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Connecting Informal Transport to the Climate Agenda: Key Opportunities for Action

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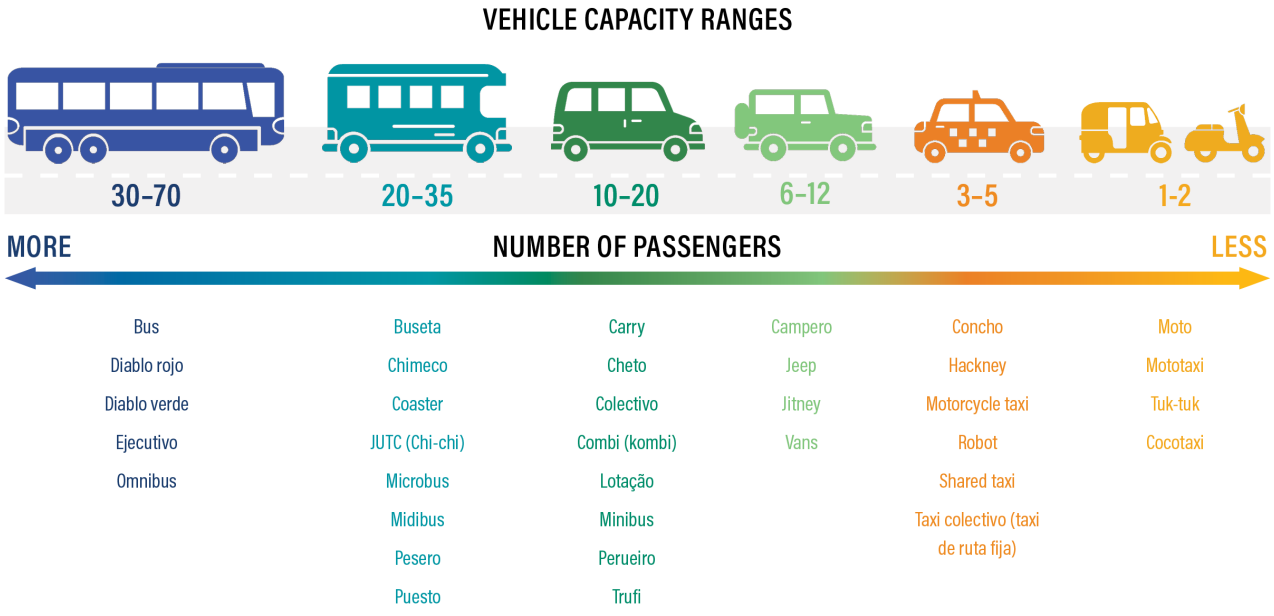
Introduction

At COP27, global leaders in climate change policy came together to discuss the next big ideas for reducing emissions and meeting collective targets to curb climate change. Although the transport sector has gained attention, particularly the electrification of motorized vehicles, global actions have thus far failed to acknowledge semiformal and informal transport services that dominate in many low- and middle-income countries (Fransen et al. 2022). Currently, over half of public transport trips in Latin America and the Caribbean (LAC) are made in semi-informal or informal public transport modes (also known as "popular," "intermediate," or "artisanal" transport), while this number can be as high as 95 percent in some sub-Saharan African cities, as well as substantial shares in the Caribbean and South and Southeast Asia (Espelia 2022; Scholl et al. 2021) Paratransit and informal services are ubiquitous; they come in various vehicles (buses, minibuses, jeeps, for-hire two- and three-wheelers, etc.) and under a variety of local names (e.g., boda boda, dala dala, jitney, matatu, pesero, trufi, tuk-tuk, and wôrô-wôrô), with contrasting political attitudes toward the informal services. (See Figure 1 for some examples from the LAC region.)

Informal transport (see Box 1 for further definition) remains a key element of urban mobility. It provides mobility to underserved areas and is more adaptive and demand responsive than "formal" transport, which has fixed routes and had restricted service, especially during the pandemic, cutting off some residents from jobs, needed services, and obligations (Cervero and Golub 2011). In South Africa, the government partnered with minibus taxi drivers to provide special "Red Dot" transport service for essential medical workers when formal public transport had to stop operating at 7 PM (Madikizela 2020). Paratransit is a more affordable means of transport in cities like Lagos, where workers may spend 40 percent or more of their income on transport (Otunola et al. 2019). From a climate perspective, informal shared buses and minibuses are also more efficient per passenger-kilometer than private cars, so depending on the local context, integrating their services as a complement to formal public transport is critical to slowing the rate of private motorization even as cities grow and travel distances become longer. Further, the informal transport sector provides important jobs for residents; supports trade, commerce, and exchange; and is an entire industry, from drivers to mechanics, often within itself, providing employment opportunities for women (Spooner and Whelligan 2017).

Figure 1 | **Examples of semi-informal or informal services in Latin America and the Caribbean**



Source: Adapted from Hidalgo et al. 2021.

Box 1 | What are semiformal and informal transport services?

In this paper, we explore the connection of the informal sector to the climate agenda, considering informal bus services as well as for-hire two- and three-wheelers (sometimes called intermediary public transport). Semiformal and informal transport (or paratransit) services are typically managed by privately owned operators, which often arise under a lax regulatory environment, due to underdeveloped infrastructure and inadequate formal transit service (Behrens et al. 2015; Cervero 2001; Thet Hein et al. 2020). The individual operators own several vehicles, operate on semifixed routes, and function as on-demand paratransit or intermediary transit, picking up passengers and dropping them off as needed—thereby serving as a complement to "formal" public transport systems in much of Latin America or as the predominant transport mode in Africa. The terms *informal* or *paratransit* (also known as popular or artisanal transport) characterize a specific transport system with distinct patterns of services, ownership, organizational structure, and regulatory frameworks. Despite limited regulation or government control, from the perspective of millions of local residents who rely on the service for daily trips, bus-based paratransit systems are indeed categorically a form of public transportation, thereby blurring the line between "formal" and "informal" transport. According to San Gil Leon (2022), the emergence of informal transport providers is a response to a gap in the market for cheap, convenient, versatile mobility, particularly in areas that are underserved by other transport options. The informal sector is critical for local economies, as it transports millions of workers and employs hundreds of thousands as drivers, mechanics, and service workers.

Despite the prevalence of informal services, recent analysis from the World Resources Institute (WRI) on public transport measures in nationally determined contributions (NDCs), the climate commitments made by members of the Paris Climate Accords, found that the informal transport sector is all but missing from global climate discussions (Kustar et al 2022). Angola is the only country that recognizes greenhouse gas (GHG) emissions from informal vans, but no countries make any recommendations for mitigating emissions from informal services (Republic of Angola 2021). Similarly, although imported secondhand vehicles represent up to 95 percent of vehicle fleet growth in developing countries, their NDCs do not acknowledge import restrictions, such as age or emissions limits (UNEP 2020a). Only Antigua and Barbuda set efficiency standards for all imported vehicles (new and used), and Mauritius pledged to phase out subsidies for imported diesel buses. Despite such vehicles' known emissions and contributions to air pollution, when it comes to countries' policies and regulations on used vehicle importation, the United Nations Environment Programme (UNEP) also finds them to be often weak or very weak (Rukikaire 2020).

Target 11.2 of the United Nations Sustainable Development Goal 11 (SDG 11) on cities and human settlements aims to ensure that by 2030, all people will have access to sustainable transport systems that are safe, affordable, and accessible (UN Department of Economic and Social Affairs 2022). This is to be achieved by improving road safety and expanding public transport networks and services to be accessible by all, with particular attention toward vulnerable groups such as women, children, and people with disabilities. In African cities, which are rapidly growing and often have high levels of informality, there is an opportunity to rethink how SDG 11 can be achieved. Rather than attempting to substitute or eliminate informal transport, informal drivers can be hired to expand the legally recognized public transport network, with innovative business models that integrate connections between formal and informal transport providers.

