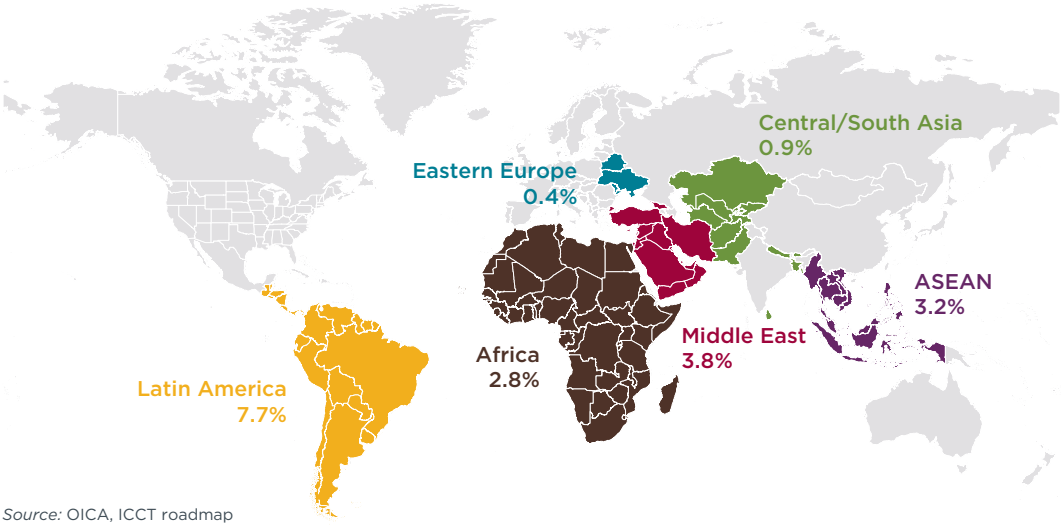

Source: OICA, ICCT roadmap

Figure 1. EMDE regions and share of the global vehicle market

Interest in the ZEV transition also aligns with research conducted by the International Council on Clean Transportation on behalf of the Zero-Emission Vehicle Transition Council or ZEVTC[3], which found that an accelerated ZEV transition could reduce global transport-related emissions by 73% by 2050 compared to 2020 levels.[4] This would put the world on a trajectory compatible with the Paris Agreement and the 2030 Agenda for Sustainable Development Goals (SDGs), whose Goal 11 calls for sustainable and equitable transport systems. In the context of EMDEs, the ICCT further found that a successful ZEV transition could reduce transport-related emissions by 51% in 2050, compared to 2020 levels.[5]

However, a successful transition to ZEVs will require development of a robust charging infrastructure that makes ZEVs at least as convenient to drive as their conventional vehicle counterparts. A review of the literature, while focused on passenger vehicles, finds a consistent link between the availability of charging infrastructure and ZEV uptake.[6] Figure 1 below shows how charging infrastructure deployment and electric vehicle (EV) sales are intertwined. On one hand, the growth in EV sales creates the demand for charging infrastructure. On the other hand, availability of charging infrastructure supports consumer confidence in purchasing EVs by reducing drivers' concerns about range.

3 On November 27, 2020, the Zero Emission Vehicle Transition Council, representing some of the largest vehicle markets in the world, was established by ministers and representatives. The Council gathered at COP26 under the presidency of Alok Sharma to consider ways to accelerate the global transition to zero-emission vehicles. Member jurisdictions are as follows: California, Canada, Denmark, European Commission, France, Germany, India, Italy, Japan, Mexico, Netherlands, Norway, Spain, South Korea, Sweden, United Kingdom (2022 chair), United States (2022 co-chair).

4 Yihao Xie, Tim Dallmann, Diane Muncrief, *Heavy-duty zero-emission vehicles pace and opportunities for a rapid global transition*, (ICCT: Washington, DC, 2022) https://theicct.org/wp-content/uploads/2022/05/globalhvsZEV-hdzev-pace-transition-may22.pdf.

5 Tanzila Khan, Zifei Yang, Sumati Kohli, Josh Miller, *A critical review of ZEV deployment in emerging markets*, (ICCT: Washington, DC, 2021), retrieved from https://theicct.org/publication/zev-market-review-global-feb22/.

6 William Sierzchula, Sjoerd Bakker, Kees Maat, Bert Wee, "The influence of financial incentives and other socio-economic factors on electric vehicle adoption," *Science Direct*, 2014, retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0301421514000822?via%3Dihub; Patrick Plötz, Till Gnann, Frances Sprei, "Can policy measures foster plug-in electric vehicle market diffusion?", *World Electric Vehicle Journal*, 2016, retrieved from https://www.mdpi.com/2032-6653/8/4/789#cite; Dale Hall and Nic Lutsey, *Emerging best practices for Electric Vehicle Charging Infrastructure,* (ICCT: Washington, DC, 2017), retrieved from https://theicct.org/sites/default/files/publications/EV-charging-best-practices_ICCT-white-paper_04102017_vF.pdf.

