GREENHOUSE GAS EMISSION IN URBAN PASSENGER TRANSPORT

Héctor Rubén Tarcaya
National University of Salta, Faculty of Engineering, IIDISA. Argentina.
Angélica Noemí Arenas
National University of Salta, Faculty of Engineering, IIDISA, INIQUI. Argentina.

ABSTRACT

Public transport of passengers is one of the development axis of the communities, due to the positive impact on socio-economic activities and its link between central and peripheral communities. In the city of Salta this situation also occurs, where public passenger transport is conceived as a metropolitan service. Such transport meets the population's need for mobility and, among its impact, contributes to the generation of greenhouse gases from combustion engine emissions. This paper presents an estimate of CO2 emissions in urban passenger transport in Salta, based on the collection of data on fuel consumption and distances. At the same time, it analyzes the CO2 emissions as a consequence of the COVID-19 pandemic. The results allow to visualize a trend of this emissions.

1. INTRODUCTION

1.1 Objet of Study

In fulfilling its main objective of providing mobility, transportation generates numerous impacts, including the generation of greenhouse gases. Globally, emissions from the transport sector correspond to 73% to road transport, 9% to international maritime transport, 11% to aviation (international and cabotage), and only 2% to rail (Barbero and Rodríguez Tornquist, 2012). In Argentina, road transport has a greater share than the word average and the national emissions of the transport sector calculated by mode reach a 90% share for road transport, followed by a distance by 5% corresponding to navigation, 4% for the air transport and 1% for rail. If road transport emissions are discriminated according to the type of demand, it is estimated that freight transport generates 61%, and passenger transport 39% (Secretaría de Ambiente y Desarrollo Sustentable, 2007).

The present work has the purpose of estimating the amount of greenhouse gases, with regard to carbon dioxide, emitted by urban passenger transport in the city of Salta. For this, the amount of fuel consumed and the factor of GHG emission is considered. It is a descriptive work, based on documentary research and field research. On the documentary side, research antecedents on the subject of this work, were firstly analyzed. The field research was based on data collection and interviews in public transport companies of the city of Salta. This article is structured as follows: in section 1 a brief introduction is presented. Section 2 presents the results and same good practices to reduce emissions. The paper ends with conclusions and references.

1.2 Characteristics of the operation of passenger transport in the city of Salta

The city of Salta, capital of the homonymous province, is located in the northwest of the Argentine Republic, and concentrates 44% of the provincial population. It constitutes the center of the so-called metropolitan area with 536.113 inhabitants (INDEC, 2010). Its population has grown by 46% in a period of 19 years. The Salta Metropolitan Area is made up of four departments, which includes eight municipalities. The public transport service is provided through a private state-owned company that unifies the management of the contracted companies for 8 corridors. It operates the 49 lines of the route network that cross the metropolitan area. The service operations include a fleet of 618 units (1,2 units per 100.000 inhabitants) with an average urban frequency in peak time of 7 minutes between bus units, which carry 650.000 passengers per day and more than 183 million per year (Arenas et al, 2016; Tarcaya et al, 2018).

2. RESULTS AND DISCUSSION

2.1 Estimation of CO2 emissions

The total number of passenger transport units is 618 vehicles powered by diesel engines that use diesel as fuel. This total is distributed in 8 transport companies. Of the aforementioned fleet of public transport vehicles for the study, two companies, called “A” and “B” were considered (Transportation companies, 2021). They have 105 and 58 units respectively. The sample considered makes a total of 163 units, representing 26,4% of the fleet of transport vehicles. In both cases, data was taken on kilometer travelled and fuel consumed, detailed per month during the years 2019 and 2020.

For the estimation of carbon dioxide emission, the conversion factor proposed by the Secretary for the Environment and Sustainable Development (2008) in version 1.0 of the document “The carbon footprint of the average Argentinian” as considered. Such conversion factor is expressed in Equation (1):

$$\text{Diesel emission factor} = 2{,}77\ (KgCO2\text{-}e\ /litre) \qquad (1)$$

Based on the data collected, we proceeded to the estimation of carbon dioxide emissions during the years 2019 and 2020, which is presented in Tables 1 and 2.