In this briefing, we seek to identify key areas where informal transport can connect to the global climate agenda and where countries and cities may assess emissions and raise ambition. While we are not providing an extensive policy outline in the sector, we seek to outline the main areas for action and reflect on these with existing research, projects, and selected policies. We hope to inform the dialogue within the broader scope of COP27 and beyond, such as a new initiative launched by the COP27 Presidency—the Low Carbon Transport for Urban Sustainability (LOTUS) initiative (COP27 Presidency 2022). This has brought together global stakeholders to improve and decarbonize the urban mobility landscape and contains three strategic aims, including one to "empower and invest in informal transportation to decarbonize, mobilize towards SDG 11" (COP27 Presidency 2022).

Areas to address decarbonization through informal transport

Emission inventories

Key message

Countries and cities should undertake emissions inventories of the informal sector—minibus fleets, motorcycle taxis, and auto-rickshaws—to establish a baseline for interventions to decarbonize.

In tackling transport decarbonization from the paratransit sector, great value can be found in collecting necessary data to calculate emissions, which has been difficult due to lack of consistent, quality data. Primarily, it is important to identify the number of vehicles in operation. In Africa, there are an estimated 27 million registered motorcycles, of which about 80 percent are utilized for passenger or freight transport, and even more minibuses, which account for 30 percent of all vehicles in African cities (Amend 2022; Odhiambo et al. 2021). Currently, research on GHG emissions and air pollution originating from the informal sector is often done piecemeal using field data, if done at all. For example, one recent study from Nairobi estimates that fuel economy for boda bodas, tuk-tuks, passenger cars, and matatus are two to three times worse than in the countries from which the vehicles are imported (Mbandi et al. 2019). Findings reveal that most Kenyan matatu buses have an average age of 16.9 ± 0.2 years and are overloaded, converted from 9-seater vans to accommodate up to 14 passengers. On a different continent, India's roads are dominated by three-wheeler auto-rickshaws, which typically used two-stroke engines with high particulate matter (PM10) emissions known to have adverse impacts on respiratory health (Thakur et al. 2018). Because of the high levels of air pollutants found in these transport modes and the frequently long commuting times, identifying and addressing the greatest contributors to transport emissions will help minimize overall population exposure.

Most promising may be the bottom-up inventories done through mapping and identification of networks. For example, the World Bank undertook such analysis to inform potential sustainable transport strategies in Egypt, finding that electrification of diesel buses would achieve only 9.5 percent of the reduction in carbon emissions needed and that 90 percent of reductions need to come from shifting passenger-kilometers away from private cars and taxis (Daito et al. 2021).

Researchers have also started using open data sets from initiatives such as DigitalTransport4Africa, a global consortium with the mission to collect General Transit Feed Specification data on informal transport systems in African cities in order to model and forecast energy demands for future electric paratransit systems (Rix et al. 2022). Nascent work of the Transport Data Commons Initiative, a coalition of over 20 international transport and climate organizations, has also begun to address the poor data systems issues through development of an open-source platform (Orschulok 2022). These platforms aim to tackle the problem of data accessibility, because often, even when data is collected, it is not easily or openly accessible or is outdated. For a systemic inventory of fleet emissions in the informal transport sector, more comprehensive data collection and sharing efforts are needed to incorporate granular information of paratransit vehicles—such as trip frequency, vehicle types, fleet composition, fuel efficiency, age, and common vehicle modifications such as additional seating.

Issues of GHG emissions and local air pollution from the informal transport sector are often addressed at the city level through fleet upgrade and renewal programs (see the next section). Given the limited data on informal transport vehicles at the city level, another, but potentially less accurate, emissions inventory could be from importation records of used vehicles. Based on the UNEP data from 2020, of the 14 million used vehicles exported from high-income areas such as Europe, Japan, and the United States, 80 percent ended up in low- and middle-income countries where used minibuses are commonly deployed in the paratransit sector (Boateng and Klopp 2022; UNEP 2020a). Unfortunately, it is occasionally cheaper to export used vehicles than to formally scrap them, as seen in European reports of vehicles destined for scrappage being sent instead to eastern Europe and Africa, allowing damaged and unsafe vehicles to remain on roads (UNEP 2020b). Wealthier countries need to be held accountable to ensure their exported used vehicles are still roadworthy, while at the same time, policymakers must pay close attention to the paratransit sector to address potentially the oldest, most driven, and most polluting and crash-prone vehicles on the road.

Improving informal services to reduce or prevent private vehicle trips

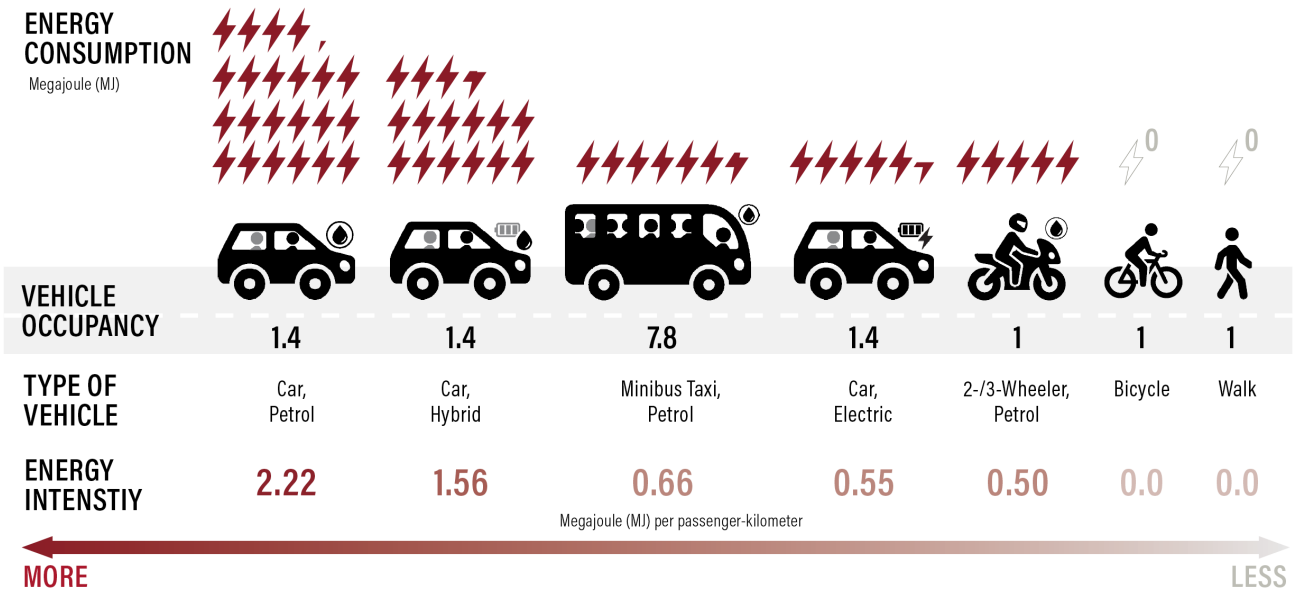
Key message

Countries, cities, development finance institutions, and banks, as well as private operator associations, working together should improve the quality of informal transport services through efforts such as integration within the wider transport system, infrastructure upgrades (e.g., transit priority, formal stops and stations, and improved staging areas), as well as improved labor conditions and user experience, such as fare payments. These improvements can abate private vehicle travel and foster trips through shared, lower-carbon mobility. .

Once baseline emissions are established, approaches vary in terms of how governments regulate GHG and particulate emissions from transport vehicles. Although informal transport is a low-carbon solution that carries more passengers than private vehicles and is both more energy and space efficient than petrol cars (Figure 2), these services have inefficiencies (e.g., lower-demand areas not being served at all or predatory fares) and room for improvements in quality, safety, and reliability (Cervero and Golub 2011). Resolving these challenges will prevent pushing riders to more carbon-intensive private vehicle travel as soon as they can afford a vehicle.

