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FACILITATION OF TRANSPORT AND TRADE IN LATIN AMERICA AND THE CARIBBEAN

Autonomous vehicles and alternative energies for logistics in the wake of the pandemic

Background

Recent editions of the *FAL Bulletin* have analysed from different perspectives how COVID-19 has delivered a series of setbacks to supply chains, as well as restricting the facilitation of trade logistics and giving an unprecedented boost

This *FAL Bulletin* continues the Reflections on Disruptive Technologies in Transport that ECLAC has been publishing through this medium. This edition analyses the advantages and challenges of autonomous-vehicle introduction in freight logistics and the opportunity that this represents for reducing polluting emissions associated with transport.

The document also highlights the particular challenges for Latin America, where there are still significant gaps in road and digital infrastructure, in addition to a fleet of cargo vehicles more than 15 years old, which complicates new-technology regulatory and investment challenges.

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United Nations

ECLAC

COVID-19 RESPONSE

to the digitization of processes. Once the health emergency is over and the process of economic recovery from the pandemic begins, the “new normal” is expected to foster a series of changes in consumption and mobility patterns towards more sustainable, inclusive models with fewer negative externalities. This is hugely important, as climate change is the imminent challenge the world will have to face as soon as the pandemic comes to an end. To that end, the Paris Agreement (which entered into force on 4 November 2016) and other multilateral agendas against climate change contain a number of measures that envisage specific efforts in the field of transport, as one of the economic sectors where the greatest contributions stand to be made in the area of climate change mitigation and adaptation.

In this context, new mobility will require not only intensive use of technologies to ensure complete supply-chain control and visibility, such as those analysed in previous editions of this bulletin, but also important advances in the automation of operations that would cut both shipping times and costs, and, above all, the polluting emissions associated with transport, through the use of renewable energies, where electromobility and, in particular, hydrogen stand as the great promises, depending on the availability of technology and its operational and economic viability (IRU, 2020).

In particular, in international logistics the expectation is that, in the face of significantly higher demand, both in terms of volume and lower operating times and costs, new opportunities for growth and optimization will have to be sought in technological developments such as robotization, artificial intelligence, and optimization of logistics operations. The same is anticipated in urban mobility, where electromobility or “mobility as a service” (MaaS) is a trend that COVID-19 has strengthened, generating the conditions for the growth of new shared-use mobility applications, using not only energy innovations but also promoting co-modality and the use of autonomous vehicle prototypes.[1]

It is important to highlight at this point the link between the deployment of autonomous vehicles and the technology shift in terms of the type of energy used, enabling growth in transport demand to decouple from an increase in greenhouse gas emissions. Innovations in engine technologies and the use of renewable energies such as electricity and hydrogen for freight mobility have led to significant gains in terms of the performance and range of such vehicles, with investment costs that, though still high, will drop dramatically once those technologies become widespread. This technology shift, in addition to replacing the use of fossil fuels, also generates new opportunities for growth and quality employment, not only in the manufacture of this equipment, but also its maintenance and transformation to the new standards, which may be crucial during the period of economic recovery and reconstruction of the social fabric after the pandemic.

[1] Mobility as a service is a trend that promotes replacing individual ownership of a vehicle by paying only for the mobility service as needed, for the time used and according to the type of vehicle required, thus saving money for the owner, as well as space in urban settings, through a more efficient, sustainable and intensive use of fleets that often include electromobility options.

The first part of this bulletin analyses the necessary decoupling of growth in transport demand from polluting emissions. The second section introduces the main background to autonomous vehicles, using a classification taxonomy for their main characteristics. The third section discusses a number of international regulations and regulatory agreements on autonomous mobility relating to design issues, safety considerations and coexistence with other vehicles. The fourth section presents the challenges that need to be addressed to enable prompt deployment of autonomous vehicles in the region. The fifth section reviews the main technological advances and existing prototypes in both autonomous vehicles and freight vehicles that use alternative fuels, particularly those related to electromobility and potential use of hydrogen. Finally, the sixth section of the document presents some reflections on technological, organizational and regulatory aspects regarding the mass rollout of this technology.

I. The necessary decoupling of growth in transport demand from the increase in polluting emissions

The transport sector is a key component of economic activity. Given the importance of fossil fuels as an energy source for transport, growth in economic activity inevitably leads not only to a rise in demand for transport but also to an increase in associated polluting emissions. Therefore, it is essential to design and implement a set of multidisciplinary public policies and update sectoral regulations that allow for regulatory, technological and institutional changes to decouple economic growth from the increase in polluting emissions through the use of more energy-efficient means of transport with fewer negative externalities, both social and environmental.

In the case of Latin America and the Caribbean, the transport sector was responsible for 36% of greenhouse gas (GHG) emissions in 2016. Of that figure, 80% was associated with automotive transport, both passenger and freight (Martinez, 2018). The high incidence of the transport sector in regional GHG emissions is partly the result of:

- The age of the freight transport fleet, which averages 15 years, almost double that of OECD countries (Barbero and Guerrero, 2017);
- the lower quality of fuels used in the region, and
- the technological obsolescence of the combustion engines in that equipment.

