A Work Project, presented as part of the requirements for the Award of a Master's degree in Finance from the Nova School of Business and Economics.

Lisbon and Porto Metropolitan Areas in context – the relevance of the car in greenhouse gas emissions, demand and supply and in residents' transportation costs

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Work project carried out under the supervision of: Professor Miguel Pita

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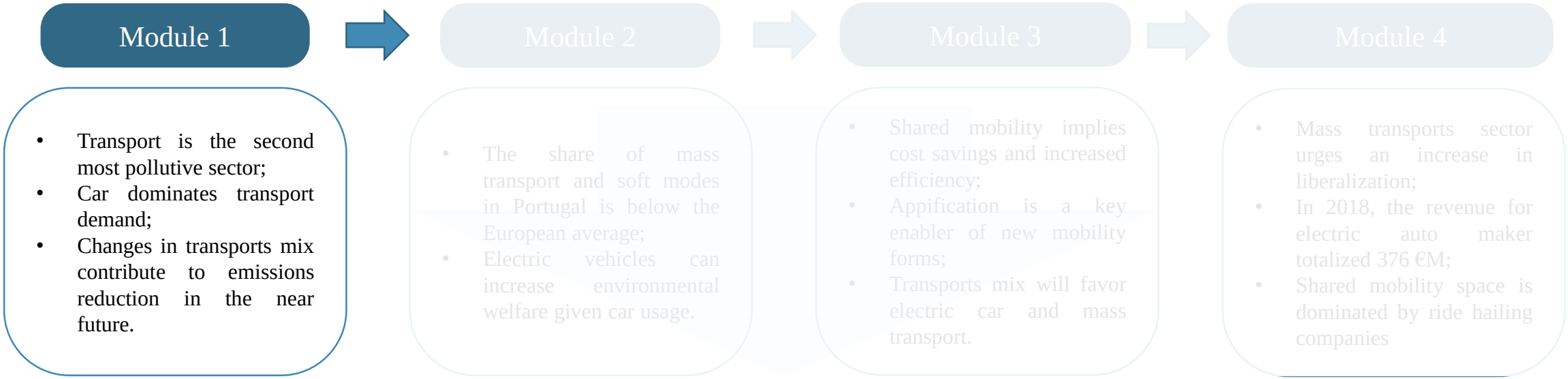

Abstract

Transports sector is the second sector that most contributes to GHG emissions across the world, with a particular emphasis in Portugal. In a world where Car dominates demand by far and where individuals, in general, refer some problems in Mass transports supply, such as low frequency in peak hours and proximity to some residential areas, transportation costs (especially the ones related with the car) appear as an important urban problem. However, changes in Transports mix to squeeze the Car and that are estimated for 2030 and 2050 may have a crucial impact on GHG emissions reduction.

Keywords: GHG emissions, Transportation costs, Transport modes, Urban mobility.

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Lisbon and Porto metropolitan areas in context – the relevance of the car in greenhouse gas emissions, demand and supply and in residents' transportation costs

Burning platform

- In both Portugal and the World, transports, especially road transports, is the 2nd sector that most contributes to greenhouse gas emissions.
- Urban mobility in LMA and PMA takes an extremely important place in all types of mobility in Portugal.

Demand and supply

- Demand for the car is approximately 5 times greater than that for the other modes of transport (mass transport and soft modes) and supply accompanies demand.
- In both LMA and PMA, the car domains in terms of usage share, more than doubling the other modes of transport, making these urban areas the worst in car dependence among a group of European Metropolitan Areas.

Costs

- GHG emissions are the greater environmental problem that appears related to the current transports mix, in LMA and PMA.
- When an individual is exposed to levels of noise pressure above the normal values, road traffic is responsible for most of the situations.
- The cost of using and possessing a car more than doubles that of using mass transports in both LMA and PMA.

Transport mix scenarios

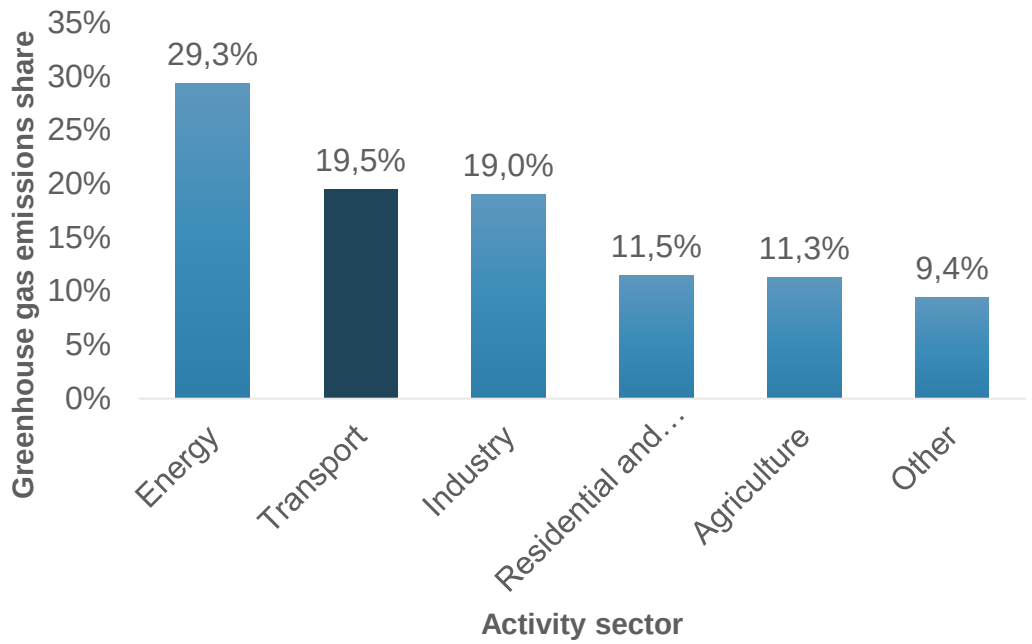
- In a utopic scenario where there were no cars, GHG emissions would be reduced in approximately 39%, in LMA.
- In a utopic scenario where there were no cars, GHG emissions would be reduced in approximately 47%, in PMA.

In both Portugal and the World, transports is the 2nd sector that most contributes to greenhouse gas emissions

Transport sector positions itself as the 2nd sector that most contributes to GHG emissions across the world (19,5%).

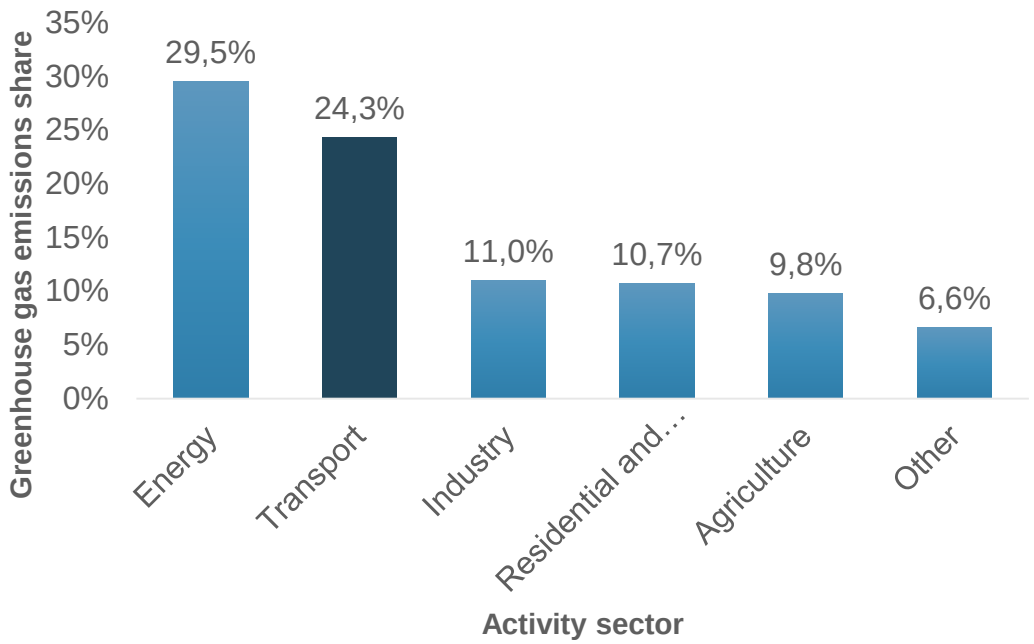
In Portugal, as it happens across the world, transports sector is the second biggest polluter, but with a higher share (24,3%).

Graph 1: Global greenhouse gas emissions share, in 2019 (%)



Source: made by the authors based on Reference list 1)

Graph 2: Sectoral greenhouse gas emissions share in Portugal, in 2017 (%)



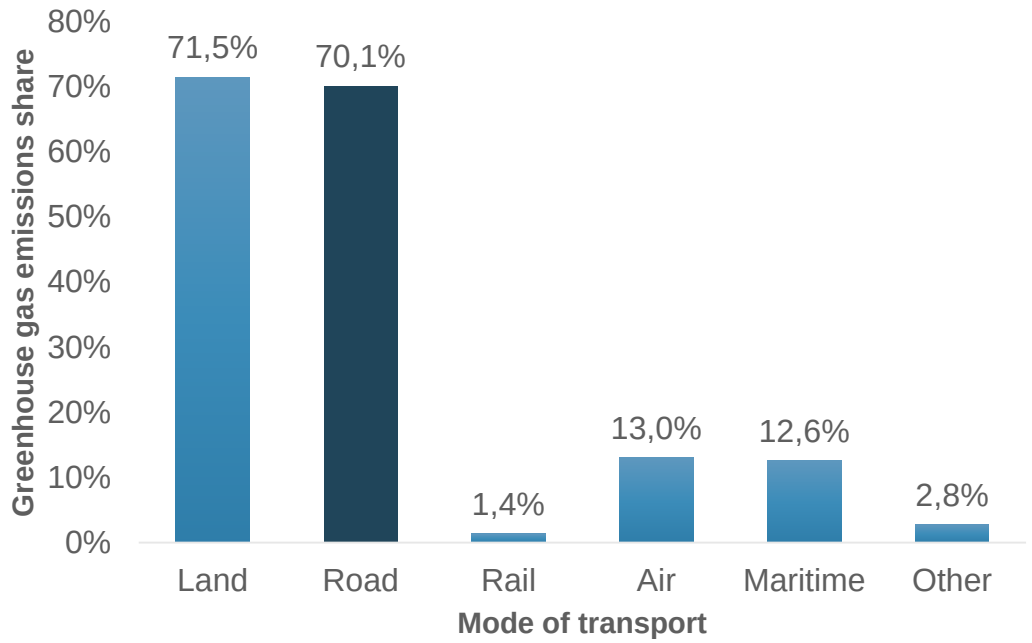
Source: made by the authors based on Reference list 2)

Road transports appear as the biggest polluters in what concerns the different transport modes, in both Portugal and the world

Land transport mode dominates GHG emissions across the world (71,5%), with the road transport mode being the most significant contributor (70,1%).

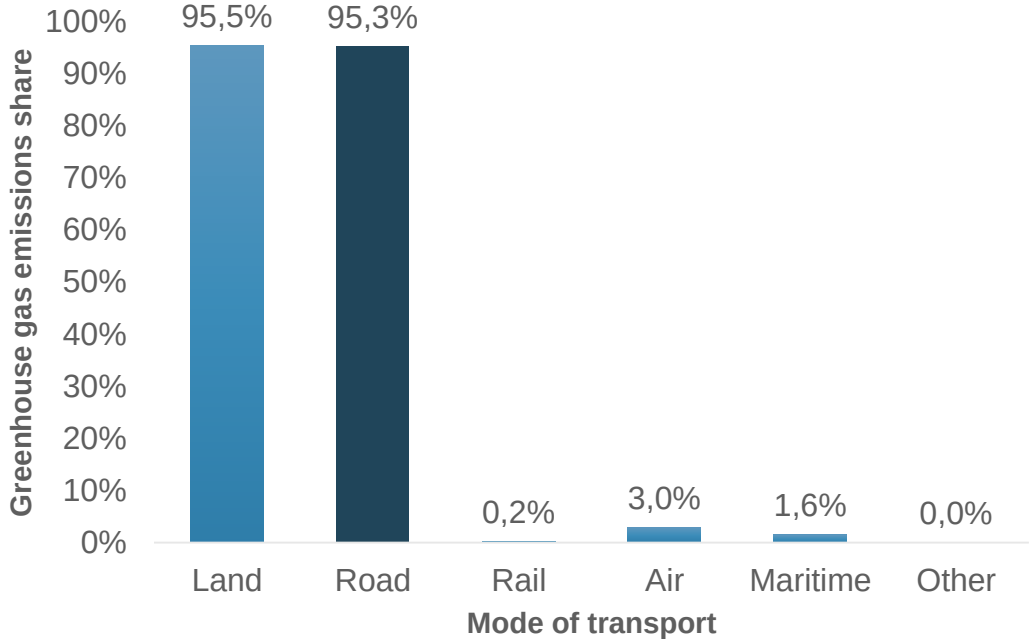
In Portugal, it is even more evident the contribution of land transport modes to GHG emissions (95,5%), with road transports filling most of this percentage (95,3%).