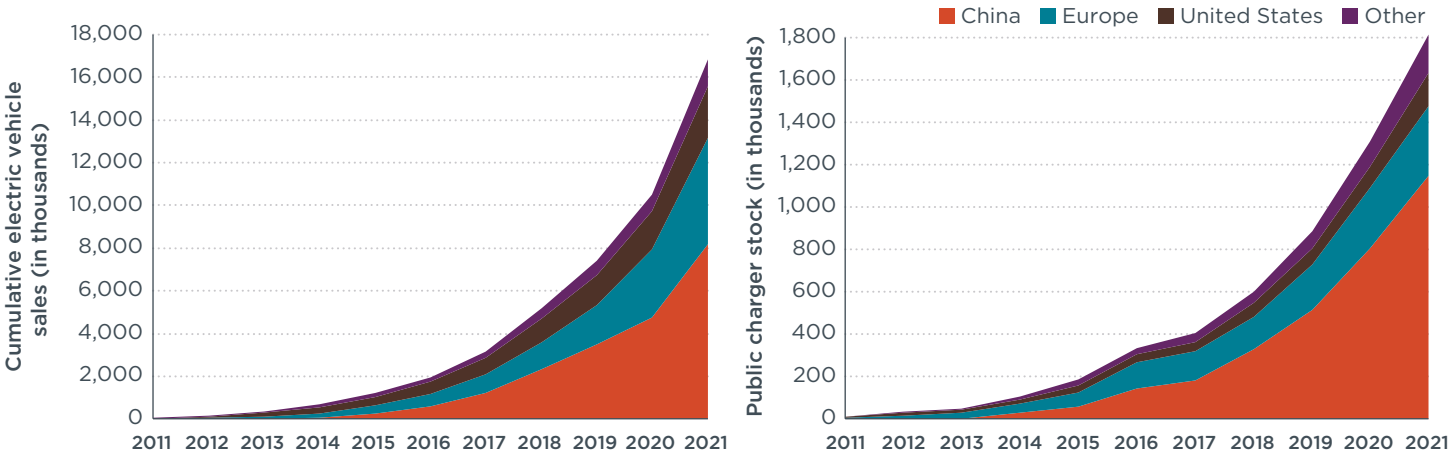

Figure 2. Global sales of electric vehicles (left) and global public electric vehicle charging points (right).

Yet most regions of the world have limited charging infrastructure in place, which constrains the pace of ZEV uptake. In the near term, EMDE governments could jumpstart charging infrastructure deployment through the use of public funding. However, in the medium to long term, reaching the scale of charging infrastructure deployment needed to achieve net zero-emissions by 2050 will require significant private sector investments.

The primary objective of this briefing paper is to summarize the discussions that took place during the ZEVTC charging infrastructure regional dialogue webinars in June 2022. It does so by first assessing the status of charging infrastructure deployment in EMDEs. Second, it identifies key challenges commonly found in deploying charging infrastructure. Third, the paper summarizes policies and practices to accelerate charging infrastructure deployment, as highlighted by the literature review. Finally, it formulates recommendations to ZEVTC members for accelerating infrastructure deployment in EMDEs, informed by insights from the ZEVTC regional dialogues, which drew on the expertise of international organizations and initiatives such as the Global Electromobility Programme, the Transport Decarbonization Investment (TDI) Series, and the World Business Council for Sustainable Development (WBCSD) Regional Business Dialogues. Recommendations were also informed by a literature review of infrastructure development conducted by the International Council on Clean Transportation (ICCT).

STATUS QUO OF CHARGING INFRASTRUCTURE DEPLOYMENT IN EMERGING MARKETS

Limited or hard-to-access publicly available data prevent a complete understanding of how ZEV uptake compares to charging infrastructure deployment in EMDEs. In June 2022, the ZEVTC secretariat sent a consultation survey to EMDE governments, asking them to describe the state of infrastructure deployment in their respective jurisdictions. Thirteen responses were received, providing insights from Africa (Côte d'Ivoire, Kenya, Nigeria, Uganda, and Zimbabwe), Asia (India, Indonesia, Nepal, Turkmenistan, and South Korea), Europe (Bosnia and Herzegovina), and Latin America (Costa Rica and Uruguay). Overall, the survey results indicated that charging infrastructure deployment remains at an initial stage in most EMDEs. Although several pilot projects have been launched (for example, DC fast chargers in Zimbabwe and charging stations for electric buses in Côte d'Ivoire), in most cases, governments have yet to establish the policy and regulatory environment needed to accelerate infrastructure deployment (see Annex B for the list of questions included in the survey).