Along with GHGs, heavy truck transport also has a high incidence in emissions of other pollutants hazardous to human health, such as CO_2, in addition to local pollution by ozone, methane, nitrogen oxides, fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}).

In the wake of the pandemic, international efforts are expected to turn fully to addressing climate change and moving decisively towards sustainable transport as one of the immediate goals of multilateral development agendas. The most common method for ranking measures to address GHG emission reductions is the "Avoid-Shift-Improve" (A-S-I) approach shown in diagram 1.

Diagram 1
A-S-I approach for sustainable mobility

Avoid	Shift	Improve
Avoid use of polluting modes of transport	Shift and combine modes of transport so that the outcome is more economically, socially and environmentally efficient	Improve technology linked to mobility and logistics to make transport services more efficient

Source: Economic Commission for Latin America and the Caribbean (ECLAC).

Such efforts, if implemented in a coordinated manner with specific sectoral investments, innovation and specific incentives, have the potential to become drivers of sustainable economic growth while generating quality employment —what ECLAC has termed the "big push for sustainability", which is especially important in the post-pandemic economic recovery phase.

To shape smart mobility, along with the deployment of these new technological tools and renewable energy sources with fewer polluting emissions, it is critical to generate institutional conditions to foster innovations and economic incentives for their prompt adoption. Autonomous vehicles, in particular, allow for significant progress in the A-S-I approach by making it possible to reduce use of transport services, and making such services more efficient, through sharing arrangements, such as MaaS, as well as a firm commitment to electromobility and hydrogen in these vehicles, as will be seen below. This would not only significantly reduce GHG emissions and dependence on hydrocarbons, but also encourage a shift in vehicle ownership towards more economically, socially and environmentally efficient and sustainable shared mobility models. Autonomous vehicles can also facilitate combination of transport modes as a result of implicit optimization algorithms in their routing systems and promote significant improvements in engine types and user information to make their mobility more efficient.

While recent advances in electromobility and the use of hydrogen fuel cells have generated a great deal of media buzz surrounding the industry, there is still a long way to go before such innovations are in use on roads. An important factor for Latin America is the long distances that trucks have to travel; therefore, as long as supply chain security is not assured along the entire route, electric trucks will continue to fall well short of achieving a significant enough market share to generate substantial changes in the energy matrix. Therefore, in the short and medium term, mature energy technologies should be chosen that have significant potential to reduce emissions and offer a freight infrastructure capacity that allows a smooth and safe operation over time across the entire road network. In the long term, electromobility and hydrogen for freight haulage could give fresh impetus to the reduction of emissions associated with transport.

Listed below are a number of alternative fuels that meet those conditions, although few reduce overall energy consumption.[2]

- Biofuels have the advantage of low vehicle cost and compatibility with the existing fuel distribution infrastructure, in addition to the experience gained by the region in the light vehicle segment, where the use of biofuels is more widespread. Second- and third-generation biofuel production requires more start-up capital, so long-term incentives are essential to finance this type of project. For example, the Argentine Federation of Freight Transport Enterprises (FADEEAC) seeks to reduce carbon dioxide (CO2) emissions by 13 million tons over the next five years by using pure biodiesel as fuel in trucks. This initiative also supports the biodiesel industry, which is going through a difficult time due to a sharp drop in demand both domestically and abroad, as a result of the decline in fossil fuel consumption due to the coronavirus pandemic. Trials began with 22 trucks filled with diesel, half of which were then pilot-tested with biodiesel for six months to show that the engines did not have any problems. At a first stage, the initiative will be aimed at bulk consumption companies that account for annual demand of 1.8 million cubic metres, and in the event that, due to regional factors, trucks cannot be supplied with biofuel, the FADEEAC-designed basket of alternative fuels also includes compressed natural gas (CNG) and liquefied natural gas (LNG) (*Infobae*, 2020).

[2] When analysing energy consumption in transport, the total energy consumption involved in the energy transformations and the vehicles' operational characteristics must be considered (European Union, 2016). For example, the energy consumption of natural gas (NG) engines is higher than that of diesel engines. Compressed natural gas (CNG), compared to diesel, is significantly more efficient in GHG emissions and can be further optimized by blending with biomethane.