Graph 3: Transport sector global greenhouse gas emissions by mode , in 2016 (%)



Source: made by the authors based on Reference list 3

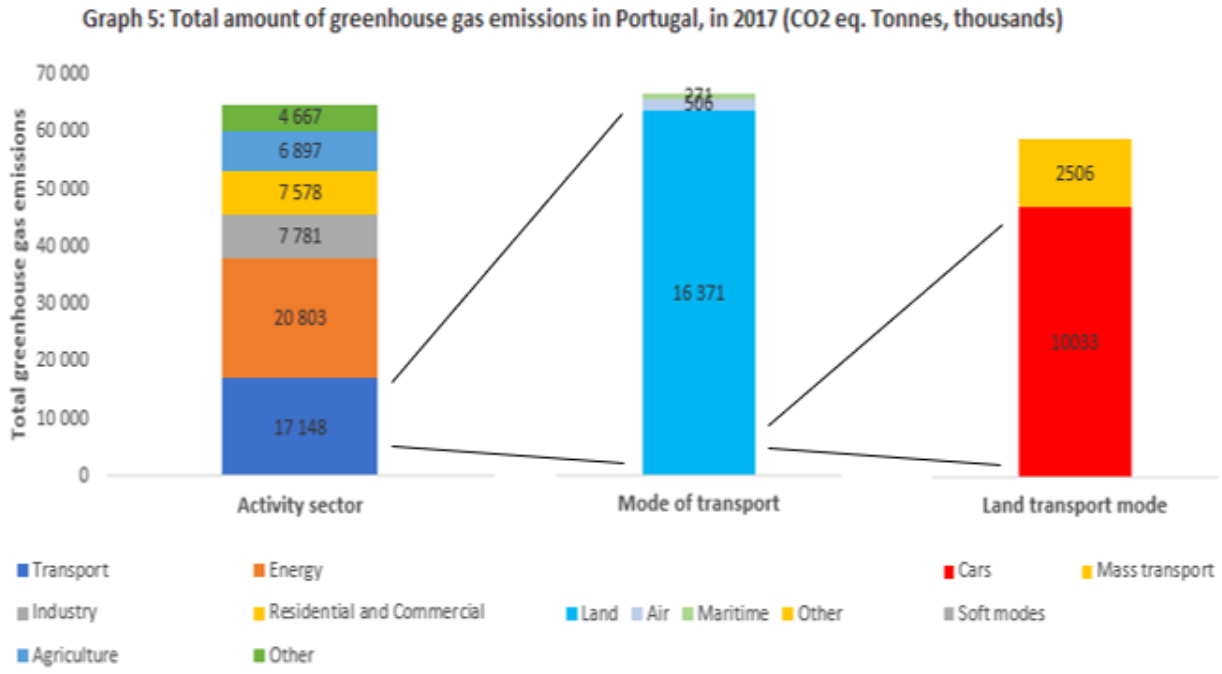
Graph 4: Transport sector greenhouse gas emissions by mode in Portugal, in 2017 (%)



Source: made by the authors based on Reference list 4

Land transport modes clearly dominate in GHG emissions, with the car being responsible for almost 60% of them

Cars are the main responsible for GHG emissions inside transports' sector, comprising more than half of the emissions of land transports (61%) and of all the entire transports' sector (59%).



Soft modes

Include all soft modes – for normal bicycles and walking modes, the amount of emissions is 0. For electric bikes and scooters, one would obtain a residual value.

Mass transport

Includes metro, train and buses emissions, the last ones being responsible for 98,6% of the emissions from all the sector.

Cars

Include diesel, petrol and electric cars. In fact, cars themselves pollute more than 4 entire activity sectors.

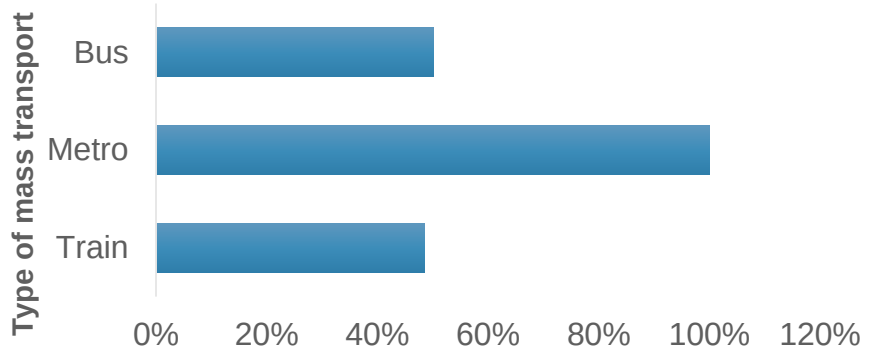
Source: made by the authors based on Reference list 5.

Urban mobility in LMA and PMA takes an extremely important place in all types of mobility in Portugal

Urban mobility comprises all dislocations that started and ended inside a metropolitan area, whereas **long-distance mobility** is focused on trips with a total distance of, at least, 100 km.

LMA and PMA together aggregate 2/5 of the Portuguese population, which makes urban movements in these MAs very relevant for the whole country.

Graph 6: % Share in urban mobilty



Source: made by the authors based on Reference list 6) to 13) and Appendix 1

Figure 1: Porto metropolitan Area

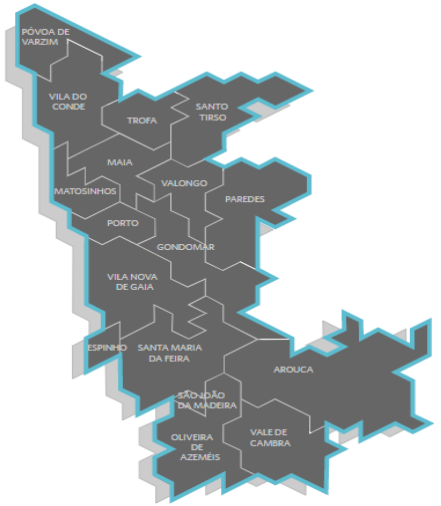


Figure 2: Lisbon metropolitan area

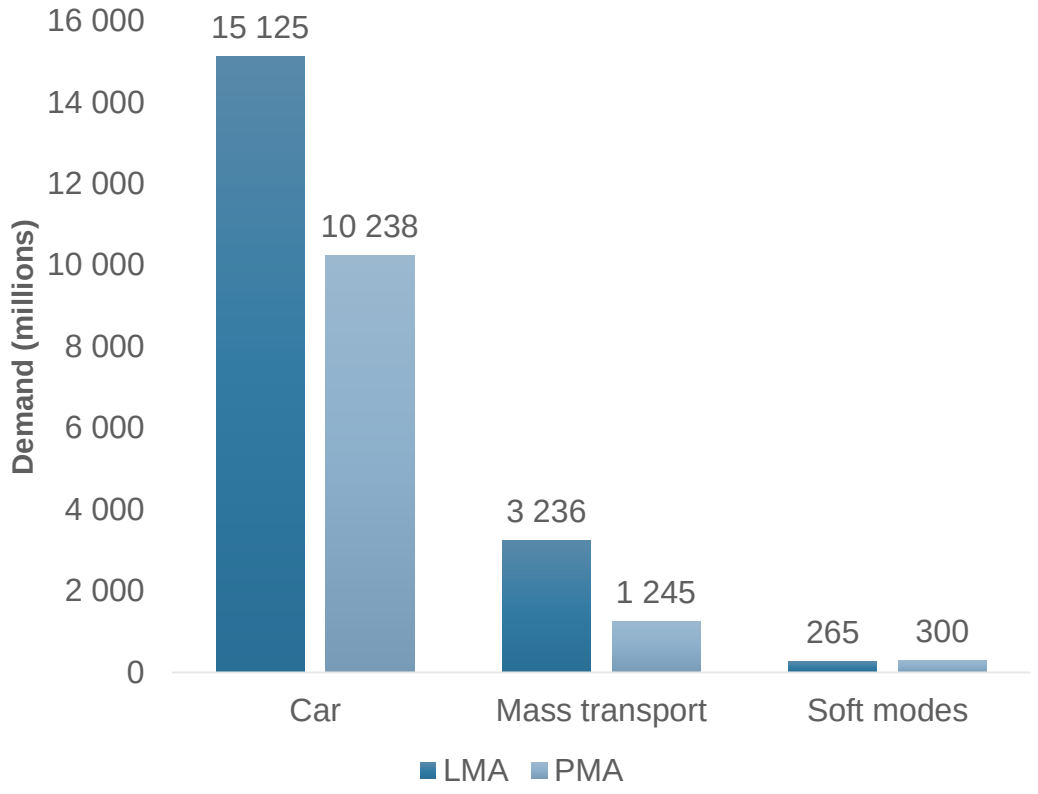
For residents in PMA, 81% of the total kms made in a year using a car are from inside the urban area.
In LMA, the number is 86%.

On the left, Porto metropolitan area – it comprises 17 municipalities, 1 836 512 inhabitants and an area of 2 041 km2. On the right, Lisbon metropolitan area – it has 18 municipalities, 2 812 678 inhabitants and an area of approximately 3 015 km2.

Source: made by the authors based on Reference list 6) to 13) and Appendix 1

Demand for the car is approximately 5 times greater than that for the other modes of transport (mass transport and soft modes)

Graph 7: Demand for the different modes of transport in LMA and PMA (pass*km)



Source: made by the authors based on Reference list 6) to 13) and Appendix 2

Measurement units

- To measure demand, one should consider pass*km as a measurement unit.
- In both LMA and PMA, demand for the car surpasses, in 2018, the 10 000 millions pass*km.

What motivates that gap?

- 90% of the adults has driver license, which makes the car the first choice for the majority.
- Most urban residents find deficits in certain mass transport characteristics (frequency, proximity, etc.)

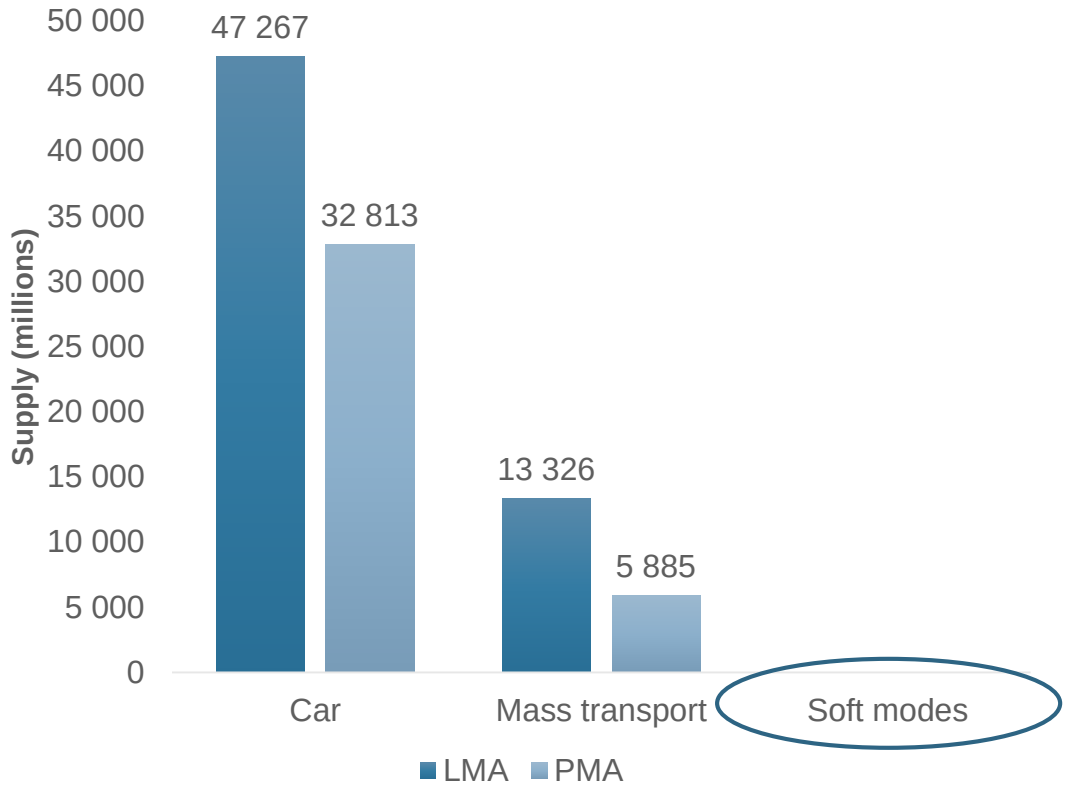
Problems

- This exaggerated demand for cars will imply social, economic and environmental problems, to be explored later in this market study.