Month	Distances (km)	Consumed diesel (liters)	$KgCO_2$-e
January	844.763	306.147	848.027
February	778.757	281.509	779.780
March	848.054	323.887	897.167
April	823.591	324.324	898.377
May	860.579	320.929	888.973
June	863.449	322.321	892.829
July	868.232	306.540	849.116
August	922.003	325.834	902.560
September	920.778	325.167	900.713
October	935.005	350.660	971.328
November	898.417	342.921	949.891
December	838.379	317.340	879.032
Total	**10.402.007**	**3.847.579**	**10.657.794**

Table 1 - CO2 emissions in company “A” during 2019

Month	Distances (km)	Consumed diesel (liters)	$KgCO_2$-e
January	853.412	306.798	849.830
February	790.954	280.202	776.160
March	593.039	207.275	574.152
April	292.284	82.930	229.716
May	431.229	131.160	363.313
June	464.065	150.481	416.832
July	505.277	154.621	428.300
August	493.483	156.447	433.358
September	398.222	140.558	389.346
October	484.965	148.779	412.118
November	482.431	154.780	428.741
December	568.148	186.335	516.148
Total	**6.357.509**	**2.100.366**	**5.818.014**

Table 2 - CO2 emissions in company “A” during 2020

In Figure 1, a comparison of carbon dioxide emissions is shown during the years 2019 and 2020, being able to observe the fall caused by the isolation measures as a consequence of the COVID-19 pandemic, stablished by the Decree of the President of Argentina in the second half of March 2020.

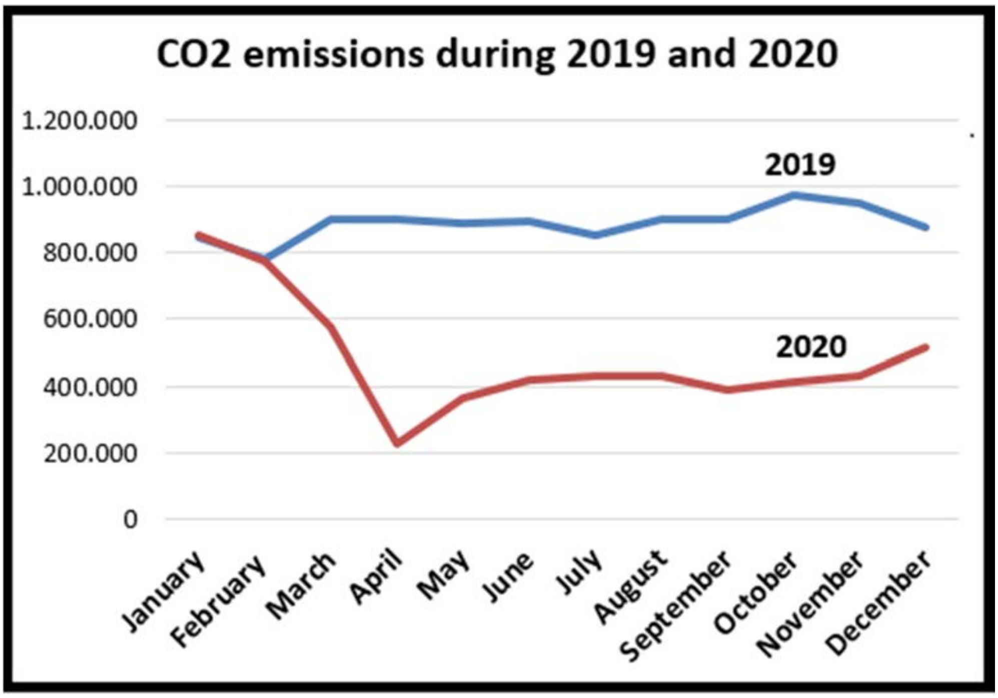

Figure 1 - CO2 emissions in company "A" during 2019 and 2020 years

Similarly, we proceeded with the data collected in company "B", which is shown in Tables 3 and 4.