ICCT conducted additional research to supplement the consultation survey's initial findings. According to the EV-Volumes.com database, as of May 2022, a total of 14,087 charging stations were installed across the 22 EMDEs for which data was available.[7] This included 9,800 normal chargers (69.6%), 4,259 fast chargers (30.2%) and 29 ultra-fast chargers (0.2%). It is also worth noting that online databases that enable assessments of how ZEV uptake compares to infrastructure deployment only exist in a few cases. In Thailand, for example, a database maintained by the EV association indicates that as of 2021, the country counted about 2,300 chargers and 35,000 electric vehicles, a ratio of 15 EVs per charger.[8] In Santiago, Chile, as of April 2022, the database supported by the Ministry of Energy listed 377 public chargers available to accommodate 819 buses, a ratio of 2 EVs per charger.[9]

Furthermore, several online media articles reported ongoing or future infrastructure project developments. In Vietnam, for example, leading EV manufacturer VinFast set up 2000 public charging stations across the country in 2021, including more than 40,000 charging ports for electric two-wheelers and cars.[10] The company is also installing more than 150,000 ports across the country, which will accommodate electric two-wheelers and electric cars.[11] In Ghana, the national utility company partnered with POBAD International (a technology firm that promotes green technologies) to facilitate the installation of 200 chargers for light-duty vehicles in key locations.[12]

As charging infrastructure develops, different charging strategies emerge across the various vehicle segments (two-and-three wheelers, passenger cars, and heavy-duty vehicles).

Electric two-wheelers (E2Ws) typically come with small batteries (2-3 kWh). For this reason, they can be charged conveniently at home, and at lower cost compared to a public charging station, by simply plugging the battery of the vehicle into a wall socket. Several EMDEs are also considering battery swapping—the periodic replacement of depleted batteries with fresh ones—which can be done cost-effectively and quickly for electric two-wheelers because of their smaller-sized batteries. Although electric three-wheelers tend to have larger batteries than two-wheelers, battery swapping remains a viable charging solution for them as well, in most cases.[13]

Passenger electric cars have been introduced in several EMDE cities and are primarily dependent on convenient, overnight home charging via a slow or intermediate-speed charger. In the longer term, as public charging stations and workplace chargers multiply, they could provide intermediate- and fast-speed charging services to accommodate EV drivers during their work commutes or intercity travels. This is

7 EV-Volume.com database (2022).

8 "Current Status," Electric Vehicle Association of Thailand, 2022, retrieved from http://www.evat.or.th/15708256/current-status.

9 Superintendencia de Electricidad y Combustibles, "Puntos de Carga Públicos," retrieved from https://app.powerbi.com/view?r=eyJrIjoiZGY4NmY3ZmIt OGFiNS00ZGM4LTgzN2Mt YzlhZWQ1NmFjYWJkIiwid CI6ImE0ZjdlMmM5LTBmMzYtNDZjOC05YWVjLWY1MDcxMmVmNmZhZSIsImMiOjR9.

10 Tran Thuy, "Investment in charging stations needed for electric car industry," September 9, 2021, VietNamNet.global, retrieved from https://vietnamnet.vn/en/investment-in-charging-stations-needed-for-electric-car-industry-777407.html.

11 Vietnam Insider, "VinFast plans to build 3,000 charging stations for electric vehicles in HCMC," April 12, 2022, retrieved from https://vietnaminsider.vn/vinfast-plans-to-build-3000-charging-stations-for-electric-vehicles-in-hcmc/.

12 Khan, et al., *A critical review of ZEV deployment*.

13 Muneeza Mehmood Alam and Yoomin Lee, *Cleaner Vehicles and Charging Infrastructure: Greening Passenger Fleets for Sustainable Mobility* (World Bank: Washington, DC, 2021), retrieved from https://openknowledge.worldbank.org/handle/10986/36516; "EV battery swapping for two- and three-wheeler markets by service type (pay-per-use model, subscription model), battery type (lead acid, li-ion), vehicle type (two-wheeler, three-wheeler) - global industry analysis and growth forecast to 2030," Prescient & Strategic Intelligence, September 2020; Chandana Sasidharan, "Charging two and three-wheelers is the big game," *Alliance for an Energy Efficient Economy (AEEE)*, January 5, 2021, retrieved from https://aeee.in/charging-two-and-three-wheelers-is-the-big-game/.

particularly true for taxi fleets, which travel long distances each day. It is important to note that public stations, whether they offer intermediate or fast charging services, will typically involve higher electricity charging costs compared to home charging, due to higher capital and operational costs.[14]

In the context of EMDEs, electrification of heavy-duty vehicles typically focuses on buses.[15] Due to their predictable itineraries, these vehicles have ample opportunities for overnight charging at depots, where the electricity cost is lowest compared to en-route chargers.[16] Other long-haul heavy-duty vehicles with less predictable itineraries or with less opportunity to stop for charging will likely rely more heavily on en-route public chargers, where the cost of electricity will be higher.