Source: Reference list 6) to 13)

Supply for the car accompanies demand and clearly surpasses that for the other modes of transport (mass transport and soft modes)

Graph 8: Supply for the different modes of transport in LMA and PMA (seats*km)



Source: made by the authors based on Reference list 7) and 8) and Appendix 3

Measurement units

- To measure supply, one should consider seats*km as a measurement unit.
- Seats*Km and pass*km are two comparable units.

Evidences

- Supply for the car dominates demand by far.
- Deficits in mass transports supply, namely in peak hours, which motivated a lower demand for these transports, explains also a lower supply.

What's next?

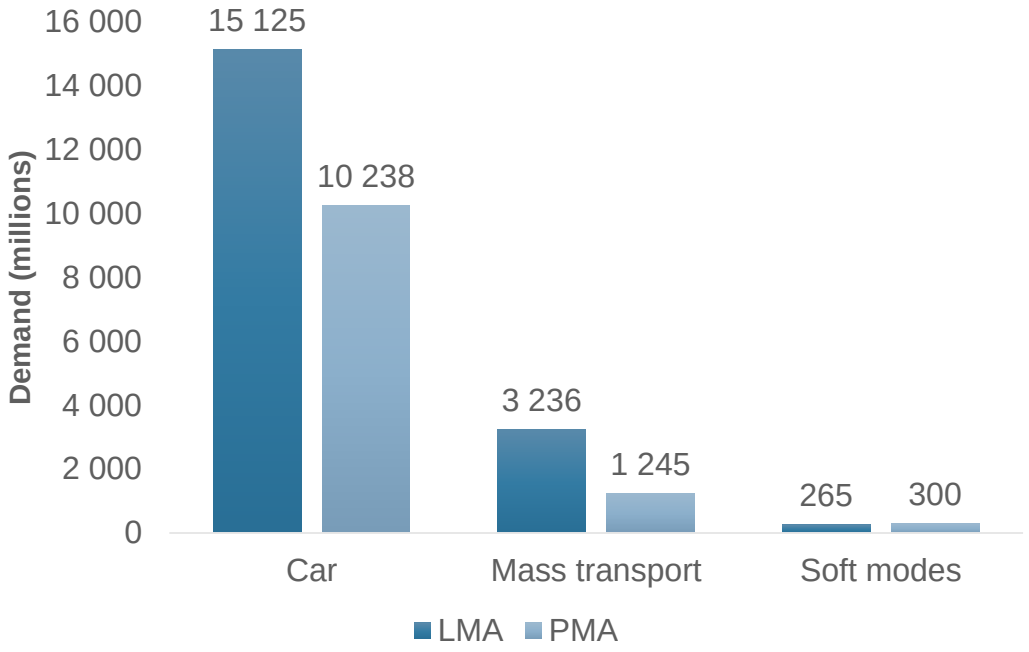
- Mass transport companies are planning new investments to renew its fleet.
- On soft modes, electric bikes and scooters appear as an alternative to the car, especially in short distances.

Source: Reference list 7) to 13) and Appendix 3

Supply clearly surpasses demand in all modes of transport, but the car remains the first choice in commuting

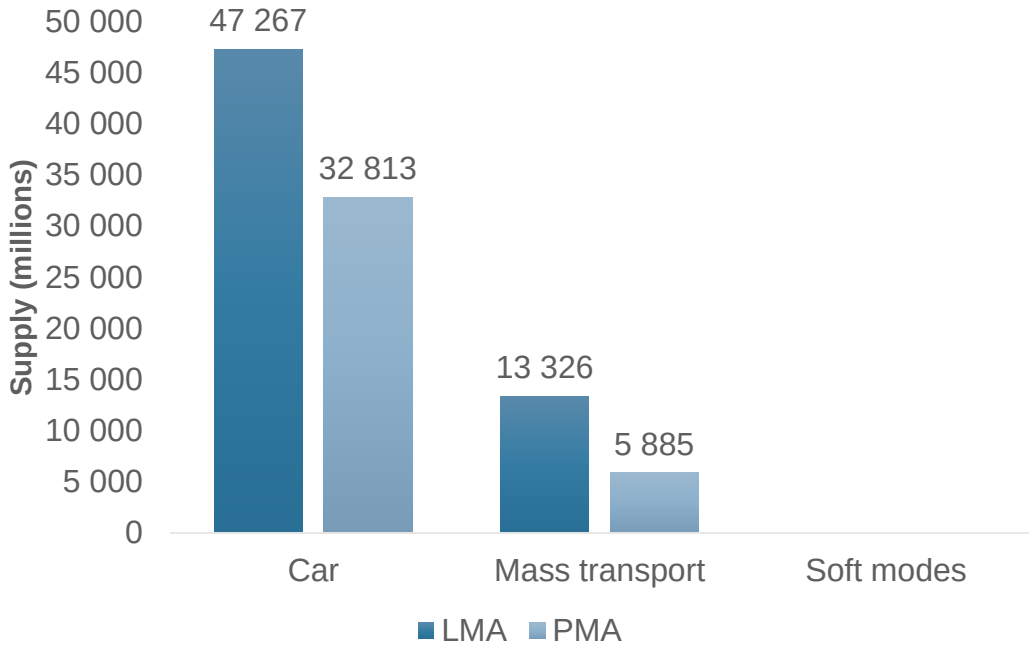
Despite the dominance of supply over demand (more seats*km than pass*km, in general terms), these greater numbers for supply are not constant during the day. Residents in LMA and PMA prefer the car, as there are problems related with the offer of mass transports in peak hours (frequency) and with the proximity of these transports to their residential and working areas.

Graph 9: Demand for the different modes of transport in LMA and PMA (pass*km)



Source: made by the authors based on Reference list 6) to 13) and Appendix 2

Graph 10: Supply for the different modes of transport in LMA and PMA (seats*km)



Source: made by the authors based on Reference list 7) and 8) and Appendix 3

Soft modes appear as a good alternative to the car, especially in short distances

Bicycles (electric and normal)	• Data on demand and supply for electric bikes is very short. • 2 companies are present in LMA (Gira and Jump), offering, together, more than 1 500 bikes for sharing.
Electric scooters	• Data on demand and supply for electric scooters is also very short. • Currently, there are 9 electric scooters companies in LMA, offering more than 5 000 scooters to their users. In PMA, Circ is present in Gondomar, Gaia, Matosinhos and Maia.
Demand and supply	• To calculate demand, it was only considered data on normal bikes. • There is no data available on km made to compute supply, but the value should be residual.

Source: Reference list 14) to 16) (all electric scooters companies were contacted but they were not interested in revealing that data)

Metro de Lisboa and *Metro do Porto* are two of the main key players in mass transport sector

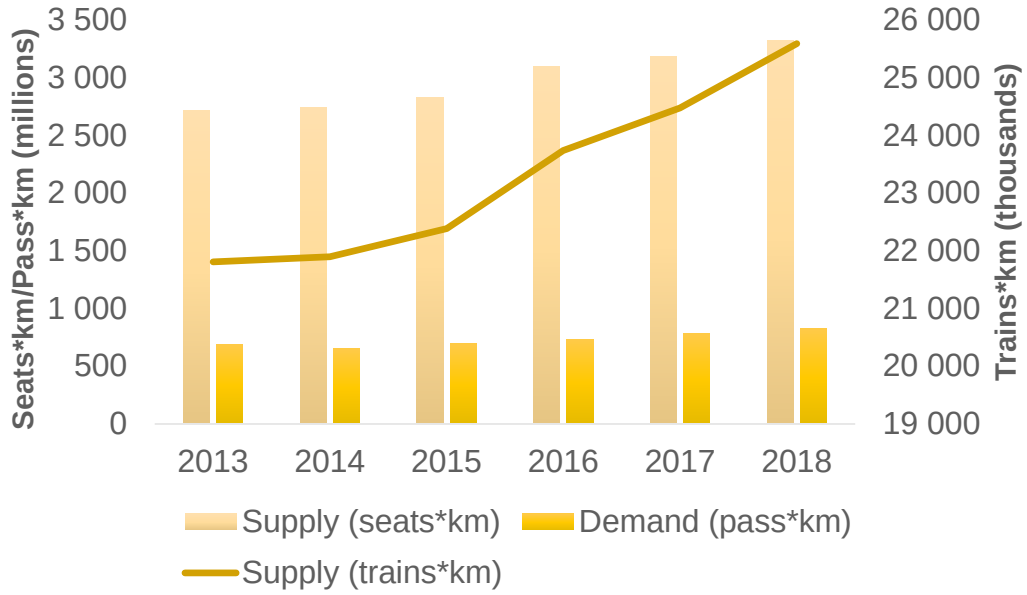
With a market share of approximately 34%, *Metro de Lisboa*, is one of the principal alternatives to the car in LMA.

The company intends to implement new investments to improve the quality of the stations and the frequency of trains in critical hours, for the next year.

In PMA, *Metro do Porto* appears with a market share of 25% in mass transports sector.

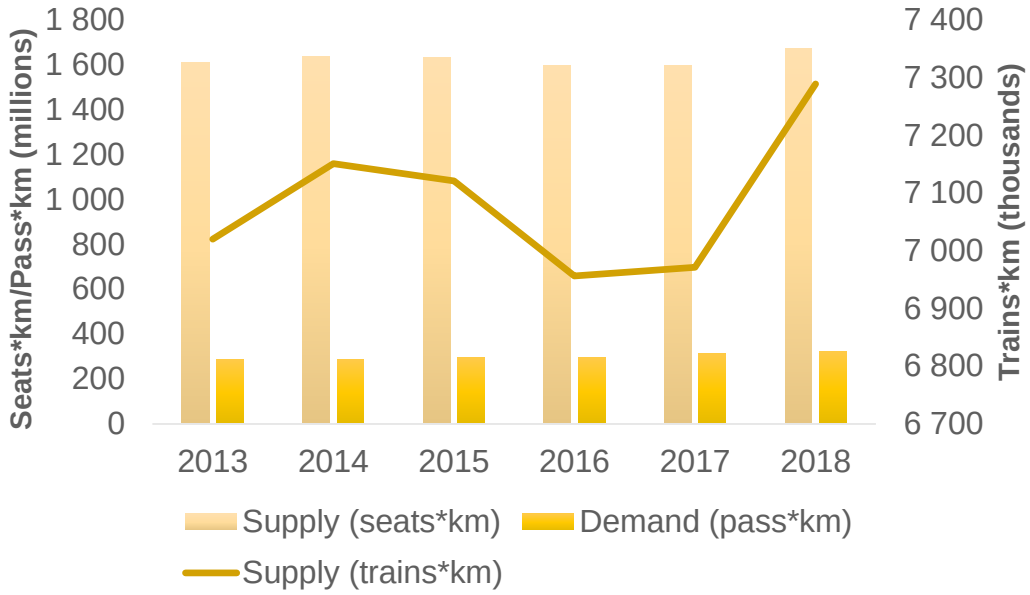
For the next years, a new line will be designed. It will increase demand and help to reduce supply lacks in peak hours and improve the proximity of the service to other areas of PMA.

Graph 11: Metro de Lisboa in numbers



Source: made by the authors based on Reference list 9)

Graph 12: Metro do Porto in numbers



Source: made by the authors based on Reference list 12)

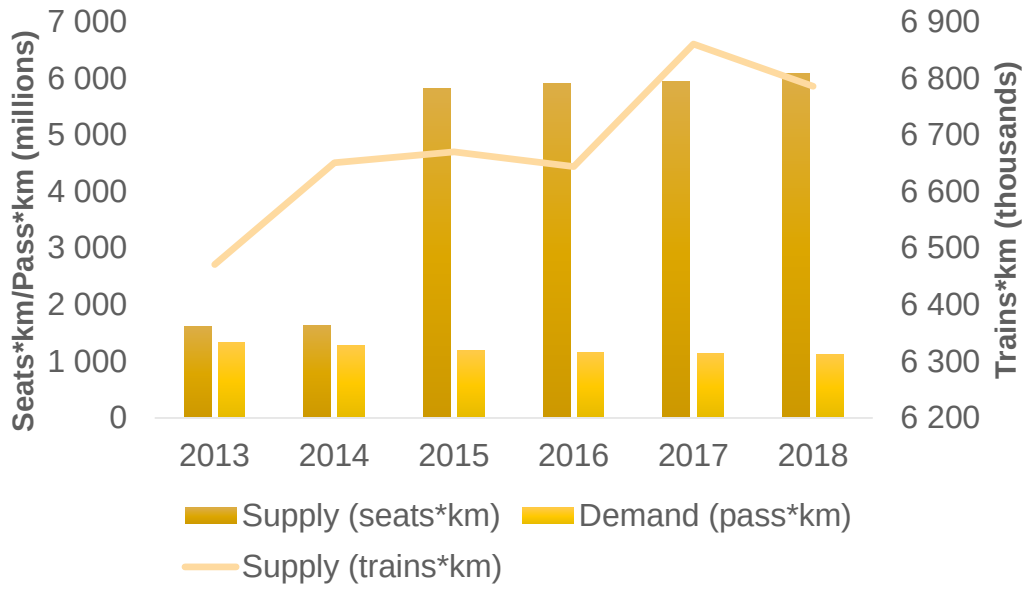
Comboios de Portugal is the main key player in connecting peripherical areas of LMA and PMA

Comboios de Portugal (CP) is the oldest mass transport in Portugal but continues to have a role of very importance in the sector.