Month	**Distances (km)**	**Consumed diesel (liters)**	**$KgCO_2$-e**
January	173.627	65.219	180.657
February	151.547	57.782	160.056
March	198.654	75.823	210.030
April	197.806	75.910	210.271
May	202.521	76.878	212.952
June	188.986	72.315	200.313
July	179.171	66.545	184.330
August	207.282	78.709	218.024
September	184.436	70.102	194.183
October	203.604	77.359	214.284
November	192.824	72.949	202.069
December	175.711	67.105	185.881
Total	**2.256.169**	**856.696**	**2.373.048**

Table 3 - CO2 emissions in company "B" during 2019

Month	Distances (km)	Consumed diesel (liters)	$KgCO_2$-e
January	177.689	67.640	187.363
February	166.610	63.781	176.673
March	125.170	47.175	130.675
April	60.099	20.114	55.716
May	90.290	30.787	85.280
June	96.988	33.703	93.357
July	106.222	34.955	96.825
August	103.325	34.790	96.368
September	84.379	28.192	78.092
October	102.113	34.874	96.601
November	101.954	34.215	94.776
December	117.959	39.994	110.783
Total	**1.332.798**	**470.220**	**1.302.509**

Table 4 - CO2 emissions in company "B" during 2020

In Figure 2, a comparison of carbon dioxide emissions during the years 2019 and 2020 in company "B" is shown. As in company "A", the fall caused by the isolation measures as a consequence of the COVID-19 pandemic is also observed, starting in the second half of March 2020.

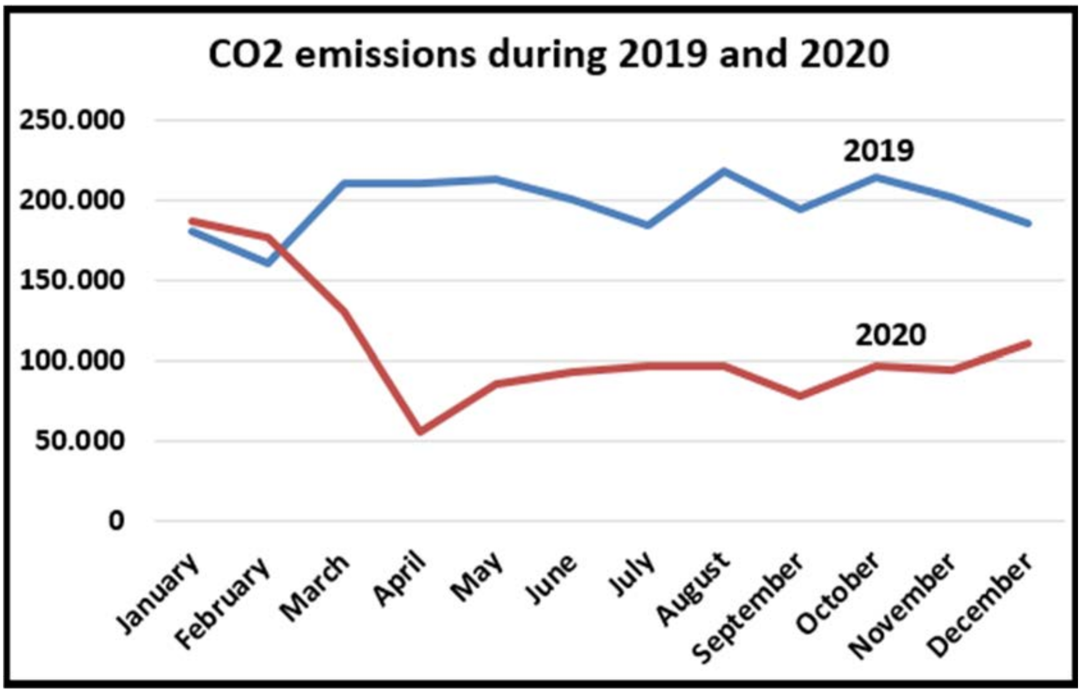

Figure 2 - CO2 emissions in company "B" during 2019 and 2020 years

In both companies, a similar trend is observed in carbon dioxide emissions proportional to the liters of fuel consumed.

This can be considered as the bases for an estimate for the entire fleet of transport vehicles.

Since the isolation measures were stablished in the city of Salta, mobility has not been the same again, since at first only essential workers could travel by public transport. This caused the buses to circulate with few passenger and, in many cases, without passenger at bus stops. This changes in mobility also caused reductions in CO_2 emissions per kilometer travelled, since driving with fewer stops, the fuel efficiency was higher, as it is observed in Figure 3.