KEY CHALLENGES TO CHARGING INFRASTRUCTURE DEPLOYMENT

Drawing on a literature review, insights from previous regional dialogues, and the consultation survey mentioned above, the major challenges to the deployment of charging infrastructure in the EMDE context can be summarized as follows:[17]

- **Lack of a detailed strategy or roadmap.** Most EMDEs have yet to develop a detailed strategy that provides all stakeholders with a common vision and sends strong signals to the private sector regarding investments.
- **Difficulties in attracting and mobilizing private sector investments**. Because governments often have limited public financial resources, the high upfront cost of charging infrastructure represents a significant barrier to its deployment. In the context of EMDEs, unclear policy frameworks and small market sizes (as individual countries) make attracting private sector investments difficult.
- **Difficulties in designing circumstance-specific business models**. As mentioned during the regional dialogue webinars, several governments struggle to identify and implement appropriate business models tailored to their specific circumstances.
- **Lack of infrastructure standards**. As EMDE governments embark on the ZEV transition, efforts to coordinate standards that harmonize chargers in terms of hardware (e.g., plugs, sockets, connectors) and software are still largely absent. These standards are needed to ensure interoperability, scaled-up investment, and safe and user-friendly charging events, and to facilitate cross-border travel.
- **Lack of timely investments resulting in limited grid capacity.** Many EMDEs struggle with building a reliable power supply and hence are hesitant to embrace the ZEV transition. Nonetheless, as EMDEs progress in the transition, there is a need to ensure that the grid is robust enough to accommodate the additional electricity load coming from ZEVs. This requires securing timely investments that future-proof the grid by taking into consideration future demand from ZEVs.

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14 Julian Conzade, Hauke Engel, Adam Kendal, and Gillian Pais, "Power to move: Accelerating the electric transport transition in sub-Saharan Africa," February 3, 2022, McKinsey&Company, retrieved from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/power-to-move-accelerating-the-electric-transport-transition-in-sub-saharan-africa; Guy Edwards, Lisa Viscidi, and Carlos Mojica, Charging Ahead: the Growth of Electric Car and Bus Markets in Latin America Cities, *The Dialogue,* 2018, retrieved from https://www.thedialogue.org/wp-content/uploads/2018/09/Charging-Ahead-web.pdf; Alejandra Cuéllar, "An EV owner in Colombia on leaving gasoline behind," Diálogo Chino, retrieved from https://dialogochino.net/en/climate-energy/45214-an-ev-owner-in-colombia-on-leaving-gasoline-behind/.

15 Regional dialogues on heavy-duty vehicles (2022).

16 Enrico Furnari, Lionel Johnnes, Alexander Pfeiffer, and Shivika Sahdev, "Why most electric trucks will choose overnight charging," McKinsey&Company, retrieved from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/why-most-etrucks-will-choose-overnight-charging.

17 Samantha Pettigrew, *Strategies for setting a national electric vehicle charger standard: Relevant factors and the case of Chile*, (ICCT: Washington, DC, 2023); Le and Yang (2022); Conzade, et al., "Power to Move," Regional Dialogues 2021 and 2022, International Energy Agency, *Policy Brief on Public Charging Infrastructure: Promoting successful roll-out strategies and business models*, (OECD Publishing: Paris, 2022) retrieved from https://doi.org/10.1787/e13b0b09-en; Alam and Lee, *Cleaner Vehicles*.

» **Lack of local technical expertise.** Limited technical capacity to install and maintain charging infrastructure exposes EMDEs to potentially higher costs for charging infrastructure installation and maintenance if those services come from abroad. Lack of domestic technical capacity could also affect the reliability of the existing charging infrastructure, potentially making ZEVs less convenient to drive than their conventional counterparts. Insufficient expertise also reduces opportunities to develop a local, more reliable supply chain for developing charging infrastructure that is well-adapted to local markets.

SUPPORTING POLICIES AND PRACTICES

Although the ZEV literature focuses heavily on leading ZEV markets, our review highlighted several supporting policies and practices to accelerate charging infrastructure deployment. Several of these practices have already been introduced in some EMDEs. Others can serve as general guidance and will have to be adapted to EMDEs' specific political and socio-economic circumstances. The following paragraphs describe some of these practices:

Developing a strategy/plan for infrastructure deployment. A critical component for building a robust charging infrastructure is creating a strategy that includes an action plan aligned with the infrastructure targets set by governments (if such targets have been defined). Ideally, the strategy will bring together all relevant stakeholders (e.g., government agencies, the private sector, financial institutions, electric utilities, landowners, EV drivers and others) under a common vision and shared responsibilities. It will also help identify shortcomings that must be addressed to implement the strategy successfully, while sending strong signals to private investors.[18] In Belarus, for example, the government has developed a charging infrastructure plan for 2030. By then, the country aims to have 1,305 charging stations. Phase 1 of the plan (2018–2021) targeted installation of 431 charging stations in priority areas (city centers and highways). Details for phase 2 (2022–2025) and phase 3 (post 2025) are yet to be revealed and will depend on whether the number of EVs exceeds 10,000 and 25,000, respectively.[19]

