

Congrès MATH.en.JEANS de Nice 20 et 21 mai 2021



# Modelling the carbon impact of students coming to school

-topic 1-

Colegiul National Mihai Eminescu

Colegiul National Emil Racovita(Cluj)

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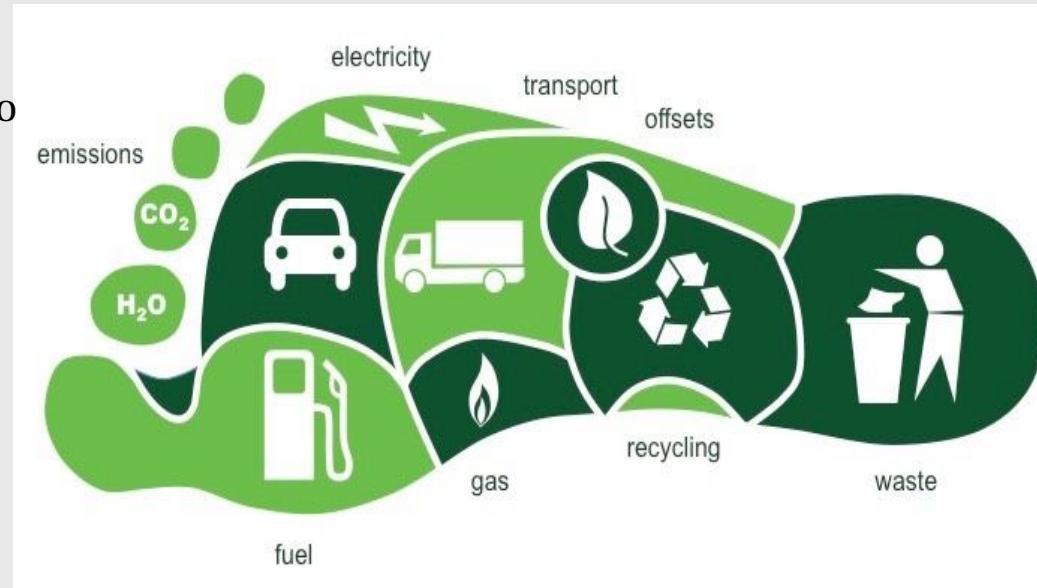
# The CO<sub>2</sub> emissions

There are several ways the CO<sub>2</sub> spreads, some of them are by polluting, using vehicles based on oil and fuels, throwing away good food or supplies.

The excessive presence of the CO<sub>2</sub> is dangerous for all living creatures, that's why we tried to do as much research as we could to give us some ideas on how to minimize the quantity of CO<sub>2</sub> released into the air.

Although we can't just make the CO<sub>2</sub> disappear by recycling, we can use it in order to minimize the quantity that it's left in the air.

By recycling we can minimize the quantity of CO<sub>2</sub> produced by rubbish by recycling wasted product and donating the big quantities of food that we don't need.



# The introduction

After a first phase of researching relevant criteria involving transporters and students, we develop a model of the carbon impact caused by the students coming to high school. After making the model, we focused on trying to find solutions to ameliorate the pollution problem.

To begin with, we made a survey to help us collect information about the methods of transportation students use to go to school. We sent it to the students from our school, as well as to the students from different schools. As a result, we received 149 answers which helped us develop a calculation formula for the CO<sub>2</sub> emissions.

After we had received the students' answers, we sorted them and arranged them in a spreadsheet:

<https://docs.google.com/spreadsheets/d/1qS1pbhufseJw684FKbs553RQo6JOp7VQtnUomDNJbwM/edit?usp=sharing>

# The questions and why we chose them



1. What school do you go to?
2. What means of transport do you usually use to come from school?
3. How far away is your school?
4. How long does it take for you to get to school using a polluting vehicle?
5. What means of transport do you usually use to go to school?

Here is the link to our survey:

**<https://forms.gle/ZRiQAkdvpxgB4Py8>**

# The sources

To find a calculation formula, we surfed the internet for information and we came to the following conclusions:

- the distance of 1 km is travelled in about 5 minutes
- the rush hour is between 7:30-8:00
- the bus CO<sub>2</sub> emissions 0.069 kg/km/person
- the car CO<sub>2</sub> emissions are 0.133 kg/km/person
- the electric car CO<sub>2</sub> emissions are 0.043 kg/km/person
- the trolley bus /electric tram CO<sub>2</sub> emissions are 0.042 kg/km/person

Figures denote kg CO<sub>2</sub> per km per passenger:

- foot: 0
- bicycle: 0
- by animal transport: 0
- rickshaw/trishaw: 0
- moped: 0.073
- motorcycle: 0.094
- auto rickshaw: 0.061
- snowmobile: 0.094
- car electric: 0.043
- car small: 0.11
- car medium: 0.133
- car large: 0.183
- car hybrid: 0.084
- taxi: 0.17
- bus: 0.069
- mini bus: 0.055
- diesel train: 0.06
- electric train: 0.065
- underground/metro: 0.065
- electric tram/trolley bus: 0.042
- ferry: 0.115
- express boat: 0.53

[https://www.co2nnect.org/help\\_sheets/?op\\_id=602&opt\\_id=98&nmlpreflang=en](https://www.co2nnect.org/help_sheets/?op_id=602&opt_id=98&nmlpreflang=en)

# Our concept

First of all, we decided to study the results that came from the students of our high school, Colegiul Național “Emil Racoviță”, so that, at the end, we will be able to create a model of the carbon usage.

We made sure that the answers made sense.

Knowing that the distance of 1 km is travelled in about 5 minutes, we calculated how many kilometers each student makes using a mean of transport. We did that by dividing the boundaries of the time that each person chose by 5. After calculating how many kilometers they travel, using the data that we found about how much CO<sub>2</sub> each mean of transport denotes, we calculated how many kilograms of CO<sub>2</sub> are used by each student when they come to school.

# Example

What is your name?

Iulia

What school do you go to?

Colegiul Național "Emil Racoviță"

What means of transport do you usually use to go to school?

Polluting public transport (bus),  
Non-polluting means of public transport (electric bus, tram, trolleybus),  
Polluting car (fuel cars)

What time do you usually leave home in the morning?

Before 7 a.m.

How long does it take for you to get to school using a polluting vehicle?

16-30 minutes

How far away is your school?

5-10 km

If it takes between 16-30 minutes to get to school and the school is between 5-10 km away, using the distance of 1 km is travelled in about 5 minutes=>

$$16/5 = 3.2 \text{ km}$$

=> the school is **5-6 km** away

$$30/5 = 6 \text{ km}$$

\*The school is 5-10 km away

Knowing that a *polluting mean of transport* emits 0,069 kg/km =>

$$0.069 \times 5 = 0.34 \text{ kg}$$

=> 0.34 kg - 0.41 kg CO<sub>2</sub>

$$0.069 \times 6 = 0.41 \text{ kg}$$

To get to the final result, we calculated the arithmetic mean for both ends of the intervals.

$$(0.34+0.66+0.21)/3 = 0.4 \text{ kg CO}_2$$

$$(0.41+0.79+0.25)/3 = 0.48 \text{ kg CO}_2$$

This means that Iulia emits between **0.4 kg - 0.48 kg CO<sub>2</sub>** on her way to school.

Knowing that a *polluting car* emits 0,133 kg/km =>

$$0.133 \times 5 = 0.66 \text{ kg}$$

=> 0.66 kg - 0.79 kg CO<sub>2</sub>

$$0.133 \times 6 = 0.79 \text{ kg}$$

Knowing that a non-polluting mean of public transport emits 0.042 kg/km =>

$$0.042 \times 5 = 0.21 \text{ kg}$$

=> 0.12-0.25 kg CO<sub>2</sub>

$$0.042 \times 6 = 0.25 \text{ kg}$$

# The final results

We calculated the final results using the arithmetic mean for both ends of the interval that identified for each student.

