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PILOT EMISSIONS COMPARISON BETWEEN NATURAL GAS TRUCKS FROM THE COMPANY HDL LOGISTICA AND DIESEL TRUCKS FROM THE COMPANY BOTERO SOTO.

CASE STUDY

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Introduction

The GiroZero project, led by the Los Andes University and Cardiff University and funded by UKPACT¹, aims to promote the adoption of low-emission technologies and best environmental practices by proposing strategies to improve fleet configuration, management and logistics, and the use of renewable fuels in the motor freight transport (TAC by its acronym in Spanish) (Giro Zero, 2022). Pilots have been developed with the aim of collecting real field information and calculating intensive indicators to make comparisons between technologies, companies and types of supply chains.

This pilot arises from the interest of the company HDL Logistica S.A.S. (HDL) in estimating the emissions generated by the new natural gas truck, as the company expects to acquire more vehicles with this technology.

¹ UK PACT (Partnering for Accelerated Climate Transitions) is a unique capacity-building program. Jointly governed and funded by the UK Government's Foreign and Commonwealth and Development Office (FCDO) and the Department for Business, Energy and Industrial Strategy (BEIS) through UK International Climate Finance.



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Pilot project participants

HDL is a Colombian Road Freight Transportation company with local, regional and national coverage, which began its operations in 2009 headed by its founder: José Hernan Bulla Luque, who had previously performed transportation services as a natural person with BIMBO DE COLOMBIA. Its focus is to provide logistics solutions to industrial customers, in a constant search for value generation to transport goods by road from urban to short or long-haul services.

In its customer service policy, HDL is committed to providing a timely and reliable freight transportation service, complying with the regulatory framework at a competitive price. Since its inception, HDL has been an allied company for Bimbo Colombia's transportation operations, guaranteeing operational efficiency, new technologies, and corporate values that promote the integrity of the relationship between HDL and BIMBO DE COLOMBIA.

GRUPO BIMBO has an ambitious global strategy to be a zero-carbon company by 2050. HDL, as an allied company, has been a pioneer in materializing this strategy on two fronts: operational efficiencies and the implementation of clean technologies in the operation. As a result of sharing these sustainability principles, both organizations work together with a high strategic commitment.

As a result of this corporate alliance, HDL has led initiatives such as the calculation of its carbon footprint, the technological change of its vehicles, and training in eco-driving for all its drivers, generating a positive social impact by contributing to the reduction of greenhouse gases from its activities.

Regarding the implementation of clean technologies, HDL began a thorough comparison of brands in Colombia to migrate to vehicles with combustion technologies other than the traditional Diesel, which allowed it to make decisions about the migration of the vehicle fleet and acquire a Natural Gas tractor-trailer offered by SCANIA COLOMBIA, which will reduce the environmental impact of current operations, cost efficiency and greater profitability for the company.

In relation to the operational efficiencies implemented, HDL has the strategic vision to optimize the maximum capacity of the vehicles with case studies taking as a baseline the data that is taken by the GPS of the fleet and the historical dynamics of orders, based on a continuous improvement of the planning and routing. Feeding the holistic view of HDL's operational management, the commitment to strengthen human capital has allowed the implementation of a vision of continuous improvement in technical skills such as defensive driving of all its drivers, with two training objectives: Road Safety and Eco-driving, an innovative and inclusive strategy.

Pilot design: Migration to New Technologies

The availability of Natural Gas Vehicle refueling stations was one of the main challenges in the migration to tractor-trailers powered by this type of fuel. This process has been a constant learning exercise, and the entire HDL team has been willing to overcome these obstacles. To achieve this, the collaborative work carried out with VANTI, SCANIA COLOMBIA, and the Logistics and Transportation area of BIMBO DE COLOMBIA has been decisive in the transition to a cleaner energy matrix in HDL's operations.

In order to make a comparison of the emissions and performance of the Natural Gas truck, it was proposed to perform the calculations with a diesel vehicle of the same characteristics covering the same route. However, HDL does not have diesel trucks that would cover the same route and transport the same products, so we proceeded to talk to BIMBO DE COLOMBIA, the exclusive customer of HDL's Natural Gas vehicle. BIMBO DE COLOMBIA has different companies that provide services on the same route, in the same period in which the pilot was made, the company Botero Soto was providing services on the same route with diesel trucks, after an introductory meeting in which the objective of the pilot was presented, they agreed to share the information in detail for the routes made in the same period.