Developing incentive programs. A study by the World Bank found that subsidizing charging infrastructure is 4 to 7 times more cost effective than subsidizing purchases of electric vehicles.[20] In the short-to-medium term of the ZEV transition, EMDE governments can implement incentive programs to support the deployment of charging infrastructure. In the medium-to-long term, these incentive programs could be phased out as the market develops and when private investments are secured. A variety of incentive programs of different designs are in place in several EMDEs.[21] Some, such as Cape Verde and Nepal, have secured funding from international institutions to deploy charging infrastructure across various vehicle segments. Cape Verde, Ecuador, Egypt, Jordan, Pakistan, and Rwanda offer incentives designed to advance the development of charging infrastructure, including tax exemptions or tariff reductions on the importation of charging station equipment, related accessories, and parts. A different approach has been adopted in El Salvador, where income taxes are waived on

18 Dale Hall and Nic Lutsey, *Electric vehicle charging guide for cities*, (ICCT: Washington, DC, 2020), https://theicct.org/wp-content/uploads/2021/06/EV_charging_guide_03162020.pdf; Dale Hall, Yihao Xie, Ray Minjares, Nic Lutsey, Drew Kodjak, *Decarbonizing Road Transport by 2050: Effective Policies to Accelerate the Transition to Zero-Emission Vehicle*s, (ICCT: Washington, DC, 2021) retrieved from https://theicct.org/publication/zevtc-effective-policies-dec2021/.

19 "Belarus to launch 431 electric vehicle charging stations by 2022," *Belta*, October 12, 2018, retrieved from https://www.belta.by/tech/view/v-belarusi-k-2022-godu-planiruetsja-zapustit-413-stantsij-dlja-zarjadki-elektromobilej-321437-2018/.

20 Shanjun Li, Binglin Wang, Muxi Yang, Fan Zhang, *The Global Diffusion of Electric Vehicles: Lessons from the First Decade*, (Washington, DC: World Bank Group, 2021) retrieved from http://documents.worldbank.org/curated/en/225111639490843204/The-Global-Diffusion-of-Electric-Vehicles-Lessons-from-the-First-Decade.

21 Khan, et al., *A critical review of ZEV deployment*.

revenues generated through charging services. In Rwanda, government-owned land is offered at no charge for installing charging infrastructure. In Indonesia, residences that use electric cars can benefit from a free charger installation upgrade.[22]

Standardizing charging infrastructure. A successful ZEV transition will require building a charging infrastructure that is reliable and user-friendly. This in turn will require ensuring the charging infrastructure's interoperability, which consists of developing standards for the hardware (e.g., plugs, sockets, connectors) and the software (to enable sharing of data and information among the different charging stations). With those standards, charging becomes hassle-free as drivers are not restricted to a specific network or provider and are not confronted by different sockets, plugs, or payment contracts. Compatible hardware and software also increase drivers' safety and reduce charging infrastructure costs by encouraging market competition.[23] Effectively in India, the government released its 2022 updated guidelines and standards for EV charging infrastructure. The guidelines set charging connector standards, among other elements, across all vehicle segments.[24]

Reducing electricity tariffs and upgrading/managing the grid. The price of electricity plays an essential role in ensuring that ZEVs' total cost of ownership (TCO) compares favorably to the TCO of their conventional counterparts. Effectively, in several EMDEs (e.g., Rwanda, Colombia, Argentina, Ecuador, Costa Rica, and Pakistan), governments have introduced lower electricity tariff structures for EV charging, thus reinforcing the value proposition for EVs.[25] In the longer term, as EMDEs progress through their ZEV transitions, the electricity grid will need to accommodate greater charging demand from ZEVs. Accommodating this demand could involve costly grid updates (for increased electricity generation and distribution capabilities), leading to higher electricity prices.

However, expensive grid updates can be mitigated through times of use (TOU) rates or smart charging metering measures. TOU rate metering programs encourage drivers to charge their cars during off-peak demand by offering lower electricity prices. Smart metering allows data exchange between ZEVs and charging stations to maximize off-peak charging sessions, when electricity prices are lower.[26] Importantly, grid upgrades should favor the integration of renewable energy sources (e.g., solar and wind) to maximize the social, economic, and environmental benefits of the ZEV transition.