CP has a market share of 47% in LMA and 52% in PMA, as it appears as the main mass transport in connecting peripherical regions of the two MAs.

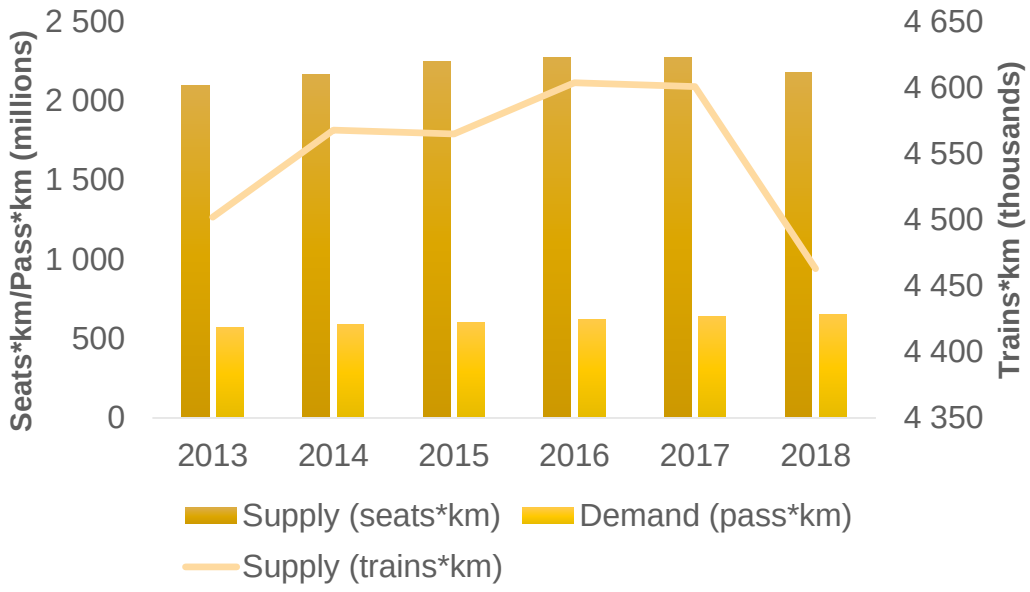
New investments are projected to fight the recent decrease in trains*km, from 2017 and 2018.

Graph 13: CP (LMA) in numbers



Source: made by the authors based on Reference list 11)

Graph 14: CP (PMA) in numbers



Source: made by the authors based on Refence list 11)

Carris and *Sociedade de Transportes Coletivos do Porto (STCP)* take a major role in road transportation, especially in places where metro does not operate

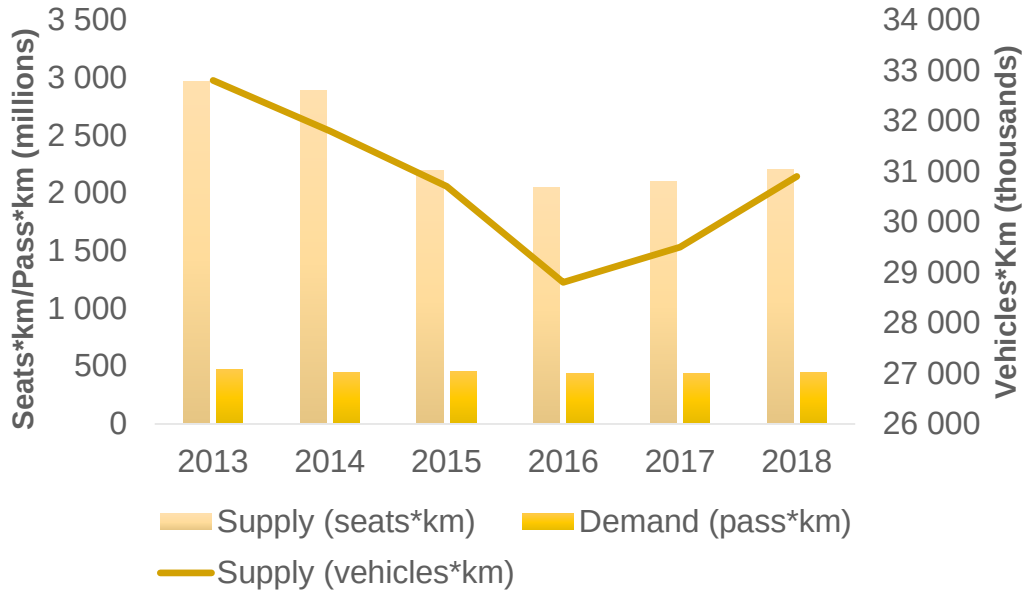
Carris is the most known bus company in LMA. It counts with more than 600 buses on its fleet and operates in a great variety of places inside LMA (mainly in Lisbon).

The company pretends to have half of its fleet with less than 3 years of age in 2021.

STCP is the homonymous of *Carris* in PMA and counts with 419 buses on its fleet.

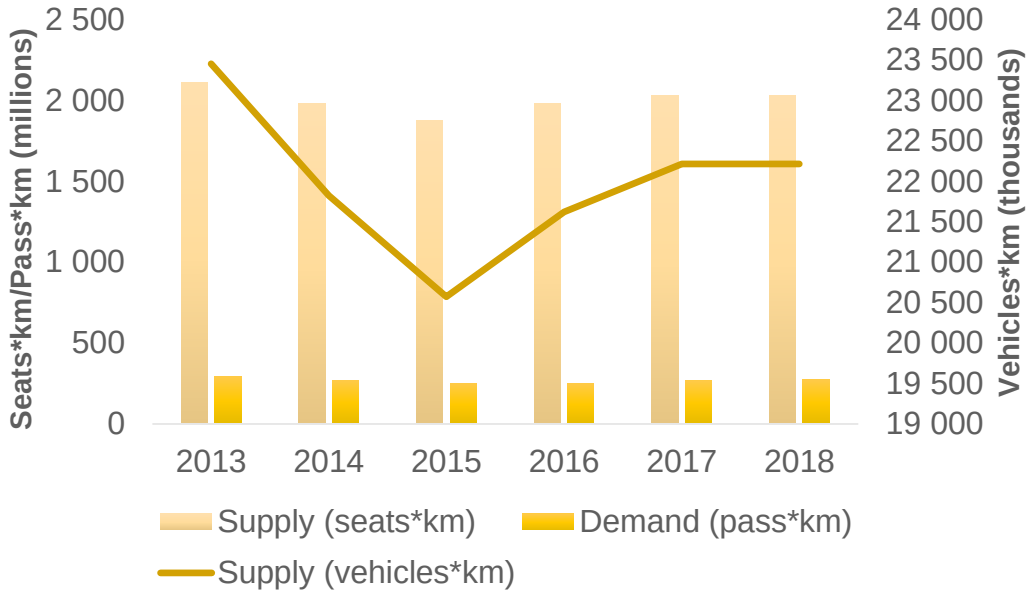
The company has made a recent change in its brand to become closer to the “Intelligent Mobility” concept. In the last year, *STCP* acquired 86 new buses (5 exclusively electric).

Graph 15: Carris in numbers



Source: made by the authors based on Reference list 10)

Graph 16: STCP in numbers



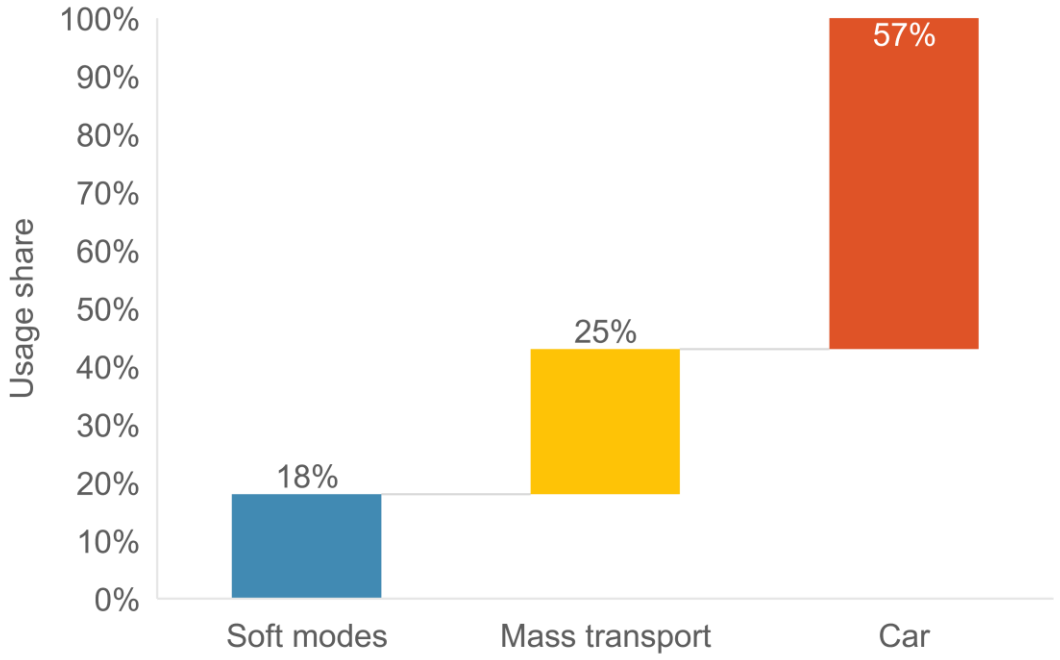
Source: made by the authors based on Reference list 13)

In both LMA and PMA, the car domains in terms of usage share (trips independently of kms made), more than doubling the other modes of transport

In LMA, the car domains in daily urban movements with a share of 57%.

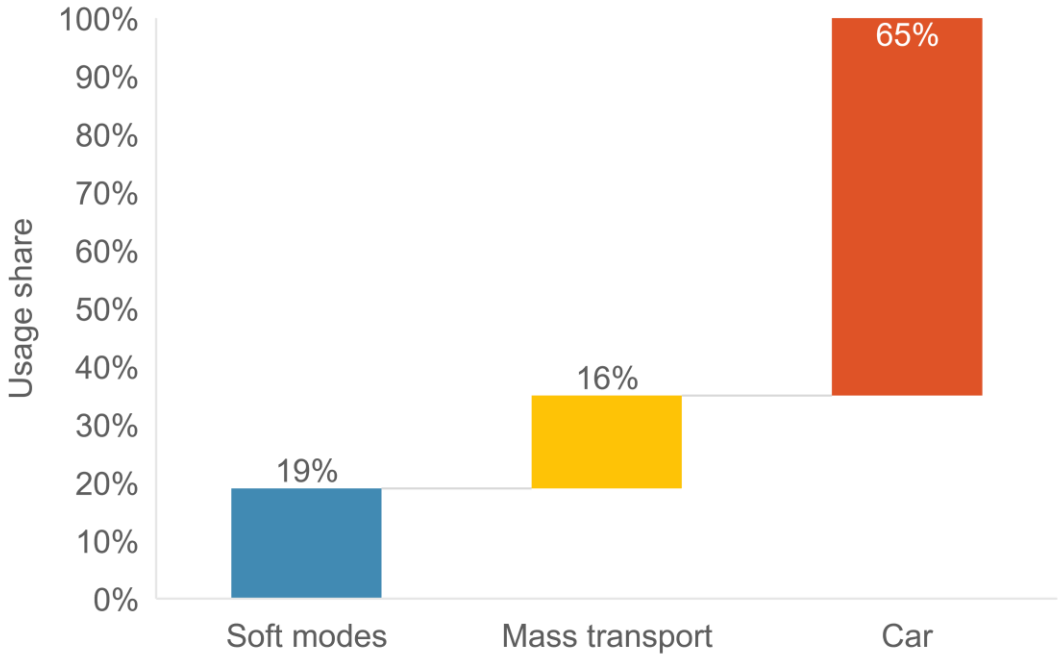
In PMA, the impact of the car is even clearer, comprising almost 2/3 of the total urban dislocations.