Botero Soto has different vehicles covering the same route, so it shared information on eight vehicles with similar characteristics.

The characteristics of the vehicles used in the pilot are detailed below.

Table 1. Specifications of the vehicles used in the pilot

Vehicle Specifications	Natural Gas Truck	Diesel Truck ²
Brand	SCANIA – G340 MINI TRUCK	International
Fuel (Diesel, Gas, other)	GNV	Diesel
Model (Year)	2021	2022
Power (horsepower)	340	336
Number of Axles (Header; Trailer)	2 ; 2	2 ; 2
Manufacture (Year)	2021	2021
Emission Technology	Euro VI	Euro V
Empty weight (kg)	15.300	14.000
Carrying capacity (kg)	16.700	18.000
Gross vehicle weight (kg)	32.000	32.000

Source: GiroZero project with information from HDL and Botero Soto.

Figure 1. Trucks used in the pilot



Source: GiroZero project with information from HDL and Botero Soto.

Operation of vehicles with different technologies

Natural gas articulated truck: SCANIA brand, model G340, is a 100% Natural Gas vehicle driven by Jesús David Guzmán, who states that it is comfortable and safe to drive, especially because being a new, automated and computerized vehicle, the comfort and functionality are much better than traditional vehicles.

This vehicle mainly covers the Bogotá - Medellín route, and transports finished bakery products of the Bimbo brand. On this route, it must make a detour to refuel with Natural Gas, in a place known as the Koran, in the municipality of La Dorada, Caldas, which is approximately eight (8) km and twenty (20) minutes in normal conditions, and the time to fill the tank is twenty (20) minutes, so the total delay on the route is at least one (1) hour.

Compared to a traditional truck, this vehicle is automated, less polluting, complies with EURO VI standards without the need to use urea, is quieter, more comfortable, more efficient, safer in braking, and has a complete and functional computer system in the cab. It should be also noted that the acceleration from 0 does not respond in the same way as a traditional diesel combustion vehicle.

² Most representative truck, of several that participated in the pilot.



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Regarding the energy efficiency of the truck, in mountainous terrain uphill and downhill the truck is efficient, in these terrains the vehicle is operated in manual mode, for flat terrain the automatic mode is used. It has an efficient and safe disc brake system with ABS control, showing a greater reaction time directly proportional to the amount of freight transported. There is no variation in the performance of the braking system. The vehicle's computerized system identifies changes in temperature and exhaust gases.

Thanks to the safe and efficient driving training received by the driver, who emphasizes the importance of driving experience and how drivers must be at the forefront of the use of new technologies in order to drive safely, efficiently, and economically or cost-effectively. In addition, the driver emphasizes that it is important to have constant gear to avoid using the brakes and consume gas efficiently.

Diesel articulated truck: The Botero Soto company uses different trucks on the same route, since they do not have exclusive vehicles for Bimbo distribution, as is the case with the Natural Gas truck. For the information required in the pilot project, we received data from 8 different trucks, all with the same carrying capacity, however, they differ in models and emission technologies.

Pilot test operation

HDL participates in the research of the case studies for sustainable mobility in the TAC of the Giro Zero project, where information is collected from the operation of two trucks: one with natural gas and the other with diesel under business operating conditions. In the pilot project, information is taken from a pre-established period of time, in order to compare both technologies.

However, two considerations must be considered when comparing the results: the first is that the selected vehicles are not comparable models, since the emission technology of natural gas is the EURO VI model 2021 and diesel technologies are several, among them the most representative was EURO V model 2022. Then, it should be considered that these results do not compare the new natural gas fleet against the new diesel fleet, but compare the new natural gas fleet with the old diesel fleet. The second consideration is due to the fact that in the pilots, unlike the technological validations, situations are not considered exactly the same. In this pilot, there was a difference in the product transported and the route, which resulted in a different average weight for natural gas of 21.7 tons/trip compared to 9.5 tons/trip for diesel. This limitation is overcome with the comparison of intensive indicators so that they can become comparable to some extent and/or be referential.