- The use of liquefied petroleum gas (LPG) has been rising in recent years, driven by the supply of enabled vehicles and growth in charging infrastructure, which is very similar to that of traditional fuels in terms of equipment and cost. Moreover, the main markets for this type of fuel have developed conversion models for aftermarket vehicles and are constantly producing parts, so that those vehicles can continue to be used, extending their useful life.
- Natural Gas (NG) can be used in its different forms of storage on board the vehicle. CNG tends to be used in urban logistics fleets and for intracity travel because of its limited range; LNG vehicles can travel about 1,000 km without refuelling and, therefore, are used for long distances in intercity circuits. Natural gas has been called a transition fuel, the ultimate goal being hydrogen, as it could share much of its infrastructure with this fuel of the future, delivers lower emissions of greenhouse gases and local pollutants, and its associated technologies and equipment are already mature. A pilot project in Chile began tests in 2020 on a land route from the Quintero LNG Terminal to the National Petroleum Corporation (ENAP) regasification plant in Pemuco, using a virtual pipeline consisting of one Iveco LNG-fuelled tanker truck with a range of up to 1,600 km, more than enough to cover the daily route of 535 km that separate the two plants. The vehicle also has the advantages of being more efficient than diesel counterparts, a 15% GHG reduction, lower noise levels and almost zero particulate matter emissions (*El Mostrador*, 2020).
- Finally, hydrogen is considered one of the key large-scale energy solutions in the long term, especially when stored in fuel cells, which can hold large amounts of energy, allowing long-distance travel without the need for refuelling. The key role of hydrogen in the energy transition could be in combination with other renewable energies. According to estimates by Wood MacKenzie, an industry research firm, by 2025, an additional 3,205 MW of electrolysers used to produce green hydrogen will have been deployed globally —a 1,272% increase (*El Periódico de la Energía*, 2019). This trend is also advancing in Latin America, where Chile, for example, aims to become a supplier of green hydrogen (produced from renewable energies such as solar and wind), which also has the potential to be transformed into other zero-emission fuels such as green methanol and green ammonia. The latter has about twice the energy density by volume of green hydrogen and could be particularly useful for maritime transport, where global infrastructure already exists to store and transport ammonia thanks to its traditional use in the agricultural sector (*La Tercera*, 2020). In the case of high-tonnage trucks, only a few pilots are planned, and prototypes are expected to reach the commercial phase around 2025.

II. An overview of autonomous vehicles

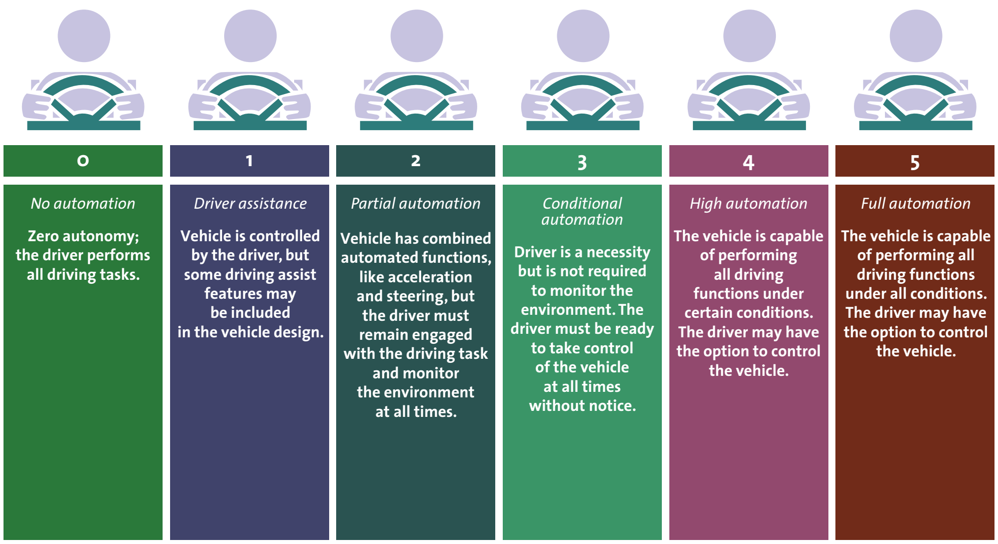
Globally, the transportation industry stands out as a sector with high potential for automation because it is feasible to control virtually all tasks —from the way pallets are assembled and unassembled, to the transportation of cargo within a warehouse or at a loading dock— through algorithms that can not only manage, but also optimize a set of variables associated with transport flows.

From a technical point of view, it is important to distinguish between vehicle automation and vehicles defined as autonomous. Very broadly, an automated vehicle is a self-propelled mobile unit that, by means of specialized hardware and software, can exercise dynamic control of a vehicle or assist its driving for a given time, improving safety, energy efficiency and the travel experience. An autonomous vehicle, by contrast, is one capable of performing all operations necessary for mobility, including control of lateral and longitudinal movements, monitoring its surroundings, reacting to unforeseen events, and piloting itself without human intervention.

Despite the novelty of the technology, the first experiments with autonomous driving began in the 1920s, followed by pilot testing in the 1950s, and reached a watershed moment in 2013, when autonomous driving was formally defined for the first time by the United States National Highway Traffic Safety Administration (NHTSA). Since no two automated driving technologies are exactly alike, in 2014 the Society for Automotive Engineers (SAE) J3016 standard was established, which defined core terms and a taxonomy of six levels of automation so that automakers, suppliers, and legislators could classify a system and use shared language.