System-wide informal transport improvements and reforms have been attempted all over the world. At the one extreme, policy approaches toward paratransit or informal systems involve self-management or no restrictions, thereby continuing congestion and unsafe vehicle and labor conditions, among other problems (Kumar et al. 2021). At the other extreme are policies that attempt to eliminate informal services and replace them with "formal" transport systems (see more case studies in Box 2)—which can adversely affect transport workers and potentially deny an affordable transport option for the most vulnerable residents. An example of this is Hanoi, Vietnam, where the government is implementing new bus rapid transit (BRT) and an elevated metro line but will be banning motorcycles and motorcycle taxis from downtown areas as of 2030 in an effort to improve urban air quality (Turner 2020). Unfortunately, the ban will jeopardize the livelihoods of thousands of informal drivers, and the lack of transit connectivity to access the transit stations creates a new mobility injustice problem, which could force more cars onto the roads. Similar bans in Beijing and Guangzhou, China, have not seen significant changes in traffic congestion and have led to increased use of electric bikes, which are legally seen as bicycles and are subject to fewer regulations (Daud 2018). It is crucial that policy strike a balance between addressing the issues posed by informal transport while also considering the impact on those who rely on these services. There are cases where public transport investments, such as BRT and light rail, should be encouraged—such as in Accra and Kampala, where there is demand

Figure 2 | **Energy intensity of passengers (MJ per passenger-kilometer) by mode in Cape Town, South Africa**



Source: Adapted from (Kane 2016) with additional data from International Energy Agency.

for high-capacity solutions to alleviate traffic—but it should be considered with informal transport in mind (Asimeng 2021). A potential solution could be to integrate informal transport into existing systems, with proper regulations and support for improvement, in order to ensure safe and accessible mobility without endangering the income of vulnerable workers.

One policy approach to reducing emissions without disrupting service is to control the quality of imported used vehicles—including regulating import age limit, setting environmental and emissions standards (e.g., Euro 3), taxing, providing incentives for electric vehicles (EVs), and banning used vehicles (Table 1). At the regional level, institutions are collaborating to promote cleaner fuels and vehicles. Recently, member countries of the Economic Community of West African States and Southern African Development Community announced the establishment of stricter vehicle emissions and fuel efficiency standards across the region (Table 2) (UNEP 2019, 2020b). However, some scholars caution that emissions inventories and vehicles regulations alone might not translate into sustained pollution and road injury reduction (see Box 2 for Senegal as a case), as further restrictions can push the trade of older, more polluting vehicles onto the black market (Boateng and Klopp 2022). Rather than placing local economic development in conflict with international climate goals, a more equitable policy is to utilize and complement market-driven incentives to finance and enhance access to cleaner fuels and vehicles. One successful case is Egypt's vehicle scrapping program, which was launched in 2013 to incentivize scrapping old taxis—sometimes over 40 years old—from the streets of Cairo (World Bank 2018). By 2018, over 45,000 taxis had been replaced with newer vehicles, resulting in 350,000 tons of carbon dioxide (CO_2) emissions avoided.

Table 1 | **Vehicle import bans across regions**

REGION	EXAMPLES OF COUNTRIES WITH USED VEHICLE BANS	COUNTRY COUNT IN EACH REGION
Africa	Egypt, Seychelles, South Africa, Sudan	54
Latin America and the Carribean	Argentina, Brazil, Chile, Colombia, Ecuador, Uruguay, Venezuela	37
Asia Pacific	Bhutan, India, Indonesia, Nepal, Philippines, Thailand	26

Source: UNEP 2020a.

Table 2 | **Emissions standard targets by select African regional organizations**

JURISDICTION	NUMBER OF COUNTRIES	EMISSION STANDARD	SULFUR FUEL STANDARD	FUEL EFFICIENCY	AGE LIMIT FOR USED VEHICLES	EFFECTIVE DATE
ECOWAS	15	Euro 4	50 ppm	8 L / 100 km	10 years	January 1, 2021
SADC	16	Euro 4	50 ppm	-	-	December 31, 2022

Notes: ECOWAS = Economic Community of West African States. SADC = Southern African Development Community. ppm = parts per million. km = kilometer.

Source: Ayetor et al. 2021.

Box 2 | **Case studies**

Paratransit mapping

A pivotal step in improving informal systems is mapping the vehicles' routes and establishing ways to digitize services. Many public transport systems lack systematic curation of basic data such as bus routes, stops, and frequencies. Mapping may indicate that certain areas have consistently higher traffic, and in this scenario, emissions could be reduced if some routes could be reallocated to areas with fewer services. Putting transit on a map by digitizing and curating in standard formats such as General Transit Feed Specification (GTFS) is an essential measure for paratransit improvement in many cities. As seen in the cases of digital mapping in Nairobi (Kenya), Maputo (Mozambique), and Santiago (Dominican Republic), community participation and local buy-in are critical for long-term sustainability of the initiative (Klopp and Cavoli 2019; Thet Hein et al. 2020; Williams et al. 2015). The data can be further used to analyze resilience, such as the impacts of seasonal flooding on transport services and accessibility, as seen in Kinshasa (Ali 2023). Making transit repositories open and enabling entrepreneurs to build on the existing digital infrastructure can spur innovation and further collaboration. Building on the open data, scholars and planners can track and analyze transportation indicators such as Sustainable Development Goal 11.2. Web applications (e.g., Kampala accessibility footprint tool, which utilizes the city's GTFS data) are effective as a communication tool among different stakeholders and can improve productivity by matching supply with demand (DT4A 2022). Apps such as Trufi offer trip planning with data from both formal and informal transport service providers and can help provide information on walking distances and details on available transport options (International Association of Public Transport 2021). In 30 Indian cities, Chalo tracks buses to provide real-time location and arrival times, as well as serving as a smart card for bus fares and providing bus drivers with reports on their daily activities (Chalo 2022). One criticism worth noting is that digital transactions and online trip booking with a set price may be too transparent in some cases and could threaten informal entrepreneurship that usually prices fares according to several factors, such as time of day, traffic, and road and weather conditions (Espelia 2022). Furthermore, traditional cash payments are harder to track, and utilizing apps could mandate that drivers pay taxes on their fares.

Incremental reforms

One way to improve the informal transport system is by restructuring the ownership of vehicle fleets. With such tight profit margins, the model of private, individual ownership translates to high individual costs and minimal funds for motor vehicle maintenance. Mexico City demonstrates an example of government and authorities stepping in to implement a centralized transport planning system, with organized maintenance service and an independent entity (Metrobús) in charge of coordinating service, regulating bus rapid transit (BRT) lines, and managing fare collection (International Association of Public Transport 2021). In 1999, after years of public transport quality decline, the transportation minister understood that certain strategic corridors had the highest flow of traffic and needed to be addressed to replace small vehicles (jitneys) with larger buses. To accomplish this without angering 30,000 members of 100 jitney organizations, he offered an incentive to pay $100,000 Mexican pesos (US$10,000) for each minibus scrapped and replaced by a bus (Dewey 2016). A substantial number of jitney drivers willingly professionalized their organizations, consolidated their associations into firms, accepted regulations, and upgraded to BRT vehicles. While the reform can be considered a comparatively successful case, the public transport system in the long term faces various challenges, including financial stresses. Present-day Mexico City still relies on its indispensable paratransit mode, with more than 1,000 routes of jitneys (or peseros), totaling 28,000 kilometers of service and offering 11.5 million passenger-trips every day (Lane 2019; MIT Department of Urban Studies and Planning 2019).