Putting in place building code mandates. As the transition to ZEVs advances, the need to ensure that drivers have convenient access to charging infrastructure will increase. Effectively, building codes are city-level mandates requiring that new or retrofitted buildings be equipped with charging infrastructure equipment, which increases charging opportunities across a city. They are advantageous because it is cheaper to install charging equipment during the construction or major retrofit of a building.[27] Such mandates have been introduced in several EMDEs such as Kenya and Rwanda and apply to all new public buildings.[28]

Developing concessional business models. Concessional models that distribute responsibilities among relevant stakeholders can be developed to lower the risk of

22 Khan, et al., *A critical review of ZEV deployment*.

23 Dan Welch, Cristiano Façanha, Rob Kroon, David Bruil, Flores Jousma, Harm Weken, "Moving zero-emission Freight toward Commercialization," (International ZEV Alliance December 4, 2020), http://www.zevalliance.org/zero-emission-freight-2020/.

24 Government of India. (2022). Charging infrastructure for electric vehicles-the revised consolidated guidelines & standards-reg. Retrieved from https://powermin.gov.in/sites/default/files/Final_Consolidated_EVCI_Guidelines_January_2022_with_ANNEXURES.pdf

25 Welch, Façanha, Kroon, Bruil, Jousma, and Weken, "Moving zero-emission freight."

26 Welch, et al., "Moving zero-emission freight."

27 Hall and Lutsey, *Electric vehicle charging guide*.

28 Khan, et al., *A critical review of ZEV deployment*.

investments in charging infrastructure. Such business models will help answer key questions such as who installs and maintains the charging infrastructure, what the role of the utility is, how the charging equipment is financed, and how revenues are generated. While there is no one-size-fits-all business model, the models developed to date commonly fall into three broad categories, namely government-driven, consumer-driven, and service provider-driven. Table 1 below shows what the division of roles could look like across the three business model categories.[29]

Table 1. Distribution of roles under the government, consumer, and service provider concession business models[30]

	Government-driven business model	Consumer-driven business model	Service provider-driven business model
Leading agency	Government agencies	Private businesses, ZEV owners, fleet operators	Charging point operator (CPO)/ utilities
Land provider	Government/public-sector owned	Privately owned or leased parking spaces	Procured from public or private entities
Charging infrastructure equipment supplier	Private sector supply equipment through public-private partnership	CPO - Private business and fleet operator Retailer/CPO/utility - EV owner	Manufacturing partners
Installation & management provider	Charging point operator (CPO), typically with government incentives	CPO/ charging service provider	CPO/Utility

RECOMMENDATION FOR ACCELERATING DEPLOYMENT

EMDEs, like other regions of the world, have limited infrastructure in place. Addressing this drawback requires bringing together a complex set of stakeholders in ways that identify win-win solutions for all. Examples of key stakeholders that could be integrated into this coordinated approach are described below:[31]

- **Governments** can create an enabling environment for charging infrastructure deployment through effective use of policies and regulations. This could include taking the lead in developing a clear strategy that includes targets for charging infrastructure deployment. It could also involve designing regulations that define standards to ensure user-friendliness and safety of charging infrastructure or that introduce new mandates such as building codes. To the extent possible, governments can also allocate public funding to support charging infrastructure projects.
- **The private sector** can leverage business opportunities created where governments lack the capacity to finance charging infrastructure projects, owing to their large

29 Marie Rajon Bernard and Dale Hall, *Efficient planning and implementation of public chargers: Lessons learned from European cities,* (ICCT: Washington, DC, 2021). https://theicct.org/wp-content/uploads/2021/06/European-cities-charging-infra-feb2021.pdf; NREL, "Electric Vehicle Charging Infrastructure: Business Model and Tariff Design Support to the Lao PDR," 2020. https://www.nrel.gov/docs/fy21osti/77671.pdf; Government of India, *Handbook of electric vehicle charging infrastructure implementation*, (2019). https://www.niti.gov.in/sites/default/files/2021-08/HandbookforEVChargingInfrastructureImplementation081221.pdf

30 Rajon Bernard and Hall, *Efficient planning and implementation.*

31 Conzade et al., "Power to move;" United States Agency for International Development, "Practitioner's Guide for Deployment of Public Charging Stations for Electric Vehicles: Learnings from first large-scale roll-out of public charging stations by EESL," (USAID: Washington, DC, 2020); Bakatjan Sandalkhan, Jennifer Carrasco, Aykan Gökbulut, and Yusuf Tasli, *How Governments Can Solve the EV Charging Dilemma,* (Boston Consulting Group: Boston, 2021), https://www.bcg.com/publications/2021/electric-vehicle-charging-station-infrastructure-plan-for-governments.

upfront costs. The private sector can help to fill the gap by investing in pilot projects that scale up to larger schemes.