Diagram 2

Vehicle automation levels



Source: Economic Commission for Latin America and the Caribbean (ECLAC), on the basis of Society for Automotive Engineers (SAE), 2018.

Under this taxonomy, the threshold between a vehicle equipped with some driving automation features and an autonomous vehicle, as previously defined, lies between levels 3 and 4, when the driver relinquishes responsibility for monitoring the driving environment to the system. See diagram 2.

Automated driving systems and autonomous vehicles must prioritize road safety in their design. In the development of these systems, not only have technical progress in the calculation capabilities of microprocessors and the increasing magnitude of sensors capable of reading, interpreting and predicting driving scenarios been important, so, too, has the incorporation of elements from other social disciplines, making it possible to advance driving algorithms, from an initial set of predetermined responses, to a deeper learning process capable of validating each event, using artificial intelligence that simulates the human brain's cognitive decision-making process.

To ensure the success of technologies of this type, the safe deployment of vehicles on the roads is critical, as is evidence regarding the use of these kinds of autonomous vehicles and their interaction with the environment and other road users, particularly where road safety is concerned, including rapid, adequate response to unexpected events or other road users' errors. Another element of particular concern for authorities is cybersecurity and protecting autonomous vehicle data, in order to prevent their potential use in terrorism or cybercrime.

III. International standards and regulatory agreements for autonomous mobility

The use of increasingly automated vehicles and systems will be the cornerstone of new mobility. Therefore, significant efforts are being made to develop legal and regulatory frameworks, as well as future standards for the widespread use of these technologies. Not only national and regional authorities (such as the European Union, for example) and vehicle manufacturing companies are involved in these regulatory developments, but also innovation centres and universities, with the intention that regulations not only keep pace with technological progress, but also generate incentives for development, encouraging collaboration between companies.

The market emergence of non-traditional technology companies in the transport sector, meanwhile, is not only generating autonomous vehicle prototypes that allow for safer, more efficient and environmentally friendly transport, but is also promoting innovative solutions that break with the traditional concept of freight or passenger vehicles. These coordinated efforts have the capacity to transform entire sectors of the economy and improve the lives of millions of people, enabling a transition from the traditional economy to a knowledge economy, in addition to the obvious benefits that such developments can have on urban mobility, with more efficient, safe and environmentally friendly services, since most of them use renewable energy.

At the global level, the United Nations agreements adopted in 1958, 1997 and 1998 provide the legal framework for both the World Forum for Harmonization of Vehicle Regulations (WP.29) and the Global Forum for Road Traffic Safety (WP.1), and significant progress has been made in the standardization of vehicle safety, the harmonization of traffic rules, road user behaviour, vehicles and infrastructure among others important topics. Recently, within this international framework and under the aegis of the United Nations, resolutions have been adopted to guide the safe deployment of automated vehicles, offering recommendations to ensure safe interaction between automated vehicles, other vehicles and, road users in general. 2018 saw the formation of the Working Party on Automated/Autonomous and Connected Vehicles (GRVA), an entity made up of the major automobile manufacturing countries that are contracting parties to the 1958 and 1998 UN agreements. There, under WP.29, important agreements have been reached on driving assistance systems, such as advanced emergency braking systems; automated lane keeping systems (ALKS); and the adoption of a draft United Nations regulation on cybersecurity and cybersecurity management system. Similar agreements are expected in the future for the protection of automated driving systems (informal working group on functional requirements for automated and autonomous vehicles, or FRAV), cybersecurity (and software updates), and other technological developments (UNECE, 2018a).

Also interesting is Ensemble, a public-private initiative financed by the European Union, in which different truck manufacturers (DAF, Daimler, Iveco, MAN, Scania and Volvo) are seeking to harmonize their systems to enable automated platooning or convoy driving. With this technology a single human driver can lead a convoy of vehicles (usually four), in which only the first vehicle has a driver, and the ones behind it are autonomous and wirelessly connected to each other (at a distance of 10 meters to ensure simultaneous braking and take advantage of slipstreams and their energy-efficiency benefits), following the instructions of the lead truck (PTCarretera, 2018). The Ensemble consortium is led by the Netherlands Organisation for Applied Scientific Research (TNO), seeking to harmonize not only vehicle-to-vehicle communications, but also different driving assistance systems to ensure safe transportation. The tests, scheduled to begin in 2021 and spanning national borders, would evaluate the impact on traffic, infrastructure and logistics of such convoys with multi-brand vehicles.

This initiative meshes with the hydrogen strategy that the European Commission is working on, which seeks to promote the use of this fuel in long-distance commercial road transport. The initiative sets ambitious targets for green hydrogen produced from 100% renewable electricity as part of a more sustainable and circular economic system, supporting the need for a holistic approach to measuring and monitoring CO_2 emissions from energy production, supply and use throughout the entire life cycle. The H2Haul Plan, also funded by the European Union, aims to develop and deploy 16 trucks equipped with zero-emission fuel cells and operated by supermarket suppliers in Belgium, France, Germany and Switzerland to analyse their early use as the sole fuel or in combination with natural gas, which could take advantage of the existing gas distribution network and vehicle refuelling infrastructure (LNG and CNG) for a faster rollout of hydrogen in transport.