Vehicle fleet renewal programs

Another approach to improve paratransit systems is by upgrading and renewing outdated vehicles with safer, higher-occupancy vehicles, which will reduce transport-related carbon dioxide emissions and local air pollution. For example, in Dakar (Senegal), 75 percent of daily trips are made by shared transport services, of which over 80 percent are provided by informal operators (Kumar and Diou 2010). The city faced problems with dense, disorderly, and low-quality transport, leading to a decision by the government to renew the minibus fleet while formalizing and professionalizing operators. Nine participating economic interest groupings (EIGs) collectively formed the Urban Transport Financing Group, which purchased the vehicles and leased them to the EIGs. To be sustainable, the fleet renewal program must be complemented with competitive business models and regulations with the right incentive structure for bus owners and drivers—who could not otherwise afford to upgrade the vehicles—to take part in the initiative. The program was launched in 2005, and by 2009 it resulted in the scrappage and replacement of 505 buses, improved services along fixed routes, higher passenger satisfaction, and lower fare costs, although drivers earn less and owners earn more. Along with vehicle maintenance practices, fleet renewal programs in larger reforms are often accompanied by route optimization approaches in order to improve efficiency and reduce combined total kilometers traveled, thereby resulting in fewer emissions in the overall transport system.

Climate actions can package a series of improvements to informal services. Instead of banning or attempting to replace informal services with wholesale bus systems, policymakers can set realistic reform expectations, recognize paratransit in policy, and leverage paratransit dividends by investing and improving existing informal services and infrastructure. In Maputo, Mozambique, after years of stalling due to lack of funding, a new BRT project funded by the World Bank will integrate chapas, the predominant mode of transit in the city, to function in tandem with the new BRT (Kedem 2022). The integration will include restructuring the fleets, introducing a digitized fare payment using smart cards, and providing owners with financing to maintain and upgrade their vehicles. Along with upgrading engine technologies and vehicle fleets, improvements in paratransit quality of service, safety, and operational efficiency can reduce emissions, particularly as a way of avoiding growth in private vehicle travel (see Box 3 for further details on safety). Possible improvements include a menu (see Table 3) of nonpunitive, relatively "quick-win" strategies that can bring substantial benefits to informal transport systems.

Table 3 | **Select nonpunitive strategies to improve paratransit sector**

CATEGORY	STRATEGIES
Business development	▪ Business consolidation and cooperatives ▪ Creation of transportation workers' unions ▪ Business skills training ▪ Business diversification
Operating environment	▪ Rank/terminus provisions and bus priority ▪ Vehicle road worthiness testing ▪ Bus priority lanes ▪ Physical integration of taxi stands and NMT with mass transit modes and public space ▪ NMT infrastructure and access improvements near bus stations and stops (e.g., speed management, clear signage, safe transfer, and access to terminals)
Fleet improvement	▪ Vehicle renewal or recapitalization incentives for upgrading to cleaner and safer vehicles (e.g., discounts for new fleets, payment of scrappage value) ▪ Cooperative loans
Operations	▪ Safe driver training and improving labor conditions ▪ Salaried drivers, improving labor conditions and workers' rights ▪ Gender inclusivity ▪ Consolidated driver recruitment and management ▪ Vehicle management and route rationalization ▪ Speed management ▪ Cashless and integrated ticketing ▪ Mapping, digitalization of transport routes, improved data on operations ▪ Passenger information systems (e.g., physical and digital maps, including via mobile phones; vehicle routes stickers; digital information at stops) ▪ Open public transportation data ▪ First-/last-mile connectivity (especially in cases of two- and three-wheelers)

Note: NMT = nonmotorized transportation.

Source: Adapted from Jennings and Behrens 2017.

Box 3 | **Informal transport and road safety**

Although not directly pertaining to emissions, the question of safety cannot be ignored in the discussion of informal transport. Low- and middle-income countries suffer severe losses due to collisions. They account for 93 percent of road traffic deaths and are overrepresented in global crash statistics relative to population and degree of motorization (World Health Organization 2018). Pedestrians are at the highest risk of death or injury from road crashes (Figure B3-1), and informal transport systems in which drivers compete for passengers increase the risk of speeding and reckless driving, placing lives at risk. Higher-capacity buses and minibuses are safer for riders and pedestrians than taxis or motorcycles, particularly when the cause of the crash is considered. Based on a study in Accra (Ghana), most collisions (47 percent) were due to speeding, with an observational study revealing the highest proportion of speeding by vehicle type are motorcycles (62 percent), compared to cars (47 percent), minibuses (40 percent), and buses (36 percent) (Accra Metropolitan Assembly 2021). Improving road safety will necessitate requiring driver safety training, supporting larger-capacity transport vehicles, increasing enforcement of speed limits, and implementing safety measures for pedestrians.

Figure B3-1 | **Road deaths in Accra, Ghana, by road user and vehicle type, 2019-20.**

Road deaths in Accra	Caused by						
Victims	Car or pickup truck	Bus or minibus	High-goods vehicle	Motorcycle	Single-vehicle crash	Unknown vehicle	Total
Occupants of cars or pickup trucks	14	1	4	2	7	0	28
Occupants of buses or minibuses	5	1	2	1	3	0	12
Occupants of high-goods vehicles	1	1	2	0	0	0	4
Motorcyclists	10	7	6	1	19	0	43
Bicyclists	0	0	1	0	0	0	1
Pedestrians *(highest risk of injuiries)*	71	33	10	21	0	5	150
Unknown	0	0	0	0	1	0	1
Total	**101**	**43**	**25**	**25**	**30**	**15**	**239**

Represents the highest tallies of each column. Shows that higher-capacity buses and minibuses are safer for riders and pedestrians than cars and motorcyles

Source: Accra Metropolitan Assembly 2021.

Electrification: Minibuses and two- and three-wheelers

Key message

Countries and cities, together with owners/associations, should identify targets and implementation schemes to electrify vehicle fleets while addressing energy supply in parallel with renewability issues.

In Latin America and sub-Saharan Africa, 19 countries mention public transport electrification in their NDCs but not specifically regarding semiformal and informal bus providers, which operate in tandem with larger buses and rapid transit such as BRT or metro and serve more than half of all shared transport trips (Kustar et al. 2022; Thet Hein et al. 2020). Ensuring that financing extends to the electrification of minibuses, motorcycle taxis, and auto-rickshaws can address the economic growth and emissions reduction goals of the transport sector in low- and middle-income countries.

Policymakers can support programs to electrify minibuses, starting with building on the cadre of pilot programs already underway in some regions. In Nigeria, one entrepreneur has had unexpected success converting combustion engine minibuses to electric and solar battery buses (Sanni 2022). Similarly, in Kenya, the e-mobility start-up BasiGo has started locally assembling electric 25- and 36-seater buses sourced from BYD Automotive, the largest manufacturer of electric buses globally (Ambani 2021). BasiGo (2022) recently secured $6.6 million in new funding, enabling the company to begin delivering locally manufactured vehicles and charging stations. Across

sub-Saharan Africa, charging stations are limited, and it is difficult to import vehicle parts, but rising oil prices may soon spur demand for electric buses. In South Africa, where 82 percent of the public transport network is composed of minibus taxi routes, Stellenbosch University, together with various industry experts, planned to launch the first electric minibuses in South Africa by January 2023 to promote electrification of minibuses as part of the national agenda for emissions reduction (Kuhudzai 2022; Ribet 2022).

A variety of policy measures and financial incentives can also be developed to support two- and three-wheeler electrification. India has set a target of having EVs make up 30 percent of vehicle sales by 2030 (Table 4), largely driven by two- and three-wheelers, which are predicted to achieve 80 percent market share among new vehicle registrations. E-auto-rickshaws (e-autos) are more cost-competitive than conventional three-wheelers and are more profitable to drivers, but to overcome the initial cost barrier, organizations like Three Wheels United (2023) are helping drivers finance EV purchases by developing their creditworthiness and offering tailored financing. Various international donors (Global Environment Facility, United Nations Human Settlements Programme, United Nations Industrial Development Organization, French Development Agency, European Union, etc.) leverage financial instruments to support the initiation of pilot projects in cities and nations and to grant loans to encourage fleet upgrades. However, loans from traditional financial institutions are not readily available for the majority of operators.