- **Development Financial Institutions (DFIs)** like the Asia Development Bank (ADB) can support the private sector in deploying critical financial resources needed to initiate and scale up charging infrastructure schemes in EMDEs.
- **Electric utilities** can collaborate closely with governments and the private sector to anticipate and plan upgrades that might be required to accommodate a growing number of ZEVs. This presents a business opportunity for grid operators: they are positioned to serve a growing pool of ZEV drivers but also to improve their services by integrating additional stocks of renewable energy and smart charging technologies into their businesses.
- **Original Equipment Manufacturers (OEMs)**, both local and international, can seize new opportunities to build electric vehicles and charging equipment and to provide maintenance and repair services on those technologies.
- **ZEV drivers** are important stakeholders who can share their experiences and perspectives to local authorities, thereby providing important feedback to ensure that chargers provide a convenient and safe experience. Electric vehicle taxi drivers who are expected to travel long distances daily could generate valuable insights to optimize charging logistics.
- **Charging point operators,** who are responsible for operating and maintaining charging infrastructure, are important partners in ensuring the reliability of chargers.

The research and the regional dialogues led the ICCT to formulate the following recommendations for ZEVTC members:

Leverage international forums (e.g., the World Bank, OECD, and the World Economic Forum) to provide technical assistance and facilitate knowledge-sharing in EMDEs.

I. Strengthen governments' capacity for developing circumstance-specific infrastructure deployment strategies and roadmaps. This includes the capacity to identify charging infrastructure needs; proper distribution of charger types; optimal areas for installation; and mechanisms to ensure timely grid upgrades.

II. Support an efficient integration of EVs in the grid and improve the business case of charging infrastructure by introducing smart charging technologies, implementing dynamic pricing schemes, and exploring vehicle-to-grid strategies.

III. Facilitate discussions on charging infrastructure standardization through appropriate forums at regional and international levels, and advance interoperability to improve charging access and to scale infrastructure efficiently.

IV. Enhance multilateral cooperation to facilitate technology and knowledge transfer targeted at vehicle modes closest to reaching price parity with their conventional counterparts. This cooperation involves strengthening connections between the private sector, governments, and institutions (at the international, regional, and country levels).

Establish a mechanism(s) and/or platform(s) to mobilize financial resources to support demand-driven infrastructure development.

I. Support pilot projects that help identify revenue-generating concession business models, which reduce the risk of investments and enable upscaling and potential replication.

II. Enhance cooperation among EMDE governments, international and regional institutions, and the private sector to develop blended finance mechanisms.

III. Showcase and share knowledge on innovative financing mechanisms (e.g., charger leasing, energy as a service) that can be introduced to increase charging access at reduced cost for private EV drivers or public fleet operators.

IV. Support the regional integration of EMDE markets to create aggregated charging infrastructure demand that attracts private investment and upscaling.

ANNEX A : 2022 CHARGING INFRASTRUCTURE REGIONAL DIALOGUES EXECUTIVE SUMMARY

The executive summary below was shared with senior officials and ZEVTC ministers in the lead-up of the 2022 ZEVTC Ministerial meeting on charging infrastructure that took place in September 2022. It was also shared with the EMDE governments that participated in the regional dialogues and International Assistance Taskforce (IAT) meetings.

EXECUTIVE SUMMARY

OVERVIEW

1. **Robust charging infrastructure** is required for an accelerated global ZEV transition that reduces emissions by 73% by 2050 compared with 2020—the trajectory compatible with the Paris Agreement goals**.**
2. There is a broad consensus that EV charging infrastructure positively correlates with EV uptake. Effectively, as governments across Emerging Markets and Developing Economies (EMDEs) take action to electrify their transport sectors, there is a parallel need to deploy the required charging infrastructure. This can be achieved only **through coordinated efforts among relevant stakeholders**, including—but not limited to—governments, the private sector, financial institutions, manufacturers, charging point operators, landowners, and the utility sector.
3. This note summarizes the key challenges and actions needed to accelerate the deployment of charging infrastructure in EMDEs, informed by insights from the EMDE regional dialogue webinars as well as written consultations. It also incorporates the latest infrastructure analyses from international organizations and initiatives such as the Global Electromobility Programme, the Transport Decarbonization Investment (TDI) Series, the World Business Council for Sustainable Development (WBCSD) Regional Business Dialogues, and a literature review of infrastructure development best practices conducted by the International Council on Clean Transportation (ICCT).

STATUS OF CHARGING INFRASTRUCTURE DEPLOYMENT

4. Charging infrastructure remains at **an initial deployment stage in most EMDEs.** A few EMDEs are making progress in setting up charging stations for various vehicle segments. For example, as of 2021, Thailand had about 2,300 chargers installed at 693 locations including more than 1,500 AC normal chargers and about 800 DC fast chargers. In Vietnam, the leading EV manufacturer VinFast set up 2000 public charging stations across the country in 2021, including more than 40,000 charging ports for electric two-wheelers and electric cars. Chile has installed 377 chargers for buses, as of April 2022. Based on the EV Volumes database, as of May 2022, selected EMDEs (n=22) have about 14,100 public charging stations with nearly 9,800 normal chargers, 4,300 fast chargers, and 29 ultra-fast chargers for various vehicle segments.