Table 2. Pilot Operation

Description of the pilot's work	Natural Gas	Diesel
Trips made	14	26
Total distance traveled (km)	11.563	10.973
Average distance / trip (km)	826	422
Average weight / trip (kg)	21.680	9.550

Source: GiroZero Project

Pilot results

The main indicator to be compared is the intensity of emissions per ton kilometer, which is recommended to compare different technologies, vehicles, products, logistics supply chains and thus be able to make an adequate benchmarking (Smart Freight Center, 2019). Likewise, the measurement methodology considers emissions under what is called "Well to Wheel" (WTW), which considers both emissions related to energy production, from natural gas or diesel "Well to Tank" (WTT) and emissions related to energy consumption "Tank to Wheel" (TTW). To calculate the emissions related to natural gas, the factor of 1.952 kg CO₂eq/m³ST taken from Decree 926, 2017 (Ministry of Environment, 2017) was used.

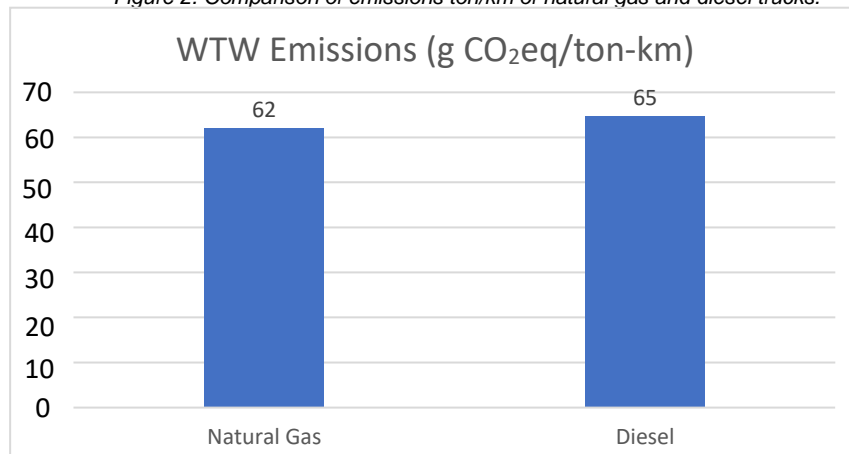
Table 3. Results of the pilot

Results Well to Wheel (WTW) & Tank to Wheel (TTW)	Natural Gas	Diesel	Diesel vs Natural Gas Difference (times)	Diesel vs Natural Gas Difference (%)
WTW Emissions (g CO ₂ eq/tons-km)	62	65	1,0	4%
WTW emissions (g CO ₂ eq/km)	1343	1409	1,0	5%
TTW emissions (g CO ₂ eq/tons-km)	39	162	4,1	314%
TTW emissions (g CO ₂ eq/km)	844	1102	1,3	31%
Energy cost (\$/km)	819	971	1,2	19%
Emission rate (g CO ₂ eq/\$COP) WTW - energy cost only -	1,64	1,46	0,9	-11%

Source: Giro Zero Project

When comparing both operations within this supply chain (in which the average weight varies from 21,680 kg/trip to 9,550 kg/trip), there is a 4% difference in the emissions of diesel vehicles, with EURO V technology, with a value of 65 g CO₂eq/tons-km compared to the operation in the natural gas vehicle with a value of 62 g CO₂eq/tons-km. As can be seen in Figure 2.³