Other signs show that the many motorcycle taxis in Africa and Asian countries may also be ready for electrification, although their predominance on roads is often a concern for the safety of passengers and pedestrians, with some cities banning motorcycles from high-traffic areas. Nevertheless, in addition to zero tailpipe emissions, electric motorcycles will bring further benefits for drivers, such as smoother rides, almost no engine noise, and easier maintenance (Amend, 2022). UNEP notes that if a global shift to

Table 4 | **Central and state-level targets to accelerate e-autos adoption in India**

NATIONAL LEVEL		
▪ Achieve carbon neutrality by 2070. ▪ Reduce the GHG emissions per unit GDP levels by 33-35% by 2030. ▪ Achieve 30% vehicle sales (including auto-rickshaws) to be electric by 2030. ▪ Launch 500,000 electric three-wheelers (including e-autos) by 2024 under the FAME scheme.		
STATE LEVEL		
Karnataka	2017-22	Transition to 100% e-autos by 2030.
Kerala	2018-23	Procure 85,000 e-autos by 2022 with a pilot fleet of 50,000 by 2020.
Tamil Nadu	2019-24	Convert all auto-rickshaws in six major cities by 2029.
Uttar Pradesh	2019-24	Achieve 100% e-autos in five major cities by 2030.
Punjab	2019-24	Achieve 25% of new auto-rickshaw sales to be electric by 2024.
Delhi	2020-23	Achieve highest number of e-autos on road as compared to other states with 5,000 e-autos to be added every year.
Maharashtra	2021-26	▪ Achieve at least 20% of new three-wheeler registrations to be electric by 2025. ▪ Achieve at least 25% of urban fleets operated by aggregators to transition to EVs by 2025.
Assam	2021-26	Deploy 75,000 electric three-wheelers by 2025.
Goa	2021-26	Achieve 30% of annual registrations to be electric from 2025.
Chandigarh	2022-27	Achieve all new auto-rickshaw registrations to be electric by 2025.

Notes: GHG = greenhouse gas. GDP = gross domestic product. FAME = Faster Adoption and Manufacturing of Electric Vehicles. EV = electric vehicle.

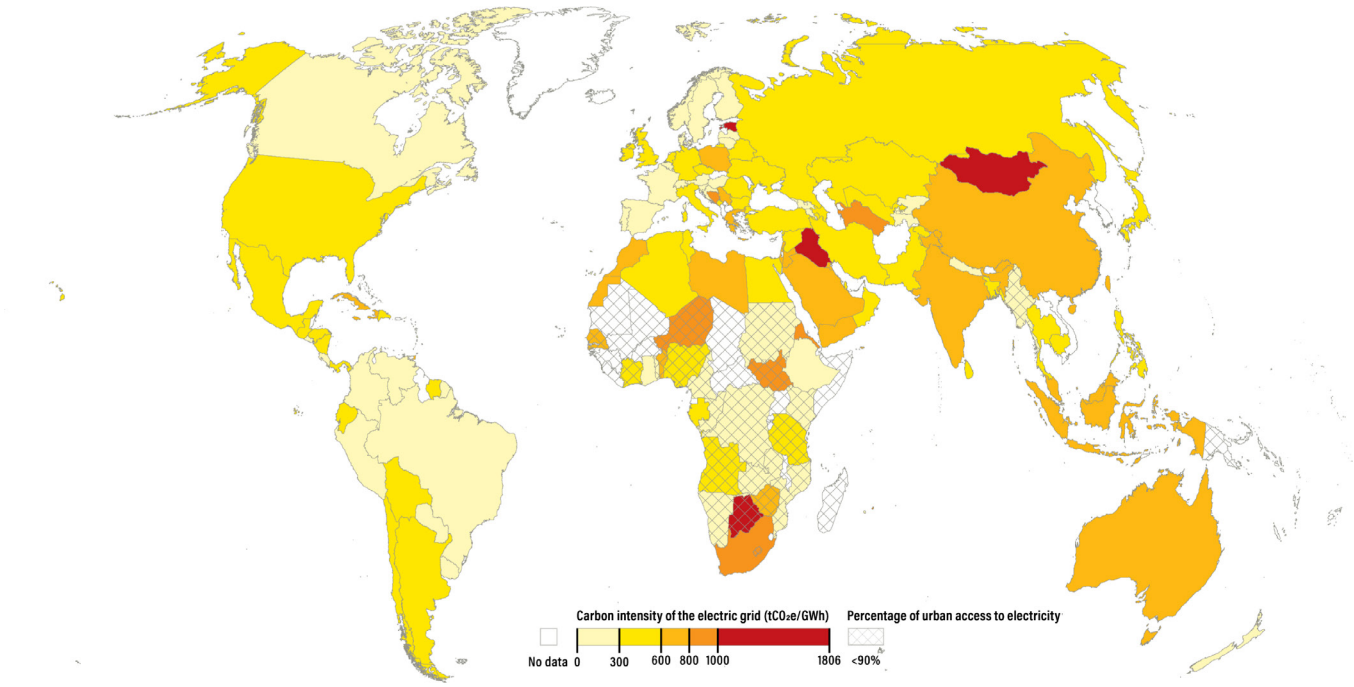
Source: WRI India, based on various state EV policy documents.

90 percent battery electric motorcycles sales by 2030 is achieved, about 11 billion tons of CO2 emissions could be avoided between now and 2050. Programs from UNEP (2018), for example, are already underway in implementing these two-wheeled EVs in Kenya, Uganda, Ethiopia, Thailand, Philippines, and Vietnam.

Policies on electrification of informal transport should also be coupled with energy supply, reliability, and renewability. If public transport networks are to be electrified, the state of the electrical grid must be considered at least from two fronts—the carbon intensity and the reliability of electricity access for urban residents. While an attractive intervention toward a cleaner transport system, electrification is not always synonymous with transport decarbonization, especially in countries like South Africa where it is dirtier to operate electric cars than petrol-based vehicles. Coal-fired power plants supply 90 percent of the country's electricity and cannot supply the additional demand that EVs would bring (Evans 2022). However, the European Union, United Kingdom, and United States have launched the Just Energy Transition Partnership with an initial commitment of $8.5 billion for accelerating the decarbonization of South Africa's economy (Zprava 2021). Until electrical grids are clean, the solution may lie in distributed renewable energy systems, which are faster to build, more reliable, more resilient, and better suited to serving rural communities, compared to traditional, centralized approaches (Global Energy Alliance for People and Planet 2021).

National grids in North and South America, Europe, and much of sub-Saharan Africa are relatively low carbon[1] (Figure 3), with many drawing from hydropower—thus making cities in these regions great candidates for transport electrification. At the same time, in countries where urban access to electricity is lower than 90 percent—a *rough* threshold to indicate that locals have adequate access to electricity—adding EVs to the local demand could create additional stress to the electrical grid, potentially exacerbating the reliability and electricity access issues for the residents (Kennedy et al. 2019). There could be a positive impact if additional electricity demand from charging vehicles is leveraged as a new business opportunity for utilities and independent power producers, as it would strengthen the financial viability of clean energy projects and grid expansion. Organizations like the Global Energy Alliance for People and Planet are working to bring together governments with technology and financing partners to expand sustainable electricity access. When considering EVs, coupling demand for vehicles with renewable microgrid expansion could assist in expanding electricity availability

Figure 3 | **Carbon intensity (2013-15 average) of national electric grid along with urban access to electricity**



Note: tCO2e/GWh = tonnes of carbon dioxide equivalent per gigawatt-hour.
Source: Adapted from Kennedy et al. 2019.

in rural areas (Hartley et al. 2022). It is critical that as EVs become more prevalent and charging stations are built, they are distributed throughout the city with particular attention to equality in access and do not take power away from homes (Ribet 2022).