Graph 17: Percentual distribution of the utilization of the different modes of transport in LMA



Source: made by the authors based on Reference list 7)

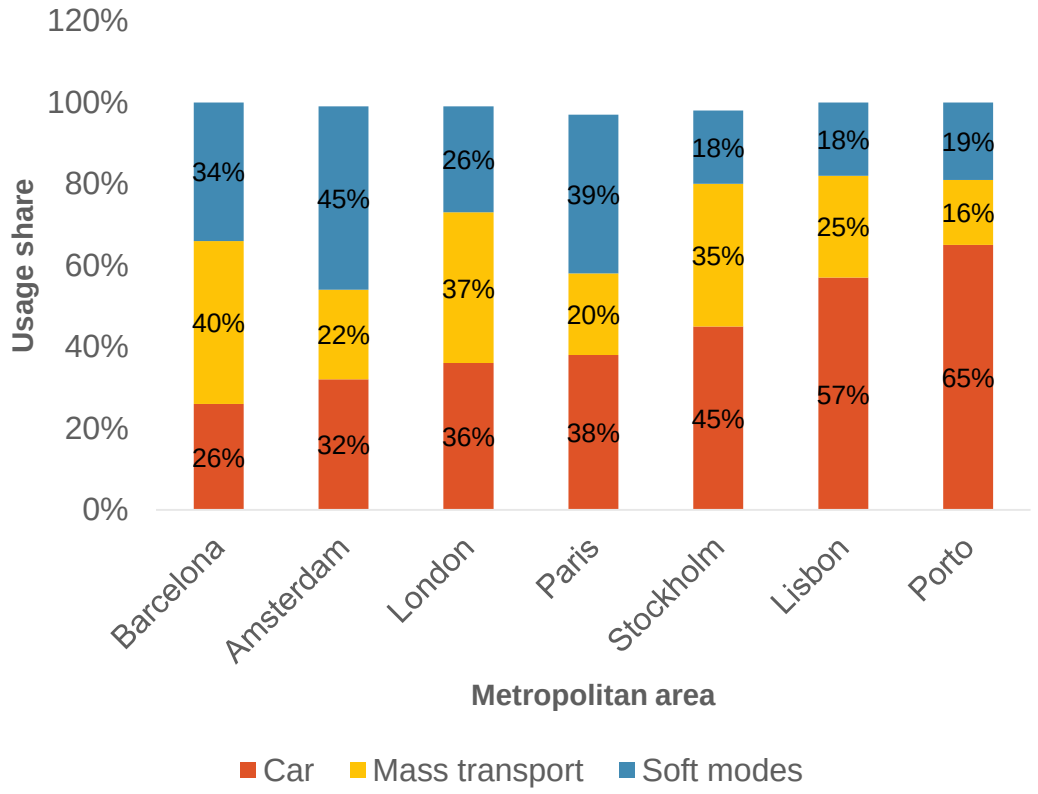
Graph 18: Percentual distribution of the utilization of the different modes of transport in PMA



Source: made by the authors based on Reference list 7)

LMA and PMA position themselves as the metropolitan areas with the worst mix of transports' utilization, in a European frame

Graph 19: Percentual distribution of the usage of the modes of transport across some European metropolitan areas



Source: made by the authors based on Reference list 7) and 17)

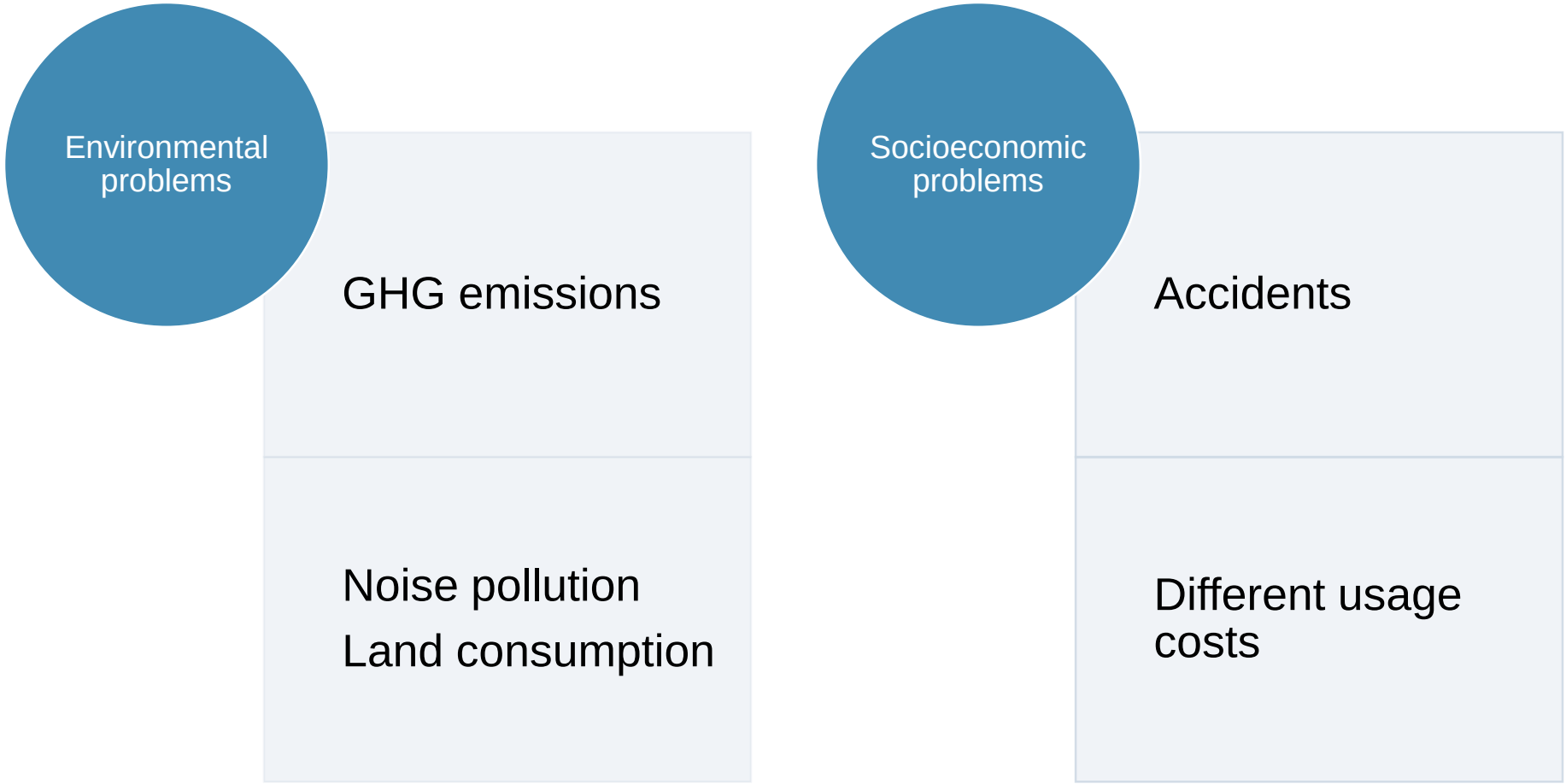
LMA and PMA are the only two MAs where the mix of transports is favorable to the car in more than half (57% and 65%, respectively).

Barcelona has a mix of transports that privileges the mass transport (40% of total dislocations): in that city, efficiency and frequency of mass transports are the priority. On the other hand, there are restrictions to certain type of cars inside the urban center.

Amsterdam is the world capital of cycling (32% of traffic movements is made by bicycle, 45% when combined with movements made exclusively on foot). In addition, 63% of its residents says they use a bike on daily movements at least once.

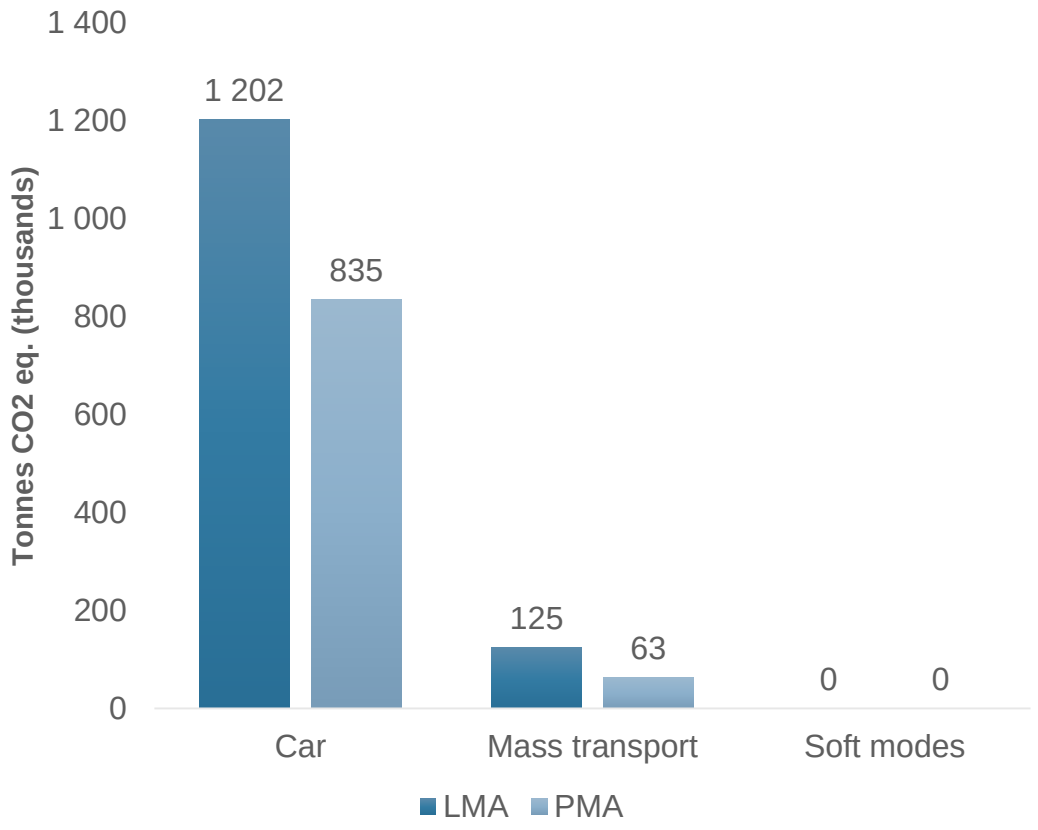
Source: Reference list 17) to 19)

An excessive usage of the car in both LMA and PMA brings socioeconomic and environmental problems



GHG emissions are the greater environmental problem that appears related with the current transports mix, in LMA and PMA

Graph 20: CO2 eq. emissions



Source: made by the authors based on Reference list 9) to 13) and Appendix 4

In both LMA and PMA, GHG emissions are almost 10 times greater for cars than those for the other modes of transport.

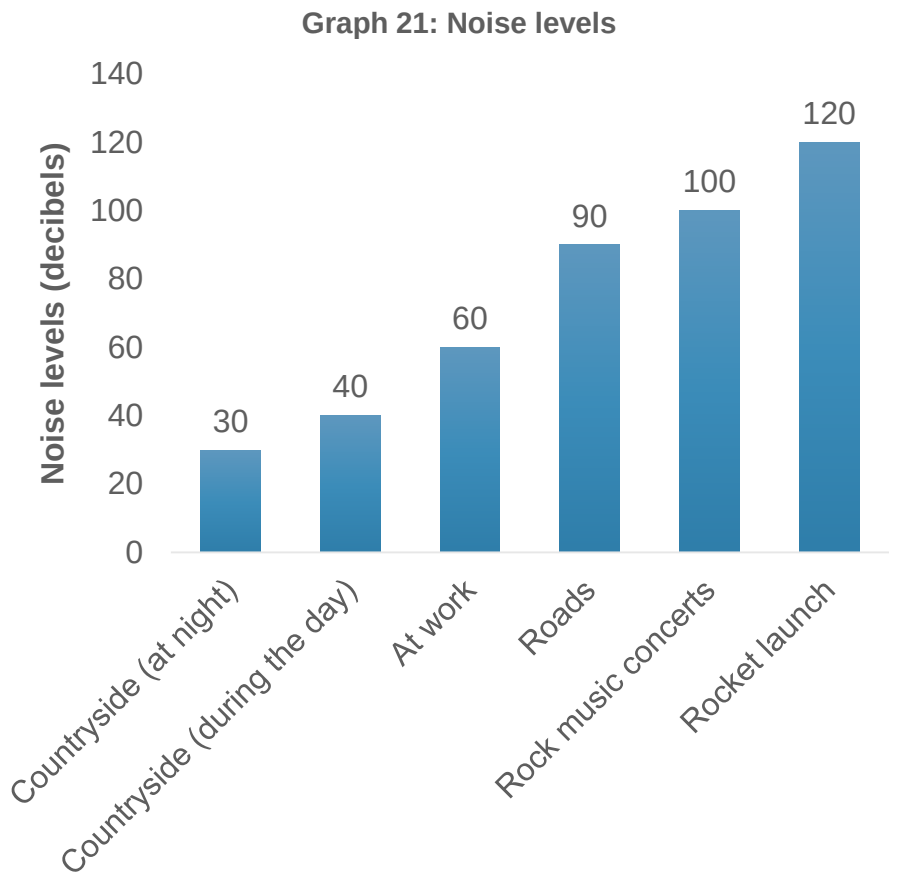
Soft modes' GHG emissions are assumed to be 0 (in fact, walking or riding a normal bicycle does not pollute. For electric bikes and scooters, the value was assumed to be residual).