Figure 2. Comparison of emissions ton/km of natural gas and diesel trucks.⁴



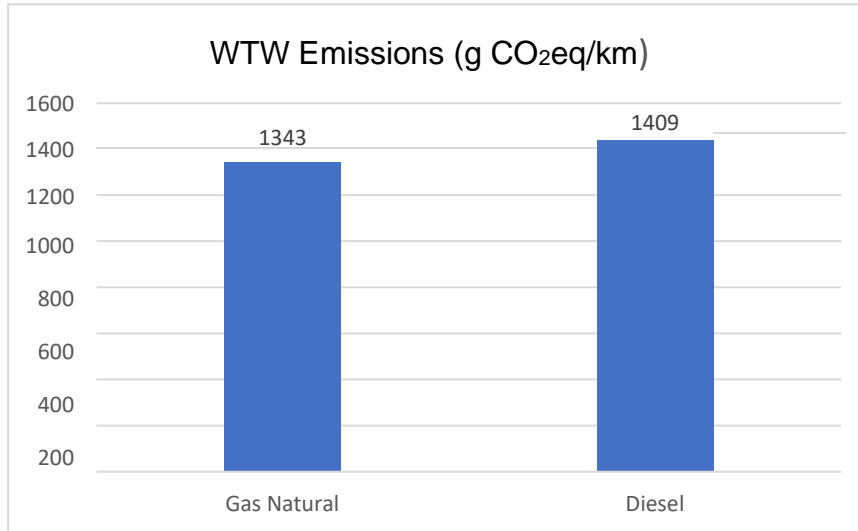
Source: Giro Zero Project

Since there was a large difference in the average weight transported between the two technologies as shown in Table 2 (where the average weight varies from 21,680 kg/trip to 9,550 kg/trip), a better indicator for vehicle selection would be the emissions per kilometer traveled in the hypothetical case that both vehicles had the same carrying capacity. For the pilot, it is observed that the emissions for the natural gas truck are 1,343 g CO₂eq/km, while the diesel truck is 1,409 g CO₂eq/km, reaching 5% for diesel compared to natural gas as shown in Figure 3.

³ Please note that as a result these two results are not comparable due to the design of the pilot, but they can be referential to the weight segment transported, which varies according to each supply chain depending on the type of product transported.

⁴ Due to the fact that the pilot had non-comparable results due to weight difference for the same technology, in the case of the intensive indicator of emissions per ton kilometers, it was assumed that both trucks transported the same load in tons.

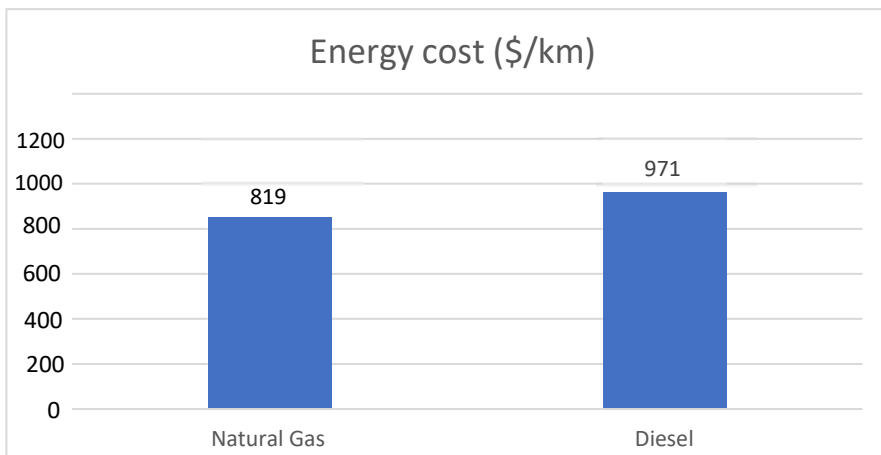
Figure 3. Comparison of emissions per kilometer of natural gas and diesel trucks.



Source: Giro Zero Project

The energy cost is one of the most important parameters in the management of operating costs. During the pilot test, the cost was 19% higher for the diesel truck compared to the natural gas truck, with the cost per emission for the electric truck being \$819 COP/km, while for the diesel truck, it was \$971 COP/km, as shown in Figure 4.

Figure 4. Comparison of emissions per kilometer of natural gas and diesel trucks.