Depending on the available energy supply as well as the existing transport infrastructure, electrification of (for-hire) two- and three-wheelers might be the appropriate initial step for cities, which should take place alongside holistic road safety strategies (e.g., urban planning and road design, driver training). In countries that have adequate electrical grids and informal services that provide a significant share of public transport rides, surveys and modeling will provide key information on where, when, and how charging stations should be added. System indicators like the number of passengers transported, fare prices, service costs, and overall economic performance are important information for these decisions but are unknown regarding the informal sector. Tracking impacts of the electrification of two- and three-wheelers on operation and supply costs, driver incomes, participation of women drivers, or changes in fare costs will be equally important to informing future policy and development decisions, as well as qualitative indicators such as ease of vehicle registration, challenges with charging, and satisfaction with financial incentives. This adds another layer of difficulty for the adoption of EVs in shared and public fleets.

Looking Ahead and Conclusion

When reflecting on discussions around informal sectors at COP27, there are some positive signs that transport is being placed higher and higher on the agenda. This includes the increased attention to electrification with updated NDCs, the various activities of the United Kingdom and others to carry this forward, and now the LOTUS Initiative that seeks to address key issues in low- and middle-income countries, including informal transport. COP27 was also the first time that wealthy nations agreed to financially compensate vulnerable nations for "loss and damage" funds to recover from climate disasters and provide critical financing for technology and capacity building for sustainable economic growth (UN Framework Convention on Climate Change 2022). While this funding is a good start to climate recovery and future adaptation, more aid will be needed, as well as efficient disbursement and deployment.

Countries in which the informal sector is the predominant share of public transport should acknowledge these emissions in their NDCs. By openly and formally discussing solutions to integrate and improve the informal sector, climate leaders can share ideas and experiences to tailor policies to their unique contexts in a manner that improves mobility access and connectivity while simultaneously reducing emissions from the transport sector. Complete electrification of informal fleets is a daunting challenge and is nearly impossible in the short term, but understanding the nuances of local informal networks can lead to intermediary progress. Collecting data on why some operators are more fuel efficient than others and replicating best practices and small improvements in efficiency will lead to significant results when implemented widely.

Fleet improvements and electrification of informal vehicles remain inaccessible without significant financial support from government subsidies or private funders due to high entry costs. National governments are the most capable of securing funding from international financial institutions for investing in the decarbonization of informal transport, but in order to implement successful changes, they must establish a comprehensive understanding of their informal transport systems. Policymakers should note that informal operators and transport providers are often low-income workers who earn their wages in cash and do not always have legal registration or permits; therefore, government-sourced benefits may

only impact the few who have legal documentation as workers and access to information regarding national or local policies.

From the public authorities' perspective, digital tools offer an opportunity to modernize informal vehicle fleets and thereby improve the overall quality of service. This context also allows new means of collecting data, as well as informing and communicating regulations with informal transport users and providers. From the local stakeholders' perspective, improved digital tools and communication can improve operation and profits by better connecting drivers to passengers, but the formalization of payment may deter drivers who need money immediately or have thus far avoided paying taxes on their incomes.

Reforming and improving the informal transport sector cannot stop at digitization but must also leverage financing, economic incentives, and social engineering to integrate existing stakeholders, including owners and operators, into public transport networks to best serve the community, improve services, and ensure a sustainable transport system.

This note is meant to provide a basic framing to connect climate and informal transport, with selected examples from different countries. The following are key areas we seek to understand as we move forward:

- Identifying methods to enhance and strengthen the ambition of NDCs by addressing emissions from informal transport, collecting robust data on systems for monitoring progress. Further opportunities lie in connecting to SDGs and global initiatives seeking to address the health, safety, and societal and economic inefficiencies of the informal sector.
- Identifying avenues for financing driver training and improving infrastructure, allowing for safe road conditions for vehicles and pedestrians. Further financing will be needed for fleet improvement and electrification, but the vehicle charging must not compete with people's need for reliable, clean-sourced electricity for daily use.
- Understanding the governance and institutional improvements necessary to engage with the informal sector. This includes forming partnerships with informal worker organizations, providing opportunities for formalization and licensing, offering loans and financing options for vehicle repair or purchase, and incentivizing electrification where possible.

Given that many people rely on the informal transport sector as a source of income or as a means of mobility to reach jobs and other opportunities, there is a need to ensure that improvements advance progress on the SDGs with increased economic opportunity, while decoupling economic and societal growth from rising emissions. Much opportunity exists in working in this part of the transport sector.

APPENDIX

Level of urbanization and electric supply charateristics of some countries

COUNTRY (POPULATION IN MILLIONS)	LEVEL OF URBANIZATION (%)	LEVEL OF URBAN ELECTRICITY ACCESS (%)	CARBON DIOXIDE INTENSITY OF ELECTRICITY (tCO_2e/GWh)
Chile (17.2)	89	100	444
Colombia (46.4)	75	100	184
Egypt (78.1)	43	100	460
Ethiopia (87.1)	17	92	1
Honduras (7.6)	52	99	368
India (1,205.6)	30	98	787
Indonesia (240.7)	44	100	713
Jamaica (2.7)	52	95	641
Kenya (40.9)	22	68	187
Mexico (117.9)	78	100	470
Nigeria (159.7)	50	78	414
Philippines (93.4)	49	97	509
South Africa (51.4)	62	94	978
Thailand (66.4)	34	100	525
Venezuela (29.0)	93	100	258
Vietnam (89.0)	30	100	405

Notes: CO_2 = carbon dioxide. tCO_2e/GWh = tonnes of carbon dioxide equivalent per gigawatt-hour.

Source: Kennedy et al. 2019.

ENDNOTE

1. Cities should still strive toward net zero carbon energy supply.

REFERENCES

Accra Metropolitan Assembly. 2021. *Accra Road Safety Annual Report 2019-2020*. Accra: Accra Metropolitan Assembly. https://ama.gov.gh/documents/Accra_Road_Safety_Report_Final_Ready_for_print.pdf.

Ali, Agraw. 2023. "DigitalTransport4Africa (DT4A) Webinar Series: What Kinshasa Tells Us about the Impact of Flooding on Urban Transport and Accessibility." DigitalTransport4Africa, February 15. https://digitaltransport4africa.org/what-kinshasa-tells-us-about-the-impact-of-flooding-on-urban-transport-and-accessibility/.

Ambani, Brian. 2021. "Kenya: Electric Matatus Set to Drive Diesel Version Off the Roads." All Africa, November 9. https://allafrica.com/stories/202111100055.html.

Amend. 2022. "The Wheels of Change: Safe and Sustainable Motorcycles for Sub-Saharan Africa," November 24. https://www.amend.org/2022/11/24/the-wheels-of-change/.

Asimeng, Emmanuel Theodore. 2021. "Bus Rapid Transit Implementation with the Inclusion of Incumbent Paratransit Operators in African Cities: Lessons from Accra." *Urban, Planning and Transport Research* 9 (1): 534–48. https://doi:10.1080/21650020.2021.2000485.

Ayetor, G. K., Innocent Mbonigaba, M. N. Sackey, and P. Y. Andoh. 2021. "Vehicle Regulations in Africa: Impact on Used Vehicle Import and New Vehicle Sales." *Transportation Research Interdisciplinary Perspectives* 10 (June): 100384. https:/doi:10.1016/j.trip.2021.100384.