Despite the increase in shared mobility and electric vehicles, LMA and PMA are currently excessively dependent on the car, that is responsible for 15% of total GHG emissions in Portugal.

In a world where environmental problems are becoming more and more relevant, changing the mix of transports in a way that approximates LMA and PMA mixes to those of some European metropolitan areas will imply a reduction in the total amount of emissions.

Source: Reference list 9) to 13) and Appendix 4

When an individual is exposed to levels of noise pressure above the normal values, road traffic is responsible for most of the situations



Source: Refeence list 21)

Transports (especially road transports) are responsible for exposing 80 million people in EU to excessive noise (above 65 dB, which is the value considered acceptable).

When exposed to levels of noise pressure above 65 dB, road traffic is responsible for 9/10 of those situations, in EU.

Also in Portugal, especially in Lisbon, the most critical situations of exposition to excessive noise occur in regions close to traffic roads and urban centers.

Land consumption

It is another big problem of the excessive usage of the car (each vehicle occupies approximately 18 m2 of land to be parked, a space that could have other utilization).

Source: Refeence list 21)

Road accidents take the highlight in the total number of incidents involving the different modes of transport

Table 1: Rail and Road incidents in 2018

Rail Incidents in 2018	
Total	293
Injured	55
Dead	68

Road accidents in 2018	Total victims	Injured in road accidents	Dead in road accidents
LMA	11 882	11 788	94
PMA	7 074	7 023	51

Accidents involving soft modes of transport in 2018		Total victims	Injured	Dead
LMA	Bicycles	319	316	3
	Pedestrians	1 718	1 680	38
PMA	Bicycles	267	264	3
	Pedestrians	1 168	1 152	16

Source: made by the authors based on Reference list 7) and 22)

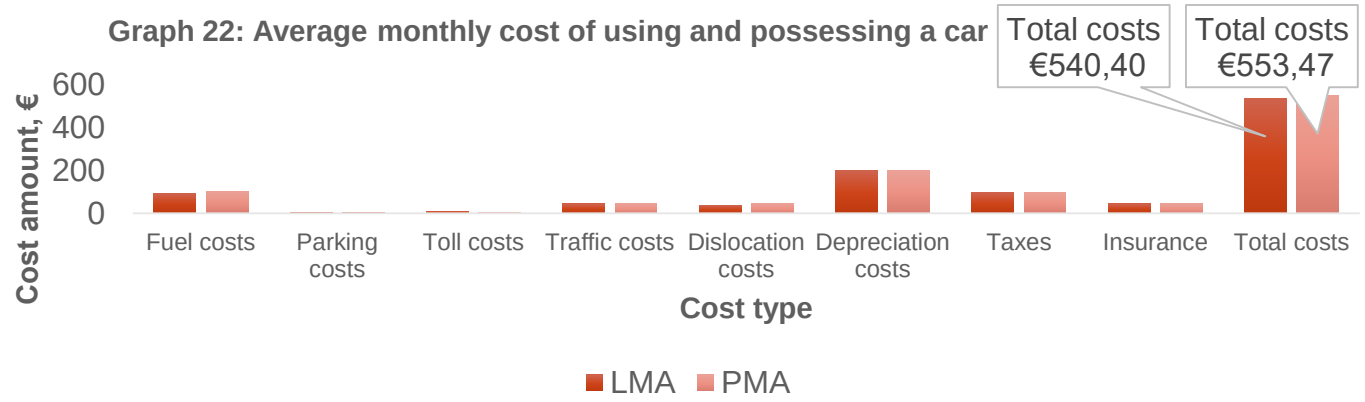
- Non of the 68 dead individuals was a *CP, Metro de Lisboa* or *Metro do Porto* client.
- Only 3 out of the 55 injured individuals was a client of one of the 3 rail companies.

- In PMA, from the 7 074 total victims, 4 412 involved the car and only 129 involved heavy vehicles (category which includes the bus).
- In LMA, the numbers were 4 874 and 176, respectively.

- From the 1 168 and 1 718 pedestrian victims in PMA and LMA, respectively, 1 059 and 1 629 are related to run over, i.e., involve the car

Source: made by the authors based on Reference list 7) and 22)

The cost of using and possessing a car more than doubles that of using mass transports, in LMA



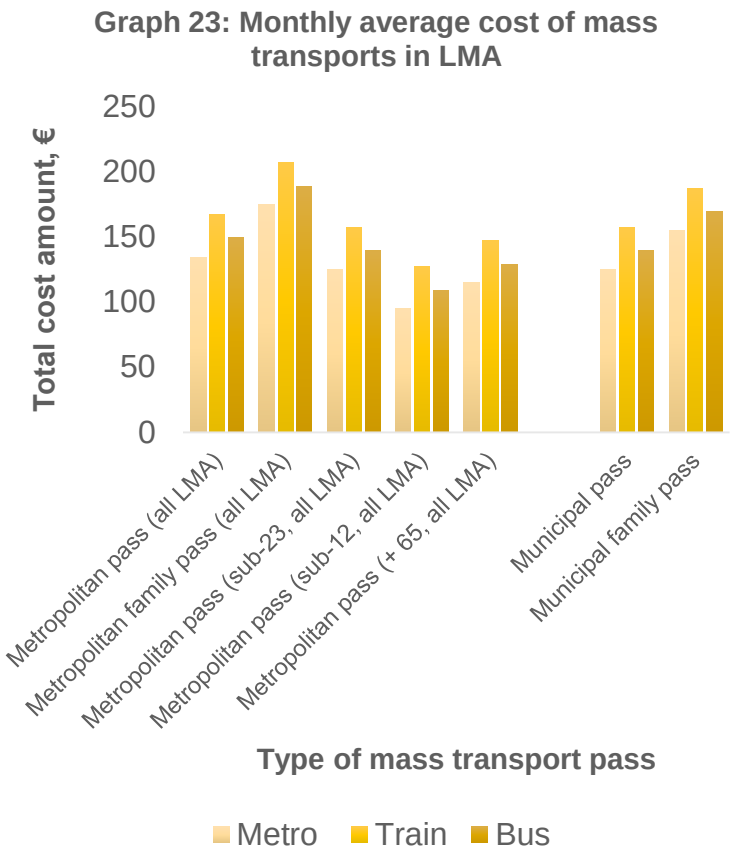
The total cost of using and possessing a car reaches more than 500€ in LMA and PMA.

From these costs, depreciations, fuel and taxes are the more relevant for the drivers.

All the different types of mass transport cost less than 210€ for a resident in LMA, less than half of the cost of using and possessing a car in LMA.

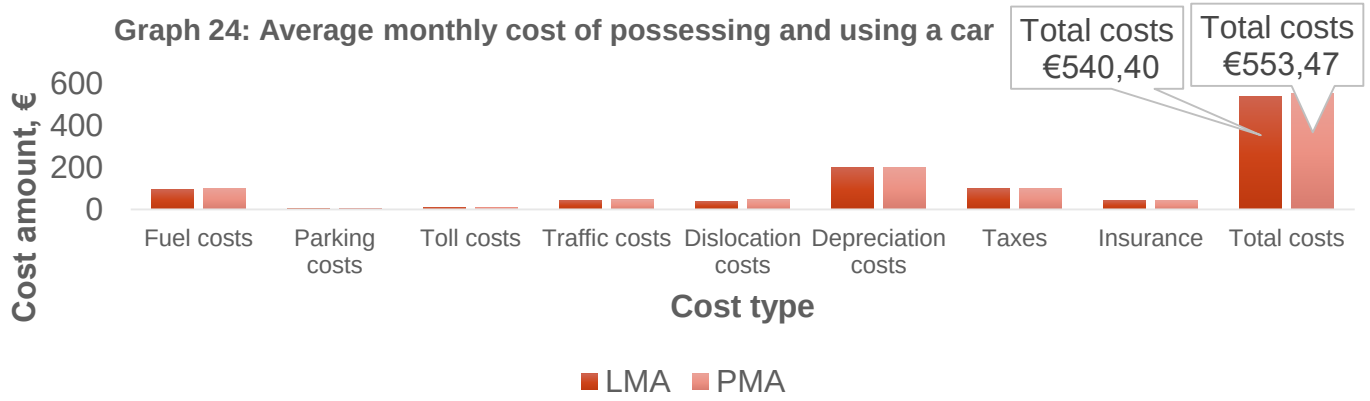
To compute those costs (for mass transport), beyond the cost of the pass itself, timing and dislocation costs were also considered.

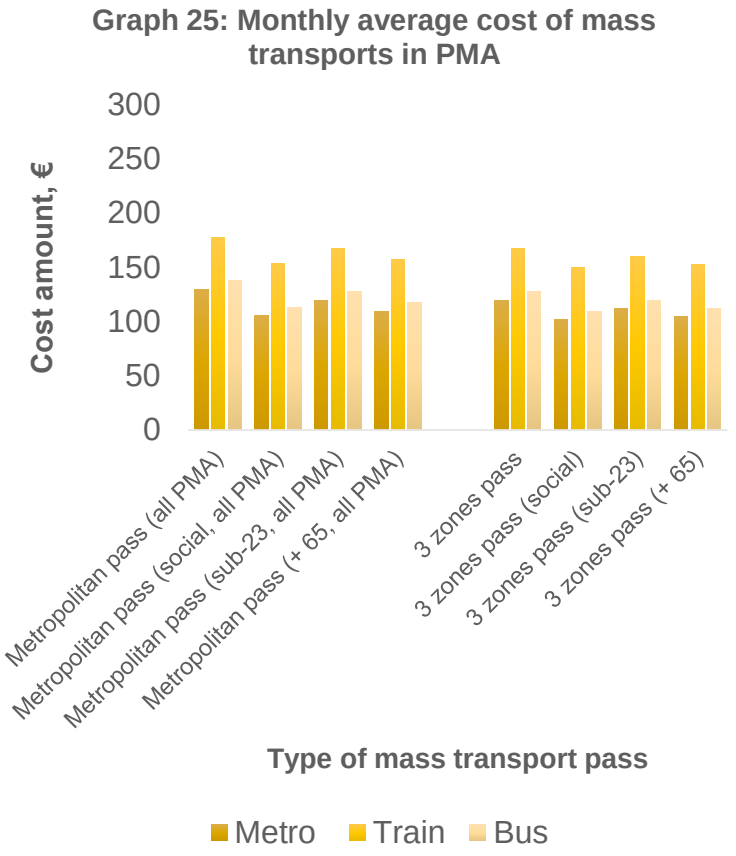
Source: made by the authors based on Reference list 24) and 25) and Appendix 5



Source: made by the authors based on Reference list 23) and Appendix 5

The cost of using and possessing a car more than doubles that of using mass transports, in PMA





The total cost of using and possessing a car reaches more than 500€ in LMA and PMA.

From these costs, depreciations, fuel and taxes are the more relevant for the drivers.

All the different types of mass transport cost less than 180€ for a resident in PMA, approximately 1/3 of the cost of using and possessing a car in PMA.

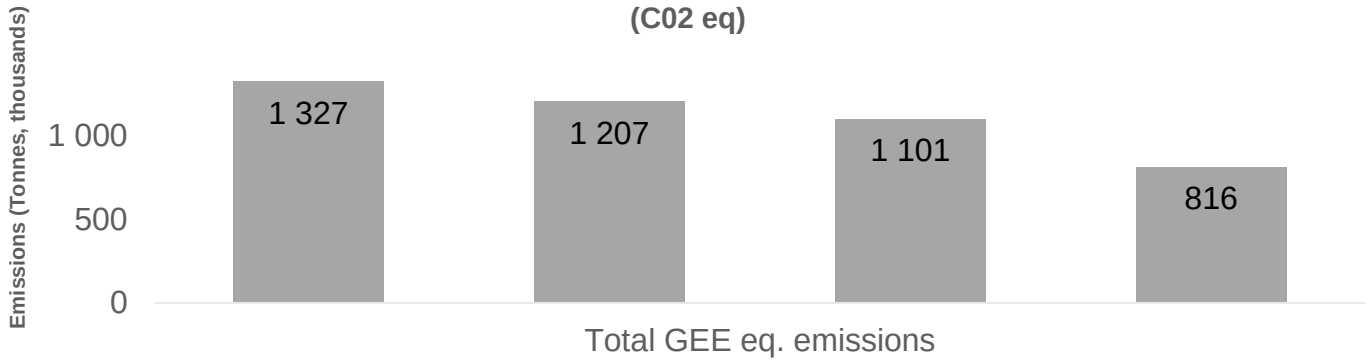
To compute those costs (for mass transport), beyond the cost of the pass itself, timing and dislocation costs were also considered.