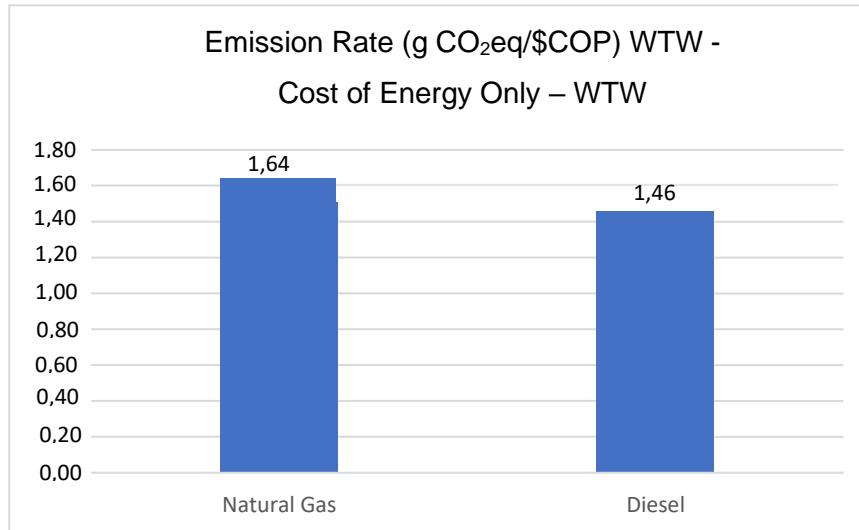


Source: Zero Giro Project

The emission rate is an indicator that relates the emissions caused to the paid value⁵ of the energy (natural gas or diesel). The cost related to emissions is one of the most important parameters in the selection of a vehicle focused on sustainability. During the pilot test, the cost of energy was 1.75 times higher in the natural gas truck compared to the diesel truck, with the cost per emission for the electric truck being 1.64 gCO₂eq/\$COP while for the diesel truck it is 1.46 gCO₂eq/\$COP, a difference of less than 11%. The above may be paradoxical, since, although there are relatively lower results for natural gas emissions per kilometer or per ton-kilometer when related to the emission rate for the end user or consumer, this is higher when polluting emissions are caused and this results in the long term more emissions by 11% for each monetary value paid to transport.

⁵ This indicator is a proposal of the Giro Zero project for those companies that do not have access to the fuel consumption information of their third-party suppliers but know the value they pay in freight to third parties or the fuel consumption of those operations. With this emission rate it is possible to have an estimate of how many emissions are generated with a calculation directly from the financial records, although this measure is not certifiable. Reference values are available on <https://girozero.uniandes.edu.co/herramientas/dashboard> (Rey-Ladino, 2021).

Figure 5 Energy cost comparison between natural gas and diesel trucks.



HDL's future in freight decarbonization

To decarbonize its operations, HDL began by identifying the factors within the company that were generating the highest greenhouse gas (GHG) emissions. This encouraged the company to actively participate in the GiroZero project, where a dashboard was created to serve as a working baseline. In addition, in collaboration with the Business Environment Corporation - CAEM and the Chamber of Commerce of Bogota, the carbon footprint was measured in a base period from August 2021 to August 2022. This was done with the purpose of making a diagnosis in order to implement an environmental policy.

As a result of this study, the company identified that it should focus its actions on the transportation used for the services provided to its customers, analyzing its current fleet. As a result, the company has initiated a process to renew its vehicle fleet, with which it currently has five SCANIA vehicles that run on natural gas, since the company believes that this energy source is cleaner than the old fleet, which contributes to reducing GHG emissions and improving air quality.

It is important to highlight that HDL's own processes also want to contribute to the goal of reducing emissions on all fronts. From its physical infrastructure, the company's own parking lot currently operates with solar energy, reducing electricity consumption, and its administrative offices are LEED (Leadership in Energy and Environmental Design) certified.

By 2023, HDL plans to carry out a new carbon footprint measurement in the expectation that its carbon footprint will be reduced as a result of the actions implemented. It is important to highlight that the preventive maintenance program contributes to this objective, avoiding damage to vehicles and optimizing costs.



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Conclusions

During the pilot, it was observed that the comparison between a natural gas and diesel truck should be made taking into account the technology and weight transported, in order to have comparable conditions. In this pilot, such a comparison was not achieved, therefore, the results are only referential, not comparable. In any case, a slightly greater reduction in emissions is observed using the natural gas vehicle. When analyzing the energy payment indicator vs. emissions generated, it is observed that there is a risk of causing higher emissions for each peso paid in the long term in HDL operations for BIMBO DE COLOMBIA, and this is especially important in the scenario where higher costs are paid for emissions, either by carbon taxes or by offsetting emissions payments (offsets).

Additionally, regarding emissions, although the indicator recommended for comparisons by the Global Logistics Emissions Council, GLEC (Smart Freight Center, 2019) is an intensive indicator that relates the emissions generated by each ton transported per kilometer traveled g CO₂eq/ton-km, during the pilot, there were different transported weights, therefore it is more advisable to compare emissions according to the vehicle independent of the weight of the products transported. In the g CO₂eq/km indicator, a 5 % higher difference was observed for the diesel vehicle, with a value of 1,409 g CO₂eq/km compared to the operation in the natural gas vehicle with a value of 1,343 g CO₂eq/km. It is also important to note that trucks with different emission standards were compared.

Finally, HDL is highly committed to reducing emissions by 2050 due to its actions both in the reduction of emissions related to the main activity of cargo transportation, as well as other actions related to secondary processes, integrally reducing its carbon footprint.

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