Results for Colegiul Național Emil Racoviță: **0.27-0.41 kg/person**

Results for the other schools: **0.42-0.62 kg/person**

Final result :**0.34-0.51 kg/person**

C	D	E	F	G	H	I	J
0,75- 0,75 kg	Adam	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz ), Autoturism propriu poluant (mașinile pe carburant)	25	înainte de 7:00	31-45 minute
0,49-0,59 kg	Alexa	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	50/50L	înainte de 7:00	16-30 minute
0,41-0,62 kg	Ana	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz )	M11	între 7:00-7:15	31-45 minute
0,28-0,33 kg	Apava	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	20 si/săptamani	între 7:16-7:30	16-30 minute
0-0 kg	Bachis	Colegiul Național " Em	Nu utilizez niciun mijloc de transport	Nu utilizez niciun mijloc de transport	-	între 7:46-8:00	Nu utilizez mijloc
0,21-0,21 kg	Balazs	Colegiul Național " Em	Mijloc de transport în comun nepoluant (autobuz )	Mijloc de transport în comun nepoluant (autobuz electric)	7	între 7:00-7:15	5-15 minute
0-0 kg	Bianca	Colegiul Național " Em	Nu utilizez niciun mijloc de transport	Nu utilizez niciun mijloc de transport	-	între 7:31-7:45	Nu utilizez mijloc
0,91- 1,3 kg	Bumbu	Colegiul Național " Em	Autoturism propriu poluant (mașinile pe carburant)	Autoturism propriu poluant (mașinile pe carburant)	25	între 7:00-7:15	31-45 minute
0-0,34 kg	Claudi	Colegiul Național " Em	Mijloc de transport în comun nepoluant (autobuz )	Mijloc de transport în comun nepoluant (autobuz electric)	06	între 7:00-7:15	Nu utilizez mijloc
0,72-0,8 kg	Comar	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	31 si 32	între 7:00-7:15	46 de minute- 1 ora
0,12-0,21 kg	Cozea	Colegiul Național " Em	Mijloc de transport în comun nepoluant (autobuz )	Mijloc de transport în comun nepoluant (autobuz electric)	47	între 7:16-7:30	16-30 minute
0,65-0,65 kg	Csvalc	Colegiul Național " Em	Autoturism propriu poluant (mașinile pe carburant)	Autoturism propriu poluant (mașinile pe carburant)	3	între 7:16-7:30	5-15 minute
0,39-0,39 kg	Daniel	Colegiul Național " Em	Autoturism propriu poluant (mașinile pe carburant)	Mijloc de transport în comun poluant (autobuz )	35	între 7:31-7:45	5-15 minute
0,06-0,19 kg	Darius	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz ), Nu utilizez niciun mijloc de transport	Nu utilizez niciun mijloc de transport	35	între 7:00-7:15	5-15 minute
0,08-0,23 kg	Diana	Colegiul Național " Em	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	Mijloc de transport în comun poluant (autobuz ), Mijloc de transport în comun poluant (autobuz )	24B	între 7:16-7:30	5-15 minute
0,78-1,17 kg	Dumitru	Colegiul Național " Em	Autoturism propriu poluant (mașinile pe carburant)	Mijloc de transport în comun poluant (autobuz )	M31	între 7:00-7:15	31-45 minute

# Solutions

## .Using non-polluting means of transportation



## 2. Online schooling



## 3. School buses



- The city hall could give us free subscriptions for electric scooters.
- Some schools should start their classes one or two hours later than the other schools.
- Installing more bike lanes around the city center.

# Study by case

In order to determine the carbon footprint emitted every day by the students of Colegiul National “Mihai Eminescu”, we decided to make a case study based on a questionnaire made by us, with the help of high school students.

We relied on the following questions:

1. What is the distance between your home and the school?
2. What mean of transport do you use?
3. Which is the area that you live in?

Link to the survey:

<https://forms.gle/odWberxTR4hcDukp6>

# Example

For example, this student is covering a total distance of 3 km from home to school, going by bus.

$$3\text{km} * 0.069\text{kg/person} = 0.207 \text{ kg/km}$$

Just like earlier, this student also goes by bus, covering a distance of approx. 7km. We multiplied both of the distances by the amount of CO<sub>2</sub> eliminated per person.

$$7\text{km} * 0.069 = 0.483 \text{ kg/km}$$

We calculated like this the rest of the responses collected. We have a total of 20 answers.

At the end of the process we have come to the conclusion that, everyday, an average of 40 kg/person is emitted by the 20 student of our college, which means about 2 kgs/person.

# The explanation

From 12 months, we go to school only 7 months and 2 weeks (thanks to holidays).

7 months and 2 weeks mean 30 weeks of school.

So, by eliminating 40 kgs of CO<sub>2</sub> in a day, 7 days a week, we eliminate  $40\text{kg} \times 7 = 280$  kgs/week. Multiplied by 30, means 8400kgs/km/person only in the days we go to school.

With the help of the site <https://www.co2nnect.org/> we managed to determine the amount of CO<sub>2</sub> emitted by vehicles used by students to come to school.

Through the study, we deduced that we can save an amount of 8,400 kg of CO<sub>2</sub> from spreading in a year by introducing an electric bus, which helps in the process of prevention of planetary pollution.

# I/ Research phase

Link for our questionnaire:

[https://docs.google.com/forms/d/e/1FAIpQLSdPbGNMyJnZBqKdAtQs\\_PZAfINoK1NALc-M87jB\\_wnZiq7i7A/viewform?usp=pp\\_url](https://docs.google.com/forms/d/e/1FAIpQLSdPbGNMyJnZBqKdAtQs_PZAfINoK1NALc-M87jB_wnZiq7i7A/viewform?usp=pp_url)