Some national efforts to develop a regulatory framework to enable the deployment of these technologies are also worth noting, as is the case of France and its National Strategy for the Development of Autonomous Vehicles. Initiated in May 2018, this process seeks to guide mobility policies both locally and at European level for the generation of vehicle regulations, interoperability of connectivity systems, and support for research and innovation, in order to generate mobility services for people and goods that are safe and aligned with the needs of current users, as well as being an opportunity to grow, invent and progress (Ministry of Ecological Transition, 2020).

The fundamental principles for this Strategy were:

- Promote public-private governance for interlinking decision-making processes in conjunction with industry and centres of innovation.
- Influence European and international regulatory frameworks, either in terms of legislative and regulatory developments, or support for experiments and innovations.
- Combine the challenges of industrial and mobility service innovations by means of pragmatic and socially acceptable business models.

France sees the development of automated vehicles as a twofold opportunity (technological and social) to promote cleaner and more united mobility, while maximizing national assets in key sectors (automotive, transport services, infrastructure, digitization) of global innovation. To date, the National Autonomous Vehicle Experimentation Program, EVRA (Expérimentation du Véhicule routier Autonome), has carried out 2 projects and 16 experiments in 3 years, with an investment of 120 million euros, including 42 million euros in grants. Thanks to this Strategy, as well as the law regulating autonomous-vehicle mobility since December 2019, France is also one of the first European countries to have a legislative and regulatory framework allowing the circulation of such vehicles.

Regarding the use of alternative fuels for transport, developments have also been significant in the United States, which, like the European Union, has partnered with industry to develop and implement pilots and strategic refuelling points for alternative fuels on main road arteries. The projects have been made possible by public-private coordination between the main industry associations, transport operators, fuel distributors, research centres and governmental entities.

Testing on real transport corridors enables measurement of the real performance of different types of fuels and prepares the infrastructure to facilitate adoption by transport operators. For example, LNG required built refuelling stations and transport operators gradually began to prefer it to traditional diesel. In 2014, LNG was already used in many vehicles made by big automakers (such as Scania, Mercedes-Benz, Volvo, Freightliner, Mack and Iveco).

IV. Challenges for autonomous-vehicle deployment in Latin America and the Caribbean

The rollout of autonomous vehicles does not necessarily mean job reductions, but rather a new means of solving the shortage of professional drivers affecting the sector. Large companies are watching developments such as these closely, both because of the impact of driver costs on operating outlays, as well as to optimize their operations by freeing them from mandatory labour restrictions such as rest hours, medical leave, permits, special conditions for COVID-19 and other problems that bear on the industry related to work stoppages, fines and internal theft.

In the case of Latin America and the Caribbean, given market conditions, the existing infrastructure gap and the lack of constant and uninterrupted digital connectivity along the entire road network, it is very likely that the deployment of autonomous vehicles will be delayed or only possible in some segments of the logistics chain that are able to afford the technology. Coupled with that, besides operating vehicles, drivers perform a series of other functions, such as those related to document management or representation before the authorities, areas where vehicle automation cannot enter until the rest of the commercial logistics ecosystem is properly digitized and systematized.

It seems likely, therefore, that the first deployments will be in port facilities and closed logistics warehouses, where, as demonstrated by some pilots already carried out in the region, it is possible not only to transform tractor-trailers used inside enclosures for moving containers to run on electricity, but even for some of them to be autonomous.

In the medium term, a more widespread adoption of automated vehicles on public roads is probable —particularly in last-mile logistics operations— before a move towards fully autonomous mobility, though this will first require resolving innumerable regulatory definitions necessary for their safe operation, as well as addressing aspects of road infrastructure and enabling technological infrastructure.

Given the heterogeneity that exists, it is very likely that in the case of Latin America, highly computerized and even autonomous vehicles will coexist in the same road space as others that use technology dating from the beginning of the last century, which will pose enormous regulatory and normative hurdles for authorities in order to ensure a safe and expeditious traffic flow for all road users.

The above tallies with the results of an Inter-American Development Bank (IDB) Delphi survey in 2020 on possible impacts of the introduction of autonomous and connected vehicles (ACVs) on mobility in cities in Latin America and the Caribbean.[3] In the survey, 13 experts from 14 countries in the region,[4] including government officials, industry representatives and academia, considered that, on a scale of 1 to 7, with 1 being unimportant and 7 extremely important, the main factor that would influence the decision to purchase an ACV, apart from price (average score of 6) and system efficiency (5.8), was the real and perceived safety of the system (5.7). They even rated this factor ahead of variables such as maintenance cost, available road and technology infrastructure, incentives, design and vehicle performance (IDB, 2020).