KEY CHALLENGES TO CHARGING INFRASTRUCTURE DEPLOYMENT

5. A consultation survey addressed to EMDE governments was conducted in June 2022. The thirteen responses received provided insights representative of countries from Africa (Côte d'Ivoire, Kenya, Nigeria, Uganda, and Zimbabwe), Asia (India, Indonesia, Nepal, Turkmenistan, and South Korea), Europe (Bosnia and Herzegovina), and Latin America (Costa Rica and Uruguay). To supplement this, key challenges and recommendations from the organizations and initiatives described above have also been reflected. In summary, the following key challenges were highlighted:

- Lack of a detailed **strategy or roadmap** that unifies relevant stakeholders under a long-term vision for the deployment of charging infrastructure.
- Difficulties in **attracting and mobilizing private sector investments** to overcome the high upfront cost barrier (e.g., level 2, fast, and ultra-fast chargers).
- Difficulties designing **business models** that address unique, local challenges.
- Uncoordinated efforts in establishing and enforcing **effective standards** and regulations for charging infrastructure hardware (sockets, plugs, connectors) and software (to enable interoperability between EVs and charging stations) that improve drivers' safety and make their charging experiences more user-friendly.
- Ensuring timely investments for **grid upgrades** that are future-proof and ensure continuous progress in the ZEV transition.
- Limited **technical capacity** to build and maintain charging infrastructure.

RECOMMENDATIONS FOR ACCELERATING DEPLOYMENT

6. Recommendations for ZEVTC members to accelerate deployment in EMDEs include:

   a. Leverage international forums to provide technical assistance and facilitate knowledge sharing in EMDEs.

   I. Strengthen governments' capacity for developing circumstance-specific infrastructure deployment strategies and roadmaps. This includes the capacity to identify the charging infrastructure needs; the proper distribution of charger types; the optimal areas for installation; and the mechanisms to ensure timely grid upgrades.

   II. Support an efficient integration of EVs on the grid and improve the business case of charging infrastructure by introducing smart charging technologies, implementing dynamic pricing schemes, and exploring vehicle-to-grid strategies.

   III. Facilitate discussions on charging infrastructure standardization through appropriate forums at both regional and international levels and advance interoperability to improve charging access and to scale infrastructure efficiently.

   IV. Enhance multilateral cooperation—strengthening the connections between the private sector, governments, and institutions (at the international, regional and country levels)—to facilitate technology and knowledge transfer targeted at vehicle modes closest to reaching price parity with their conventional counterparts.

   b. Establish a mechanism(s) and/or platform(s) to mobilize financial resources to support demand-driven infrastructure development.

   I. Support pilot projects that help identify revenue-generating concession business models, which de-risk investments and enable upscaling and potential replication.

   II. Enhance cooperation among EMDE governments, international and regional institutions, and the private sector to develop blended finance mechanisms.

   III. Showcase and share knowledge on innovative financing mechanisms (e.g., charger leasing, energy as a service) that can be introduced to increase charging access at reduced costs for private EV drivers or public fleet operators.

   IV. Support EMDE markets' regional integration to create aggregated charging infrastructure demand that attracts private investments and upscaling.

ANNEX B: CHARGING INFRASTRUCTURE REGIONAL DIALOGUES CONSULTATION SURVEY

To inform the 2022 charging infrastructure regional dialogues, a consultation survey was sent to emerging markets and developing economy governments during May of 2022. The questions of the survey are listed below:

1. What country are you based in or do you represent?
2. How do you describe the status quo of charging infrastructure deployment in your country to support electrification in different vehicle segments, e.g., passenger cars, buses, trucks, two-wheelers/three-wheelers? Please provide relevant data, if available and helpful, including website links.
3. Please **tick the top 3 challenges** to deploying charging infrastructure for electric vehicles in your country and/or region:
    - » *Not having a clear strategy and/or roadmap for the deployment of charging infrastructure*
    - » *Building coalitions of stakeholders at a country and/or regional level e.g., those that work in the energy and transport sectors*
    - » *Standardization and interoperability, including across a country and/or region*
    - » *Ensuring timely investment in grid infrastructure*
    - » *Attracting and mobilizing private sector investment*
    - » *Charging infrastructure standards (for chargers and connectors)*
    - » *Technical capacity to build and maintain infrastructure*
    - » *Implementing grid upgrades and management programs*
4. Is there anything missing from the above that you also think is a challenge for your country and/or region in the deployment of charging infrastructure for electric vehicles?
5. What business model(s) for charging infrastructure deployment has your country piloted, adopted, or considered?
6. Has your country been involved in any international or regional collaborations or received financial and/or technical support for deploying charging infrastructure? If yes, please describe them briefly below.
7. Where do you think greater financial and/or technical support could be most impactful in your country and/or region?
8. Is there anything else you would like to share with us that you think should also be taken into consideration when developing recommendations for how/where the international community could enhance its support for countries?
9. If you would be happy for us to follow-up with you for further information, please provide your email address.