Source: made by the authors based on Reference list 24) and 25) and Appendix 5

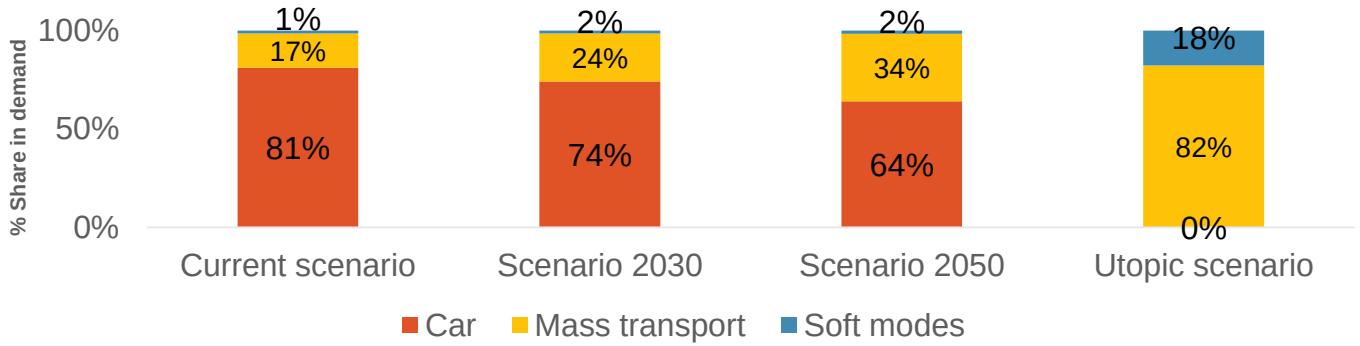
Source: made by the authors based on Reference list 26) and Appendix 5

In a utopic scenario where there were no cars, GHG emissions would be reduced in approximately 39%, in LMA

Graph 26: Evolution on GHG emissions depending on transport mix scenarios (C02 eq)



Graph 27: Possible scenarios for transport mixes in LMA



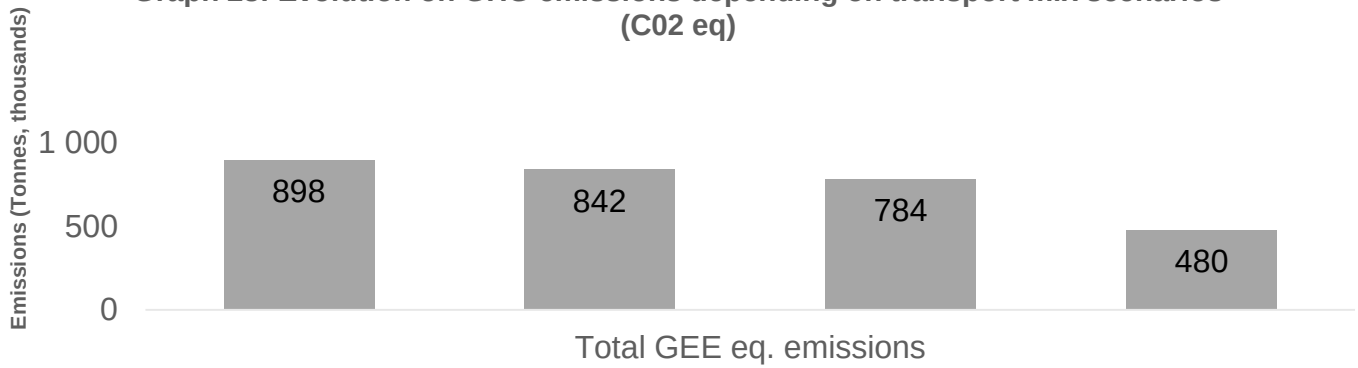
Demand for the car is gradually decreasing, assuming that the same will be satisfied with the other two modes of transport (mass and soft), according to the expected increase in these two modes for 2030 and 2050, respectively.

As one will always have to deal with the car, a scenario where cars do not exist seems implausible. However, for 2030 and 2050, if projections apply, it will be possible to reduce GHG emissions in 9% and 17%, respectively.

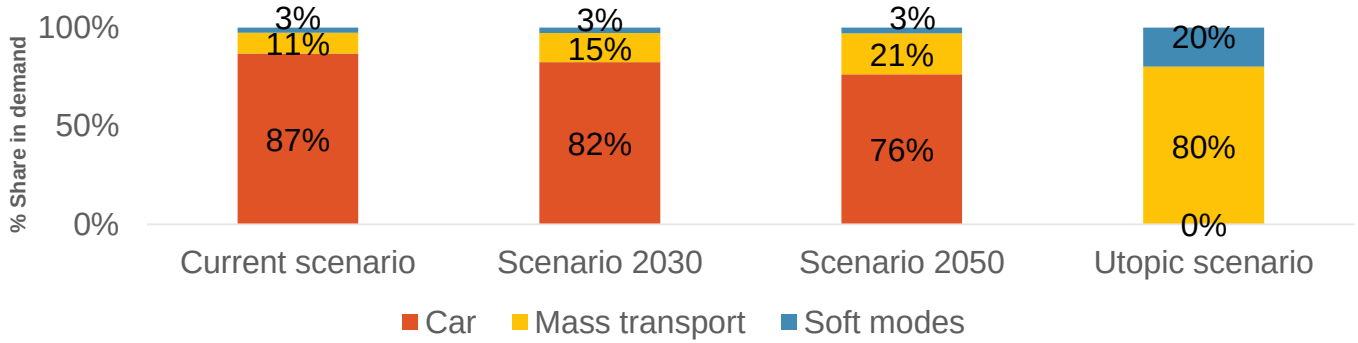
Source: made by the authors based on Reference list 7),to 13, 20),27) and 28) and Appendix 6

In a utopic scenario where there were no cars, GHG emissions would be reduced in approximately 47%, in PMA

Graph 28: Evolution on GHG emissions depending on transport mix scenarios (C02 eq)



Graph 29: Possible scenarios for transport mixes in PMA



Demand for the car is gradually decreasing, assuming that the same will be satisfied with the other two modes of transport (mass and soft), according to the expected increase in these two modes for 2030 and 2050, respectively.

As one will always have to deal with the car, a scenario where cars do not exist seems implausible. However, for 2030 and 2050, if projections apply, it will be possible to reduce GHG emissions in 6% and 13%, respectively.

Source: made by the authors based on Reference list 7),to 13, 20), 27) and 28) and Appendix 6

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Appendix 1 – Importance of Urban movements in Total dislocations

Graph 6: % Share in Urban mobilty

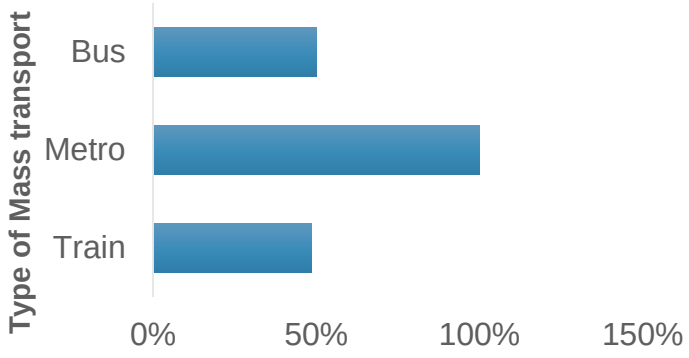


Table 1: Share in Urban movements in Total dislocations computation

	Pass*Km Urban movements	Pass*Km Total movements (urban and long-distance)	Share of Urban movements in Total movements
Train	1989,32	4 104,31	48%
Bus	2060	4 113	50%
Metro	1144,67	1 144,67	100%

This table contains information about the importance of urban movements in LMA and PMA in the total dislocations made by residents in Portugal in these three different transport modes.

Table 2: Cars' demand computation

	Cars/inhabitant	Inhabitants	Total amount of cars	Occupancy rate	Passengers	Total number of km per year	Pass*Km (millions)
LMA	0,459	2 812 678	1 291 019	1,6	2 065 631	7322	15125,35
PMA	0,459	1 836 512	842 959	1,56	1 315 016	7785	10237,58

This table contains information about demand (measured in Pass*Km) for cars in both LMA and PMA.

Table 3: Importance of urban dislocations in total dislocations using the car, in LMA and PMA

	Total number of Km per year	Average number of Km per year for a Portuguese	Share of Urban movements in Total movements
LMA	7322,3891	9 000	81%
PMA	7785,14048	9 000	87%

This table contains information about the share of urban movements in the total dislocations made by residents in LMA and PMA in a year.

Appendix 2 - Demand

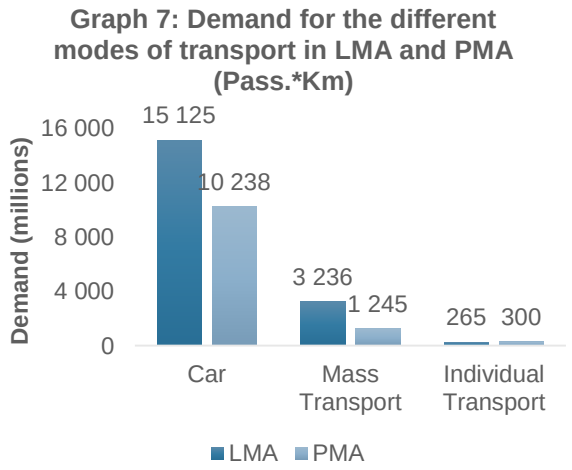


Table 4: Demand for main Mass Transport in LMA/PMA

Passengers/Km (millions)	2017	2018
Grupo Barraqueiro	-	625,6
Carris	440,1	449,1
Metro de Lisboa	777,7	823,3
STCP	267,0	272,0
Metro do Porto	312,5	321,4
CP (LMA)	1270,5	1338,2
CP (PMA)	639,0	651,2

This table contains information about demand (measured in Pass*Km) for the most relevant players in LMA and PMA

Table 5: Soft modes' demand computation

	On foot	Bicycle
	LMA	PMA
Average distance	1,5 km	2,3 km
Total distance (Km)	547,5	839,5
Population	2 261 393	1 449 008
Usage share	18,5%	23%
"Passengers"	418 358	333 272
"Passengers"*Km (millions)	229	280
Greenhouse gases emissions (millions)	0	0

This table contains information on demand (measured in Pass*Km) for the modes of transport "On foot" and "Bicycle.

Table 2: Cars' demand computation

	Cars/inhabitant	Inhabitants	Total amount of cars	Occupancy rate	Passengers	Total number of km per year	Pass*Km (millions)
LMA	0,459	2 812 678	1 291 019	1,6	2 065 631	7322	15125,35
PMA	0,459	1 836 512	842 959	1,56	1 315 016	7785	10237,58

This table contains information about demand (measured in Pass*Km) for cars in both LMA and PMA.

Table 6: Demand for different Transport Modes

Passengers*Km (millions)	LMA	PMA
Car	15 125,4	10 237,58
Mass Transport	3 236,2	1244,5
Soft modes	265	300

This last table aggregates, per mode of transport, the information contained in the previous tables, presenting the final values for Passengers*Km.

Appendix 3 - Supply

Graph 8:Supply for the different modes of transport in LMA and PMA (Seats.*Km)

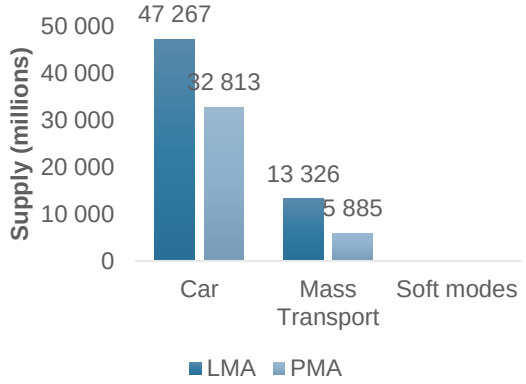


Table 7: Supply for main Mass Transport in LMA/PMA

Seats*Km (millions)	2017	2018
Grupo Barraqueiro	-	2072,3
CARRIS	2101,0	2200,0
ML	3177,6	3322,1
STCP	2035,0	2032,0
METRO DO PORTO	1598,4	1670,1
CP (LMA)	6001,0	5732,0
CP (PMA)	2276,0	2183,0

This table contains information about supply (measured in Seats*Km) for the most relevant players in LMA and PMA.