BasiGo. 2022. "BasiGo Secures $6.6M in New Funding from Leading Autotech Investors," November 15. https://www.basi-go.com/news/basigo-secures-66m-in-new-funding-from-automotive-investors.

Behrens, Roger, Dorothy McCormick, and David Mfinanga. 2015. *Paratransit in African Cities: Operations, Regulation and Reform*. New York: Taylor & Francis. https://books.google.com/books?id=J0WDCgAAQBAJ.

Boateng, Festival Godwin, and Jacqueline M. Klopp. 2022. "Beyond Bans: A Political Economy of Used Vehicle Dependency in Africa." *Journal of Transport and Land Use* 15 (1): 651–670. doi:10.5198/jtlu.2022.2202.

Cervero, Robert. 2001. "Informal Transit: Learning from the Developing World." Access 18 (Spring): 15-22. https://www.shoupdogg.com/wp-content/uploads/sites/7/2016/07/access18-03-informal-transit-learning-from-the-developing-world.pdf.

Cervero, R., and Aaron Golub. 2011. "Informal Public Transport: A Global Perspective." *In Urban Transport in the Developing World: A Handbook of Policy and Practice*, edited by Harry T. Dimitriou and Ralph Gakenheimer, 488 -518. Cheltenham, UK: Edward Elgar.

Chalo. 2022. "Chalo Live Bus Tracking, Buy Bus Tickets Online." https://chalo.com/. Accessed Mar 10, 2023.

COP27 Presidency. 2022. "Low Carbon Transport for Urban Sustainability (L^cO_2TUS)." Knowledge Brief. https://cop27.eg/#/presidency/initiative/lotus.

Daito, Nobuhiko, Dahlia Lotayef, and Arturo Ardila-Gomez. 2021. "Reducing Air Pollution in Greater Cairo Involves Switching from Private Vehicles to Improved Public Transport." *World Bank Blogs*, September 20. https://blogs.worldbank.org/arabvoices/reducing-air-pollution-greater-cairo-involves-switching-private-vehicles-improved-public.

Daud, Muhammad. 2018. "Challenges of Urban Traffic Management: The Need to Suspend Prohibitions on Motorcycles". Paper. New York: Marron Institute. https://marroninstitute.nyu.edu/uploads/content/Daud_Final_paper_012418_Edited.pdf.

Dewey, Onesimo Flores. 2016. "How Mexico City Is Transforming a Jitney System into a World Class Bus Rapid Transit System." Draft paper. Harvard University Graduate School of Design, Transforming Urban Transport – The Role of Political Leadership. https://research.gsd.harvard.edu/tut/files/2020/07/MexicoCityCase2016.pdf.

DT4A (DigitalTransport4Africa). 2022. "Kampala Public Transit Accessibility Footprint." https://worldresources.maps.arcgis.com/apps/webappviewer/index.html?id=cbab16378f0e410f830c2fcc6021d6ae. Accessed February 1, 2023.

Espelia. 2022. *Paratransit in Asia: Scalable Solutions to Reform, Modernise and Integrate*. Villeurbanne, France: CODATU, French Development Agency, and MobiliseYourCity. https://www.mobiliseyourcity.net/sites/default/files/2022-05/%5BMobiliseYourCity%5D-Paratransit%20in%20Asia-Final%20Report.pdf.

Evans, Julia. 2022. "Should Electric Cars Be Used in a Country with an Energy Crisis as Serious as South Africa's?" *Daily Maverick*, November 8. https://www.dailymaverick.co.za/article/2022-11-08-should-electric-cars-be-used-in-a-country-with-an-energy-crisis-as-serious-as-south-africas/.

Fransen, Taryn, Christopher Henderson, Ryan O'Connor, Natalia Alayza, Molly Caldwell, Subrata Chakrabarty, Aarjan Dixit, et al. 2022. The State of Nationally Determined Contributions: 2022. Washington DC: World Resources Institute. https://www.wri.org/research/state-nationally-determined-contributions-2022.

Global Energy Alliance for People and Planet. 2021. "The Global Challenge." https://www.energyalliance.org/the-global-challenge/. Accessed January 20, 2023.

Hartley, Ben, Bernard Obika, Stefanie Sohm, Marvin Stolz, and Philip Turner. 2022. Electromobility and Renewable Electricity: Developing Infrastructure for Synergies. GRA in Action Series. Washington, DC: Sum4All. https://www.sum4all.org/data/files/electromobility_and_renewable_electricity-developing_infrastructure_for_synergies.pdf.

Hidalgo, Dario, Thet Hein Tun, Lynn Scholl, and Claudio Alatorre. 2021. "Modernization and Inclusion? Informal and Semiformal Transport in Latin America." The City Fix, January 19. https://thecityfix.com/blog/modernization-and-inclusion-informal-and-semiformal-transport-in-latin-america/.

International Association of Public Transport. 2021. "Key Insights into Transforming the Informal Transport Sector." Knowledge Brief. Brussels: International Association of Public Transport. https://www.uitp.org/publications/key-insights-into-transforming-the-informal-transport-sector/.

International Energy Agency. 2022. "Energy Intensity of Passenger Transport Modes, 2018—Charts—Data & Statistics," October 26. https://www.iea.org/data-and-statistics/charts/energy-intensity-of-passenger-transport-modes-2018.

Jennings, Gail, and Roger Behrens. 2017. The Case for Investing in Paratransit: Strategies for Regulation and Reform. Gothenburg, Sweden: Volvo Research and Educational Foundations.

Kane, Lisa. 2016. *What Do We Mean by Low Carbon Transport: Understanding How People Move in Cape Town*. Open Streets Briefing Paper. Cape Town: Open Streets Cape Town.

Kedem, Shoshana. 2022. "Maputo's New Public Transport System Takes Shape." African Business, October 5. https://african.business/2022/10/trade-investment/maputos-new-transport-system-drives-social-economic-and-environmental-change/.

Kennedy, Christopher, Iain D. Stewart, and Michael I. Westphal. 2019. "Shifting Currents: Opportunities for Low-Carbon Electric Cities in the Global South." Working Paper. Washington, DC: World Resources Institute. https://www.wri.org/research/shifting-currents-opportunities-low-carbon-electric-cities-global-south.

Klopp, Jacqueline M., and Clemence Cavoli. 2019. "Mapping Minibuses in Maputo and Nairobi: Engaging Paratransit in Transportation Planning in African Cities." *Transport Reviews* 39 (5): 657–76. https://10.1080/01441647.2019.1598513.

Kuhudzai, Remeredzai Joseph. 2022. "First Minibus Electric Taxis Are Coming to South Africa." CleanTechnica, July 6. https://cleantechnica.com/2022/07/06/first-electric-minibus-taxis-coming-to-south-africa/.

Kumar, Ajay, and Christian Diou. 2010. *The Dakar Bus Renewal Scheme: Before and After*. Dakar: SSATP. https://www.ssatp.org/publication/dakar-bus-renewal-scheme-and-after.

Kumar, Ajay, Sam Zimmerman, Fatima Arroyo Arroyo, and SSATP. 2021. *Myths and Realities of Informal Public Transport in Developing Countries: Approaches for Improving the Sector—Discussion Paper*. Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/37083.

Kustar, Anna, Ben Welle, and Thet Hein Tun. 2022. *Sustainable Urban Mobility in the NDCs: The Essential Role of Public Transport*. Working Paper. Washington, DC: World Resources Institute. https://www.wri.org/research/sustainable-urban-mobility-ndcs-essential-role-public-transport.

Lane, Clayton. 2019. "Using Smart Technology to Make Public Transport Visible in Mexico City." Medium, May 16. https://medium.com/@claytonlane/using-smart-technology-to-make-public-transport-visible-in-mexico-city-df2d4943717e.