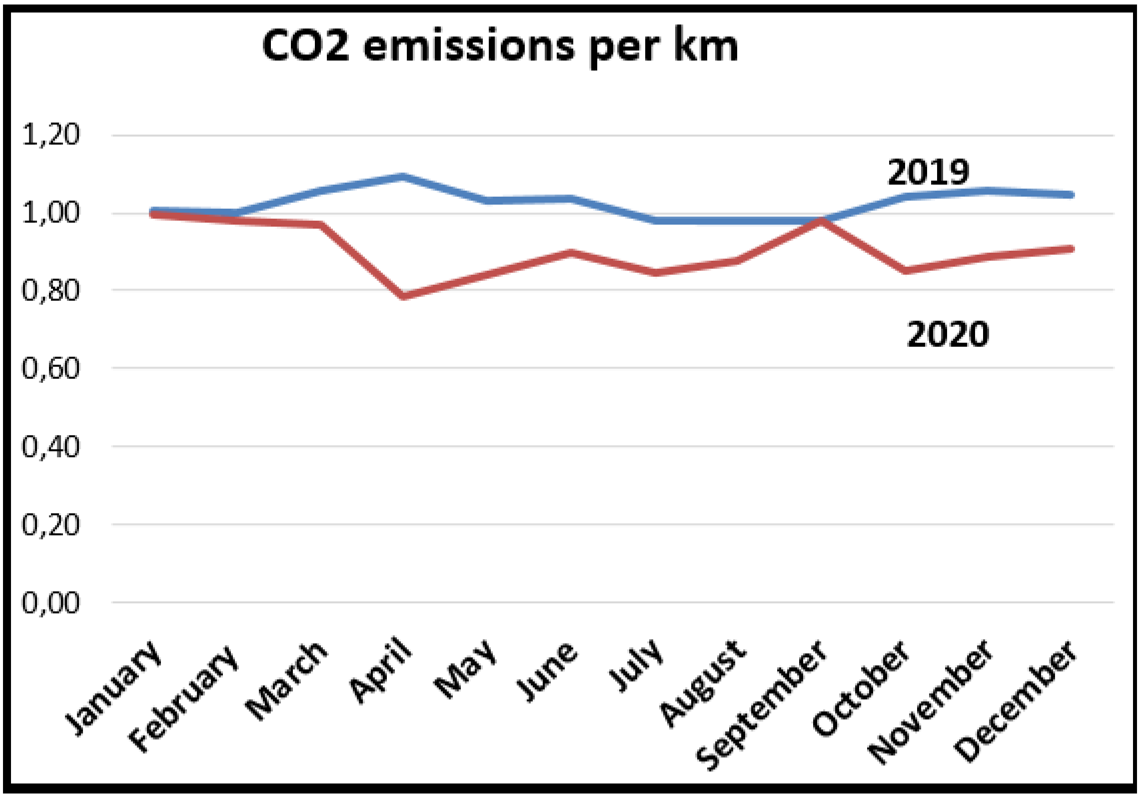

Figure 3 - CO2 emissions per km during 2019 and 2020 years

2.2 Good practices to reduce emissions

Among the good practices that are recommended to reduce carbon dioxide emissions in buss transports we can mention:

Maintenance controls: Maintenance is not only a strategy for reducing fuel consumption, but it also a key aspect of vehicles safety. Tires pressure control is substantive, since in case of being deflated they have greater resistance to rolling. Greater pressure translates into less flattening, reducing the area of contact with the pavement and reducing the resistance force (Instituto del Transporte, 2016). Air and fuel filter controls are also recommended, leading to a richer mixture in combustion, with a more rational use of fuel.

Efficient driving: Considering that fuel consumption increases at high and low speeds, it is recommended to ride in the longest possible gearbox and at low revolutions. It is also recommended to keep the speed of circulation as uniform as possible and driving with anticipation and foresight, avoiding sudden accelerations (Instituto del Transporte, 2016).

Fuel change: Public transport vehicles using compressed natural gas (CNG) engines is a pilot test in Argentina. The change from diesel fuel to CNG is an important mechanism not only to reduce emissions, but also to reduce total costs (Puliafito and Castesana, 2010; Montero Sanz and Díaz López, 2014; Scania, 2019).

3. CONCLUSIONS

The work shows a first approximation of the estimates of carbon dioxide emissions in part of the fleet of public transport of passenger vehicles, with the limitations and the availability of data and information by the time of doing it. However, even with these restrictions, it was possible to identify trends and good practices to improve fuel efficiency, and therefore reduce the emissions.