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3 For the purposes of that study, those findings refer to vehicles with level 4 (high) or 5 (full) automation, i.e., those that can be driven without human intervention, at least in specific environments.

4 Argentina (2): Buenos Aires and Rosario; Bolivia (Plurinational State of) (1): Santa Cruz de la Sierra; Brazil (10): Belo Horizonte, Brasilia, Curitiba, Florianopolis, Manaus, Porto Alegre, Recife, Rio de Janeiro, Salvador de Bahia and Sao Paulo; Chile (1): Santiago; Colombia (4): Barranquilla, Bogotá, Cali and Medellín; Costa Rica (1): San José; Ecuador (1): Quito; Mexico (3): Mexico City, Guadalajara and León; Panama (1): Panama City; Peru (1): Lima; Uruguay (1): Montevideo; Venezuela (Bolivarian Republic of) (1): Caracas.

In the region, truck manufacturers in Brazil are leading the process of producing more sustainable vehicles, either with electric models, or vehicles powered by natural gas or biomethane. One of the Brazilian manufacturers, Volkswagen Caminhões e Ônibus (VWCO), started assembly line production of the first 100 e-delivery electric trucks for the company AMbev and its distributors, which plan to purchase 1,600 trucks by 2023. These vehicles will initially be used for deliveries in São Paulo and Rio de Janeiro, where proprietary solar power plants are being installed to recharge their batteries, which offer a range of 200 km on a full charge. The cost of the vehicles remains undisclosed; however, given the cost of the battery (imported), it should be between 2 and 2.8 times higher than the diesel version. (NTC y Logística, 2020).

In the case of urban mobility, autonomous buses would have the following additional characteristics that make them an especially interesting proposition for Latin American cities owing to advantages in terms of safety, comfort, predictability of travel times and reduction of waiting times due to greater interval regularity (Tirachini, 2020):

- Fitting of sensors along the entire length of the bus helps to prevent collisions and accidents.
- Bus precision docking: computerized support to ensure a small and constant separation between vehicle and platform at stops.
- Speed control: regularity of travel times and intervals between vehicles.
- Vehicle-to-vehicle (V2V) and infrastructure-to-vehicle (I2V) communication, from traffic lights for example, helps to promote the prioritization of public transport over private cars.
- Ecodriving: 5%–10% energy-cost savings, depending on the type of engine and fuel used.

V. Advances in automated vehicles for freight logistics

The versatility of ground transportation makes it the most efficient way to deliver goods within cities, between regions and even internationally. Technological advances for light-duty vehicles include all alternative and low-emission fuels available on the international market, but closer inspection of the heavy-duty vehicle segment shows offerings decrease abruptly, with energy replacement possibilities limited to small fleets that have ventured into biofuels, natural gas or LPG, as well as some electric prototypes that have the still-pending issue of battery range.

In the case of mobility for people and last-mile logistics, leading vehicle makes already have their own lines of electric cars, many of which are already on the streets of Latin America and the rest of the world. The most advanced prototypes, which are also autonomous, have been developed by technology companies primarily in the United States state of California, which must comply with a number of local regulations, such as the Federal Motor Vehicle Safety Standards (FMVSS), to operate a vehicle on United States soil. Those standards require vehicles to comply with a number of specific minimum features such as steering wheels, rear-view mirrors and transparent windshields when used for passenger transport, in addition to other design and road safety requirements.

Zoox, an Amazon company, unveiled an autonomous electric taxi for transporting people that also allows the possibility of ridesharing on demand. Its sensor-laden design is capable of bi-directional driving, with four-wheel independence to allow it to manoeuvre in tight spaces and change direction without the need to reverse. Inside, it has a four-seat symmetrical (face-to-face) seating configuration, similar to what a train passenger might encounter, and it is equipped with a 133-kilowatt-hour battery that allows it to run for up to 16 hours continuously on a single charge. The vehicle has cameras and radar that give it a 270-degree field of view at all four corners to constantly track objects beside and behind it, including pedestrians, cyclists, and other road users (Tech Crunch, 2020). This model has already been submitted to federal motor vehicle safety regulators and passed crash and safety test standards, but it has not yet received FMVSS approval to operate in the United States.

At the moment, the Nuro R2, a low-speed electric vehicle designed for delivery services, is the only autonomous vehicle to receive temporary authorization from FMVSS to operate legally without a driver in the United States. Its authorization was possible because, as an autonomous delivery vehicle, it does not require a steering wheel or cabin for a human to drive it, it only has to comply with protocols and delivery of reports on the operation of the system and appropriately notify the communities where it will circulate next. In terms of design, the vehicle has only one compartment with folding doors to access the interior, where different compartments are located for parcels and food for delivery, which can be removed only at the destination address.