Madikizela, Bonginkosi. 2020. "100 Minibus Taxis to Assist Fight against COVID-19." Western Cape Government, May 18. https://www.westerncape.gov.za/news/100-minibus-taxis-assist-fight-against-covid-19.

MIT (Massachusetts Institute of Technology) Department of Urban Studies and Planning. 2019. "3Q with Onésimo Flores," August 9. https://dusp.mit.edu/news/3q-onesimo-flores.

Mbandi, Aderiana Mutheu, Jan R. Böhnke, Dietrich Schwela, Harry Vallack, Mike R. Ashmore, and Lisa Emberson. 2019. "Estimating On-Road Vehicle Fuel Economy in Africa: A Case Study Based on an Urban Transport Survey in Nairobi, Kenya." *Energies* 12 (6): 1177. https://doi/10.3390/en12061177.

Odhiambo, Edna, Dan Kipkoech, Abdleraham Hegazy, Mikhail Manuel, Herrie Schalekamp, and Jacqueline M. Klopp. 2021. *The Potential for Minibus Electrification in Three African Cities*. Cairo, Nairobi, and Cape Town: Volvo Research and Educational Foundations. https://transportforcairo.com/wp-content/uploads/2021/09/PotentialforMinibusElectrificationinAfricanCitiesStudyReport.pdf.

Orschulok, Kirsten. 2022. "Transport Data Commons Initiative: We Won 2nd Place!." Changing Transport, October 27. https://changing-transport.org/german-mobility-award/.

Otunola, Biodun, Oliver Harman, and Sebastian Kriticos. 2019. *The BRT and the Danfo: A Case Study of Lagos' Transport Reforms from 1999-2019*. Case Study. Lagos, Nigeria: International Growth Centre. https://www.theigc.org/wp-content/uploads/2019/10/lagos-BRT-case-study.pdf.

Republic of Angola. 2021. Nationally Determined Contribution of Angola. Luanda: Government of Angola. https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20Angola.pdf.

Ribet, Louise. 2022. "The Role of Data in Electrifying Informal Transport." SLOCAT, August 30. https://slocat.net/the-role-of-data-in-electrifying-informal-transport/.

Rix, A.J., C.J. Abraham, and M.J. Booysen. 2022. "Why Taxi Tracking Trumps Tracking Passengers with Apps in Planning for the Electrification of Africa's Paratransit." *iScience* 25 (9): 104943. https://doi/10.1016/j.isci.2022.104943.

Rukikaire, Keisha. 2020. "New UN Report Details Environmental Impacts of Export of Used Vehicles to Developing World." United Nations Environment Programme, October 26. http://www.unep.org/news-and-stories/press-release/new-un-report-details-environmental-impacts-export-used-vehicles.

San Gil León, Andrea. 2022. "Reimagining the Race to Zero in the Global South: Exploring the Role of Informal Transport in Africa's Transition towards Inclusive, Sustainable and Decarbonised Transport." SLOCAT, March 31. https://slocat.net/reimagining-the-race-to-zero-in-the-global-south-blog/.

Sanni, Kazeem. 2022. "Nigerian Entrepreneur Builds Electric Mini-Buses in Clean Energy Push." Reuters, May 16. https://www.reuters.com/world/africa/nigerian-entrepreneur-builds-electric-mini-buses-clean-energy-push-2022-05-16/.

Scholl, Lynn, Alana Fook, Juan David Barahona, Maria Eugenia Rivas, Laureen Montes Calero, Valentina Montoya-Robledo, Laura Maria Pedraza, et al. 2021. *Transport for Inclusive Development: Defining a Path for Latin America and the Caribbean*. New York: Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Transport-for-Inclusive-Development-Defining-a-Path-for-Latin-America-and-the-Caribbean.pdf.

Spooner, Dave, and Jess Whelligan. 2017. *The Power of Informal Transport Workers*. ITF Educational Booklet. Manchester: International Transport Workers' Federation. https://www.itfglobal.org/media/1691170/informal-transport-workers.pdf.

Thakur, Palak, Sugandha Pal, and Jai Kishan Malik. 2018. "Estimating Vehicular Emissions from Auto Rickshaw Plying in Bengaluru." Namma Auto Research Paper. Bengaluru: Energy and Resources Institute. https://www.teriin.org/policy-brief/estimating-vehicular-emissions-auto-rickshaw-plying-bengaluru.

Thet Hein, Tun, Benjamin Welle, Dario Hidalgo, Cristina Albuquerque, Sebastian Castellanos, Ryan Sclar, and David Escalante. 2020. *Informal and Semiformal Services in Latin America: An Overview of Public Transportation Reforms*. New York: Inter-American Development Bank and World Resources Institute. https://publications.iadb.org/en/informal-and-semiformal-services-latin-america-overview-public-transportation-reforms.

Three Wheels United. 2023. "Tech-Enhanced Finance Company." https://www.threewheelsunited.com. Accessed January 20.

Turner, Sarah. 2020. "Informal Motorbike Taxi Drivers and Mobility Injustice on Hanoi's Streets. Negotiating the Curve of a New Narrative." *Journal of Transport Geography* 85 (May): 102728. https://doi/10.1016/j.jtrangeo.2020.102728.

UN (United Nations) Department of Economic and Social Affairs. 2022. "SDG Goal 11." https://sdgs.un.org/goals/goal11. Accessed January 20, 2023.

UNEP (United Nations Environment Programme). 2018. "Electric Two and Three Wheelers." http://www.unep.org/explore-topics/transport/what-we-do/electric-mobility/electric-two-and-three-wheelers. Accessed January 20, 2023.

UNEP (United Nations Environment Programme). 2019. "Workshop—SADC Regional Framework for Harmonisation of Low Sulphur Fuels and Vehicle Emission Standards," June 6–7. http://www.unep.org/events/workshop/sadc-regional-framework-harmonisation-low-sulphur-fuels-and-vehicle-emission.

UNEP (United Nations Environment Programme). 2020a. *Global Trade in Used Vehicles Report*. Nairobi, Kenya: United Nations Environment Programme. http://www.unep.org/resources/report/global-trade-used-vehicles-report.

UNEP (United Nations Environment Programme). 2020b. "Used Vehicles Get a Second Life in Africa—but at What Cost?," October 26. http://www.unep.org/news-and-stories/story/used-vehicles-get-second-life-africa-what-cost.

UNEP (United Nations Environment Programme). 2021. "Electric Motorbikes Launch," March 2. http://www.unep.org/events/unep-event/electric-motorbikes-launch.

UN (United Nations) Framework Convention on Climate Change. 2022. "COP27 Reaches Breakthrough Agreement on New 'Loss and Damage' Fund for Vulnerable Countries," November 20. https://unfccc.int/news/cop27-reaches-breakthrough-agreement-on-new-loss-and-damage-fund-for-vulnerable-countries.

Williams, Sarah, Adam White, Peter Waiganjo, Daniel Orwa, and Jacqueline Klopp. 2015. "The Digital Matatu Project: Using Cell Phones to Create an Open Source Data for Nairobi's Semi-formal Bus System." *Journal of Transport Geography* 49 (December): 39–51. https://doi/10.1016/j.jtrangeo.2015.10.005.

World Bank. 2018. "Egypt: Scrapping and Recycling Old Vehicles to Lower Pollution and Improve Livelihoods," October 25. https://www.worldbank.org/en/news/feature/2018/10/25/egypt-scrapping-and-recycling-old-vehicles-to-lower-pollution-and-improve-livelihoods.

World Health Organization. 2018. *Global Status Report on Road Safety 2018*. Global Report. Geneva: World Health Organization. https://www.who.int/publications-detail-redirect/9789241565684.

Zprava, Tiskova. 2021. "Just Energy Transition Partnership with South Africa." European Commission, November 2. https://ec.europa.eu/commission/presscorner/detail/cs/ip_21_5768.

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