Some aspects of this study might be limited. For example, the sample considered represents only 26,4% of the fleet of transport vehicles. This and other limitations of the work will be the focus of further research.

This work is a starting point for future research to complement it, in order to reduce carbon dioxide emissions and thus contribute to the preservation of the environment.

REFERENCES

ARENAS, A., DOMÍNGUEZ, O., PANOZZO M., ROBIN J.; MARZETTI A., TUERO, I. (2016). Diagnóstico de movilidad en la ciudad de Salta. CIT2016 – XII Congreso de Ingeniería del Transporte, 7-9 Junio 2016. Universidad Politécnica de Valencia. Valencia, España.

BARBERO, J., RODRÍGUEZ TORNQUIST, R. 2012. Transporte y cambio climático: hacia un desarrollo sostenible y de bajo carbono. Revista Transporte y Territorio Nº 6, Universidad de Buenos Aires. pp. 8 a 26. https://www.redalyc.org/pdf/3330/333027352004.pdf (accessed 10 March 2021).

INDEC (2010). Instituto Nacional de Estadísticas y Censos. Censo nacional de población, hogares y viviendas 2010. Argentina. https://www.indec.gob.ar/indec/web/Nivel4-Tema-2-41-135 (accessed 16 February 2021).

INSTITUTO DEL TRANSPORTE (2016). Lineamientos para la eficiencia energética y el desarrollo de bajo carbono en el Transporte Automotor de Cargas (TAC). Universidad Nacional de San Martin. Argentina https://www.unsam.edu.ar/institutos/transporte/publicaciones/Lineamientos%20para%20EE%20en%20TAC%20_%20IT%20UNSAM.pdf (accessed 10 March 2021).

MONTERO SANZ, I., DÍAZ LÓPEZ, C. (2014). El Gas Natural Vehicular frente a los combustibles tradicionales: comparativa de emisiones de Gases de Efecto Invernadero de su ciclo de vida en España. Congreso Nacional del Medio Ambiente CONAMA 2014. Madrid. España. http://www.conama2014.conama.org/conama2014/download/files/conama2014/CT%202014/1896711612.pdf (accessed 10 March 2021).

PULIAFITO, S., CASTESANA, E. (2010). Emisiones de carbono del sector transporte en Argentina. Avances en Energías Renovables y Medio Ambiente (AVERMA). Vol. 14, 2010. ISSN 0329-5184. Asociación Argentina de Energías Renovables y Medio Ambiente (ASADES). Buenos Aires. Argentina. http://sedici.unlp.edu.ar/handle/10915/100136 (accessed 12 March 2021).

SCANIA (2019). Scania presenta su primer bus a GNC para transporte urbano. https://www.scania.com/ar/es/home/experience-scania/news-and-events/News/2019/scania-presenta-su-primer-bus-a-gnc-para-transporte-urbano.html (accessed 12 March 2021).

SECRETARIA DE AMBIENTE Y DESARROLLO SUSTENTABLE. (2007). Segunda Comunicación Nacional de la República Argentina a la Convención Marco de las Naciones Unidas Sobre Cambio Climático. Buenos Aires. http://docplayer.es/5748152-La-huella-de-carbono-version-1-0-4-de-junio-de-2008-documento-de-referencia-la-huella-de-carbono-del-argentino-promedio.html (accessed 12 March 2021).

SECRETARIA DE AMBIENTE Y DESARROLLO SUSTENTABLE (2008). La huella de carbono del argentino promedio. Versión 1,0. Argentina. URL: http://docplayer.es/5748152-La-huella-de-carbono-version-1-0-4-de-junio-de-2008-documento-de-referencia-la-huella-de-carbono-del-argentino-promedio.html (accessed 12 March 2021).

TARCAYA, H., ARENAS, A., ARGENTI SALGUERO, P., LUGONES, L. (2018). Buenas prácticas de seguridad vial para el transporte automotor de pasajeros. CIT2018 – XIII Congreso de Ingeniería del Transporte, 6-8 Junio 2018. ISBN: 978-84-09-00787-5. Campus Universitario de Gijón. Gijón, España.

TRANSPORTATION COMPANIES (2021). Interviews in companies "Alto Molino" and "San Ignacio". Interviewer: Héctor Rubén Tarcaya. Date: 18 February 2021.