Among other companies, Google is also working on this idea through its autonomous car subsidiary Waymo, which reportedly has a version equipped with lockers to make secure deliveries directly to customers. There is also a wave of tech start-ups that are focusing on autonomous last-mile delivery, using small robots or drones.

While the main problem for electromobility is limited range due to the use of batteries, the price of batteries has come down by more than 70% since 2010 (Bloomberg, 2018), making electric vehicles increasingly affordable, while competition among manufacturers is increasing the number of offerings, especially for the short-trip segment and urban operations, such as buses and waste disposal trucks, though not yet for long distances, due to the weight of the batteries.

Globally, Tesla, for example, advertises a total range of up to 800 km for its Semi model, in addition to other models that can be driven in autonomous convoys. Mercedes-Benz with its eActros model, proposes an alternative for lighter loads and a range of up to 500 km; it is said to be close to entering the market. Nikola TRE is the result of collaboration between IVECO, FPT Industrial and Nikola Corporation, which have developed a battery electric truck based on the IVECO S-WAY heavy truck, a 4x2 prototype that promises a range of 400 km and is powered by a 480 kW (644 hp) engine that delivers a maximum torque of 1,800 Nm; however, it is expected also to be available in 6x4 or 6x2 drive configurations and power outputs of between 500 and 1,000 hp, with ranges of between 500 and 1,200 km thanks to its electric power supply from a modular battery system with a maximum total capacity of 720 kWh (Fuel Cell Trucks, 2020).

While large automotive and battery manufacturers continue to look for solutions to develop electric vehicles with greater range, other energy sources have proven a valuable ally to reduce polluting emissions in the short term for the long-distance transport sector, through cheap alternative fuels, such as natural gas (ideally obtained from renewable sources) and cleaner biofuels that can be used in current diesel engines without any major problems, as well as the fuel combinations on which hybrid vehicles run.

The companies Hyliion and Dana have teamed up to demonstrate the operation of a hybrid diesel propulsion system that aims to create a transitional solution between battery electric vehicles and fuel cell electric vehicles to accelerate towards green commercial transportation. In addition to its hybrid system, the company also manufactures the Hyliion Hypertruck ERX, which uses renewable natural gas to generate enough electricity to power the platform (Transport Drive, 2020).

Quantron Energon is another Iveco prototype that converts an Iveco Strator 4x2 diesel into an electric truck with 700 km of range thanks to its fuel cell and hydrogen tanks. Its 10.3-litre 416 hp diesel engine has been replaced with a fuel cell system that has a power output of 130 kW and drives a 340 kW (456 hp) electric motor, allowing it to carry up to 44 tons. Where initial price is a barrier to buyers, Quantron will offer the Energon as a transportation service, with the contract including the use of the truck, a driver, and hydrogen supply (Híbridos y Eléctricos, 2020).

Hyundai has unveiled its Class 8 prototype, HDC-6 NEPTUNE, which is powered by hydrogen fuel cell, and it aims to manufacture 500,000 hydrogen vehicles annually by 2030. This zero-emission alternative system also provides a comfortable cabin that equipped with home comforts when the driver needs to sleep, eat or rest; the possibility of autonomous driving; projected screens on the windshield for full connectivity, navigation instructions, and a camera monitoring system with eye-tracking technology.

Mercedes Benz also has a preliminary development with liquid hydrogen, called GenH2, which promises up to 1,000 km of range owing to the use of hydrogen in liquid rather than gaseous form because it has higher energy density, allowing for smaller and lighter fuel cells, as well as freeing up more space and cargo weight capacity. Customer trials are planned for 2023, and assembly line production for the second half of this decade. The GenH2 will be fitted with twin stainless-steel tanks with a total capacity of 80 kg (40 kg each) and equipped with two electric motors that separately deliver 230 kW of continuous power (with peaks of up to 330 kW) and a maximum torque of 2,071 Nm; based on the Mercedes-Benz Actros, it will have a gross weight of 40 tons and a payload capacity of 25 tons (Passion Engine, 2020).Finally, as this has bulletin has noted, long-distance freight haulage has operational requirements that exceed the current offerings of electric vehicles, so the arrival of hydrogen-powered trucks is eagerly awaited for incorporation into fleets, price permitting. However, as this edition went to press, all the prototypes on the market were in the final stages of experimental testing and there were still no models at the commercial phase.

VI. Recommendations

Automated goods transport could generate significant efficiency gains, among other things, by reducing the activity's negative social and environmental externalities. This is particularly important for a recovery from the crisis caused by the COVID-19 pandemic that is transformative, sustainable and in line with the commitments to reduce polluting emissions associated with transport.

However, autonomous mobility also brings with it new challenges, not only in the field of engineering, but also in areas related to safety standards, traffic rules, insurance, cybersecurity and data protection, to name but a few, which will also have to be addressed before the mass introduction of such vehicles on the market.