## III/Analysis and sorting of results

Diesel engine : 29%

Bus : 31%

Petrol car : 25%

Electric car : 9%

Hybrid car : 1,6%

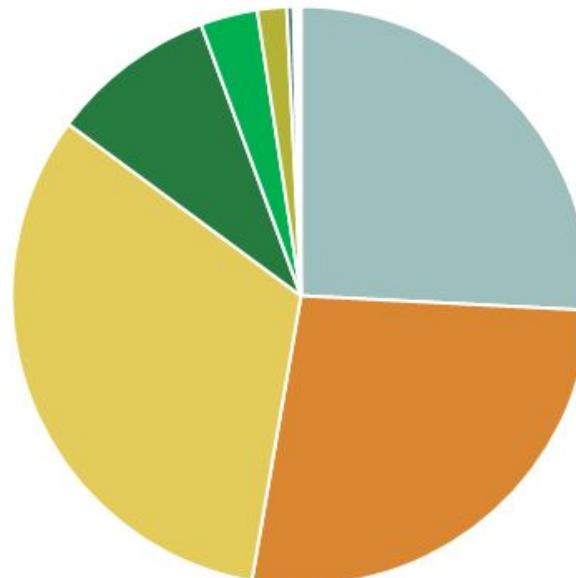
Train : 0,76%

Bike : 0,4%

On foot : 3%

Motorbike : 0,19%

Scooter : 0,04%



■ Essence ■ Diesel ■ Bus ■ A pied ■ Electrique ■ Hybride ■ Vélo ■ Moto ■ Scooter ■ Train

# III/Carbon emission (Toyota)

Gamme Petrol	Aygo	Yaris	Prius	GR Supra	Hilux	Proace city	Proace	Proace city verso	Proace verso/combi
CO <sub>2</sub> emission(g /km)	114	125	134	177	237	149	150	185	173

Gamme Hybrid	Yaris	Corolla	Toyota C-HR	RAV4	RAV4 rechargeable	Prius	Prius rechargeable	Camry
CO <sub>2</sub> emission(g /km)	93	111	115	119	22	99	29	121

# Calcul:

## For one journey: (petrol)

of 5 km →  $5 \times 159 = 795$  g = 0,795 kg CO<sub>2</sub>

10 km →  $10 \times 159 = 1590$  g = 1,59 kg CO<sub>2</sub>

20 km →  $20 \times 159 = 3180$  g = 3,18 kg CO<sub>2</sub>

## Average

Toyota petrol car: 159 g/km

Toyota Hybrid car : 76 g/km

Diesel engine (2015-2020):

110 g/km

## For one journey: (hybrid)

of 5 km →  $5 \times 76 = 380$  g = 0,380 kg CO<sub>2</sub>

10 km →  $10 \times 76 = 760$  g = 0,76 kg CO<sub>2</sub>

20 km →  $20 \times 76 = 1520$  g = 1,52 kg CO<sub>2</sub>

## For one journey: (diesel)

of 5 km →  $5 \times 110 = 550$  g = 0,550 kg CO<sub>2</sub>

10 km →  $10 \times 110 = 1100$  g = 1,1 kg CO<sub>2</sub> 20

km →  $20 \times 110 = 2200$  g = 2,2 kg CO<sub>2</sub>

# Model Impact

**Carbon emission for one day:**

15 km (320p×159 g/km + 76 g/km×20p + 374p×110 g/km + 40p×43 g/km + 401p×69 g/km + 2p×94 g/km + 2p×73 g/km + 1p×70 g/km) = 4 124 975 g ≈ 4 125 kg per day

**Carbon emission for one week:**

15 km (2238p×159 g/km + 76 g/km×142p + 2616p×110 g/km + 277p×43 g/km + 2810p×69 g/km + 16p×94 g/km + 13p×73 g/km + 7p×70 g/km) = 12 918 664 g ≈ 12 919 kg per week

159 g/km = petrol car

76 g/km = hybrid Toyota

110 g/km = diesel car

43 g/km = electric car

69 g/km = bus

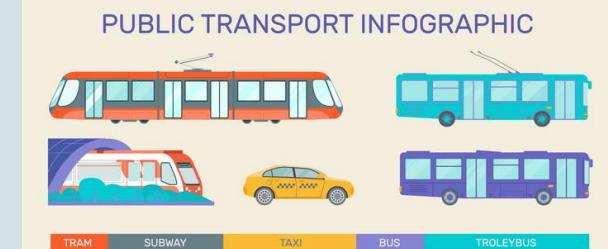
94 g/km = motorbike

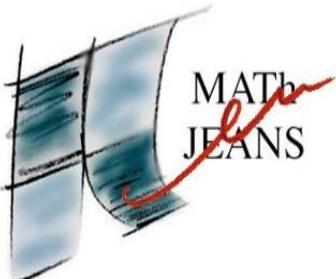
73 g/km = scooter

70 g/km = train

## IV/ Solutions

Let's Carpool!



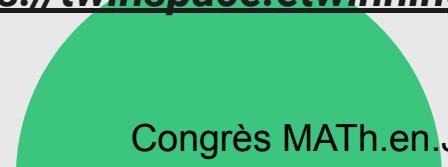


***Thank you for listening!***

***We are available to answer your questions!***

*If you want to follow our work :*

**<https://twinspace.etwinning.net/122026/home>**



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