In the case of Latin America, before these vehicles are rolled out, it is essential to deal with the existing physical and technological infrastructure gap, as well as the regulatory and organizational asymmetries between large and small transport companies. In the meantime, running pilot projects in controlled environments would allow important information to be collected on the use of this technology, the need to adapt existing road infrastructures and improvements that would enable their coexistence with conventional vehicles. Moving forward with the use of these vehicles entails adapting to the technological advances and changes that such a reform implies, which includes addressing the road infrastructure deficit as one of the chief obstacles. It is therefore advisable to start with those domestic fleets —municipal, state, police and others— that have a power supply at a single facility. Ports are an example of that; they have been gradually electrifying and using alternative fuels for equipment that performs intensive work over short distances. Battery electric vehicles are clearly a good solution for short distances and urban environments, and possibly for medium distances (500 km) in the future, but even that remains questionable owing to their very limited energy storage capacity.

Given the characteristics of the structure of foreign trade, even if it is possible to use autonomous trucks on some sections of road, the need for a manual driving mode is inevitable, especially for the first mile, in order to connect dairy, grain, agriculture, livestock and other raw material-producing hubs situated in rural areas that lag behind large urban centres in terms of both physical and digital infrastructure. As a result, methods such as the automated platooning, which allows a combination of systems, could be a solution more in tune with the regional reality, while also contributing to a reduction in fuel consumption.

It should also be noted that Latin America and the Caribbean is a highly urbanized region, where 81% of people live in cities, making it the second most urbanized region in the world (after North America), and the most urbanized in the developing world (United Nations, 2018). For these reasons, integrated, multisectoral policies to contain urban sprawl and promote much more sustainable cities are essential. Autonomous vehicles, electromobility and mobility as a service, will not solve the problems of congestion and territorial segregation on their own, and could even aggravate them by leading to more motorized travel.

In order to close development, environmental, territorial and social gaps, ECLAC has called on the countries of the region to move towards progressive structural change on the basis of an environmental big push through coordinated sectoral policy measures in combination with investment, regulation and tax schemes. This big push should, in turn, align the paths of different stakeholders, sectors and investments, in order to enable innovations and synergies involving supplies, skills, equipment, services, distribution, networks, demand and patterns. In the particular context of urban mobility, actions should focus on promoting safe, affordable, quality public transport.

Automating transport and promoting renewable energy use are not ends in themselves, but part of the necessary response —in terms of strategy and coordinated instruments— for building sustainable mobility in line with the 2030 Agenda and the Paris Agreement.

Therefore, as highlighted by ECLAC, mobility and logistics policies should be more integrated and managed through a systemic approach. To increase efficiency and reduce costs within the system, not only will a wider range of technologies and fuels be needed, but also new planning tools, supportive regulatory frameworks and greater political dialogue at both the national and regional levels. Developing countries can benefit from regional integration in terms of capacity-building, adoption of regional best practices and institutional and regulatory solutions that would allow them to generate a market size that would make such efforts viable (Kreuzer and Wilmsmeier, 2014).

Although the experiences documented here are limited to proofs of concept, prototypes or implementations, there has been a notable coordination effort both among companies, and between them and the public sector to adapt regulations and generate standards to enable their prompt rollout on the roads. As international experiences show, it is essential for Latin America to encourage public-private coordination in these developments, as well as the active participation of trade associations, transport operators, fuel distributors, research centres and government entities to analyse and report on these issues.

New technologies will require large investments, which can be a constraint in the case of small and medium-sized enterprises. It will be necessary, therefore, to design a strategy that promotes financial incentives and the prioritization of funds and incentives for research and development of new technologies, so that companies can plan investments in more energy-efficient fleets and thus support not only their recovery from the COVID-19 pandemic, but also facilitate the technological and energy transition in a way that is operationally and economically viable. It is essential to train workers in the sector, first so that they can fully grasp and understand this new logistics scenario, and then to provide them with the necessary skills to participate actively in the digital economy. This involves not only resolving issues of access, cost and speed of broadband, but also providing digital and cybersecurity knowledge that allows them to fully leverage the potential of the digital transformation of the logistics sector.

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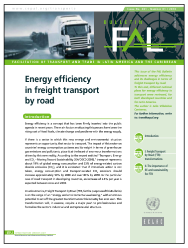
VIII. Publications of interest


Energy efficiency in freight transport by road

FAL Bulletin Nº 281

Energy efficiency in freight transport by road

Julio Villalobos

This issue of the *FAL Bulletin* addresses energy efficiency and its challenges in terms of freight transport by road. To this end, different national plans for energy efficiency in transport were reviewed, for both developed countries and for Latin America.

Available in: Spanish English


Technology and alternative energy use in motor vehicle transport in Latin America and the Caribbean

FAL Bulletin Nº 368

Technology and alternative energy use in motor vehicle transport in Latin America and the Caribbean

Rolando Campos Canales
Gabriel Pérez

This document provides background on energy consumption in the road transport sector, and on the advantages and disadvantages of new propulsion technologies in this field.

Available in: Spanish English