Table 8: Cars' supply computation

	LMA	PMA
Population	2 812 678	1 836 512
Cras/Inhabitant	0,459	0,459
Number of cars	1 291 019	842 959
Average number of seats	5	5
Average number of kms per year	7322	7785
Seats*Km (millions)	47267	32813

This table contains information about supply (measured in Seats*Km) for cars in both LMA and PMA.

Table 9: Supply for different Transport modes

	LMA	PMA
Car	47 266,7	32 812,8
Mass Transport	13 326,4	5 885,1
Soft modes	-	-

This last table aggregates, per mode of transport, the information contained in the previous tables, presenting the final values for Seats*Km.

Appendix 4 – GHG emissions

Graph 20: CO2 eq. emissions

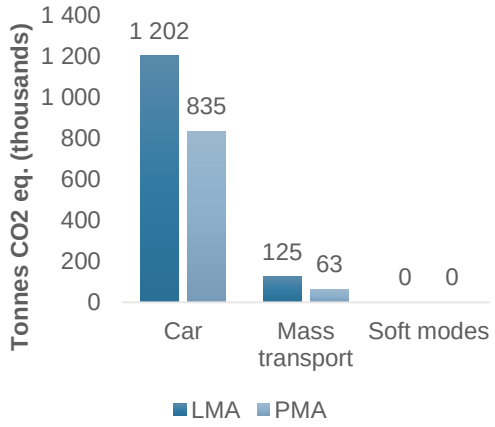


Table 10: GHG Emissions for Mass Transport

	Kg CO2 e
CARRIS	51 729,00
ML	38 000,00
STCP	34 124,00
METRO DO PORTO	12 400,00
CP (LMA)	35 276,56
CP (PMA)	16 956,55

This table contains information about GHG emissions (measured in Tonnes CO2) for the most relevant players in LMA and PMA.

Table 11: Cars' GHG emissions computation

	LMA	PMA
Number of cars	1 291 019	842 959
Number of kms made in a year	7322	7785
Average age of a car in Portugal	9,3 years	9,3 years
Average emissions (for a car with 9,3 years of age, gCO2/km)	127,2	127,2
Average number of dislocations made by a resident	2,6	2,72
% of dislocations made by car	58,9%	67,6%
Total amount of emissions (Tonnes CO2 eq., thousands)	1 841,46	1 534,88

This table contains information on the estimation of the amount of cars' GHG emissions.

Table 12: GHG emissions for different Transport Modes

CO2 eq. Emissions (Tonnes CO2 eq., thousands)	LMA	PMA
Car	1 202,47	834,76
Mass transport	125,01	63,48
Soft modes	0	0

This table aggregates GHG emissions per mode of transport in both LMA and PMA, using information from the previous tables. The values are presented in Thousands CO2 eq. Tonnes.

Appendix 5 – Economic costs for the car and Mass transports

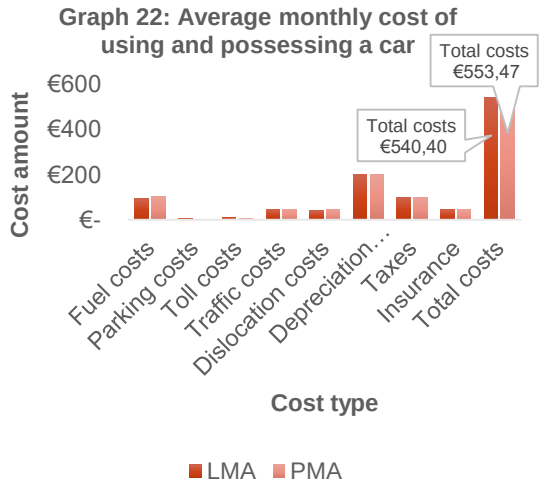
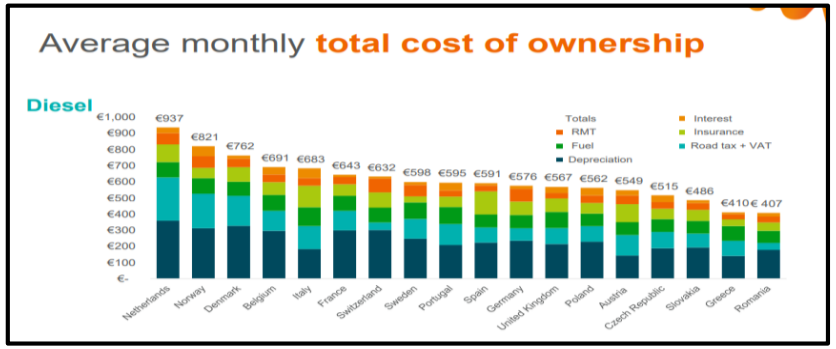


Figure 3: Cars' average monthly cost



This table contains information about the cost of using and possessing a car (diesel powered) in some European countries.

Table 13: Cars' different cost types

	LMA	PMA
Fuel costs	95,20 €	103,21 €
Parking costs	6,15 €	3,89 €
Toll costs	8,80 €	7,19 €
Traffic costs	45,35 €	50,13 €
Dislocation costs	39,91 €	47,37 €
Depreciation costs	200,00 €	200,00 €
Taxes	100,00 €	100,00 €
Insurance	45,00 €	45,00 €
Total costs	540,40 €	556,78 €

This table resumes, by item, the different costs associated with the usage and possession of a car.

Figure 4: Extra travel time in peak hours in PMA

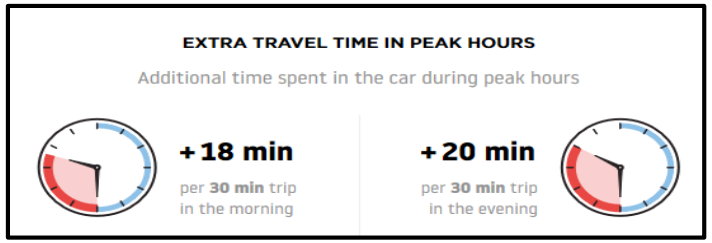
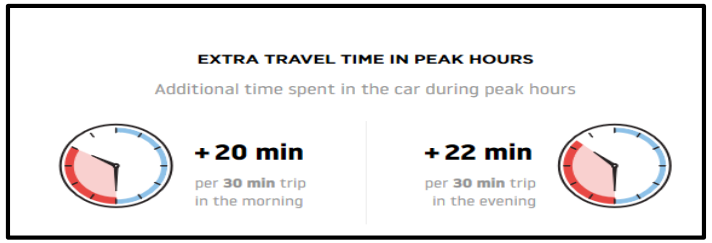


Figure 5: Extra travel time in peak hours in LMA



This figure contains information about the extra time lost in peak hours (in traffic) in LMA and PMA.

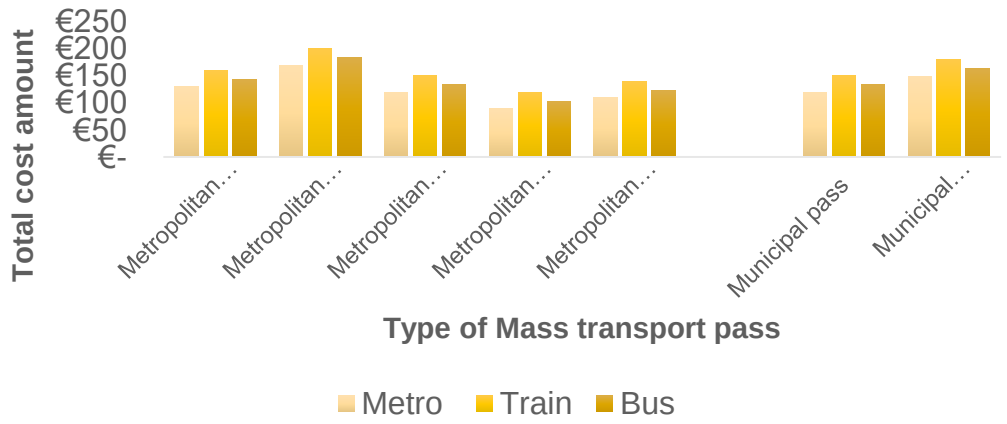
Table 14: Average hourly wage in Portugal

	2018
Average wage in Portugal (€)	943,00
Average number of hours worked in Portugal per week (hours)	36
Average hourly wage in Portugal (€)	6,51

This table contains information about average hourly wage in Portugal, used to measure (in €) the cost of traffic, presented in *Table 13*, as well as the dislocation costs, from *Table 13.*

Appendix 5 – Economic costs for the car and Mass transports

Graph 23: Monthly average cost of Mass transports in LMA



Graph 25: Monthly average cost of Mass transports in PMA

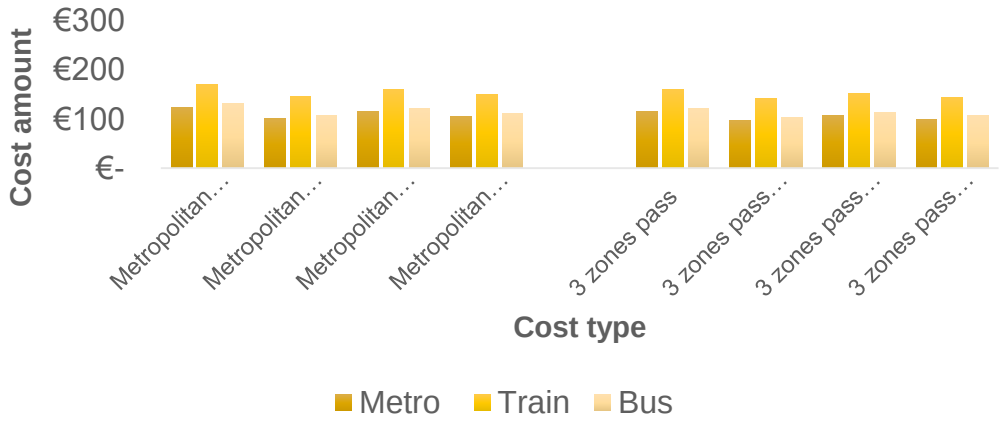


Table 15: Pass costs in LMA

Type of public transport pass	Pass cost
Metropolitan pass (all LMA)	40,00 €
Metropolitan family pass (all LMA)	80,00 €
Metropolitan pass (sub-23, all LMA)	30,00 €
Metropolitan pass (sub-12, all LMA)	- €
Metropolitan pass (+ 65, all LMA)	20,00 €
Municipal pass	30,00 €
Municipal family pass	60,00 €

Table 16: Pass costs in PMA

Type of public transport pass	Pass cost
Metropolitan pass (all PMA)	40,00 €
Metropolitan pass (social, all PMA)	16,00 €
Metropolitan pass (sub-23, all PMA)	30,00 €
Metropolitan pass (+ 65, all PMA)	20,00 €
3 zones pass	30,00 €
3 zones pass (social)	12,00 €
3 zones pass (sub-23)	22,50 €
3 zones pass (+ 65)	15,00 €

Table 17: Dislocation costs for Mass transports

LMA	Dislocation costs
Metro	94,80 €
Train	127,51 €
Bus	109,37 €
PMA	**Dislocation costs**
Metro	89,78 €
Train	137,54 €
Bus	97,43 €

These tables contain information about the pass and dislocation costs of using the different Mass transports in LMA and PMA. The dislocation costs were converted into euros using the information in Table.

Appendix 6 – Transport mix scenarios and respective GHG emissions

Table 18: Reduction in Portuguese population

	Portuguese population	Reduction from 2018
2018	10 283 822	-
2030	9 845 000	4%
2050	9 216 000	10%

This table presents information on the percentual reduction in Portuguese population for 2030 and 2050. These percentages will be used to estimate the reduction in global demand, which is assumed to be the same (4% and 10%, for 2030 and 2050, respectively).

Table 19: Demand in current situation (2018)

Demand (Pass*Km)	LMA	PMA
Car	15 125,4	10237,58
Mass Transport	3 236,2	1244,52
Soft modes	265	299,88
Total	18 626,9	11781,98

As *Table 6,* this table aggregates, per mode of transport, the values for Passengers*Km.

Table 20: GHG Emissions in current situation (2018)

CO2 eq. Emissions (Tonnes CO2 eq., thousands)	LMA	PMA
Car	1 202,47	834,76
Mass transport	125,01	63,48
Soft modes	0	0,00
Total	1 327,47	898,24

This table aggregates GHG emissions per mode of transport in both LMA and PMA, using the same information that was needed to build *Table 12* The values are presented in Thousands CO2 eq. Tonnes.

Appendix 6 – Transport mix scenarios and respective GHG emissions

Table 21: Demand in 2030, considering only the effect of the reduction in population

Demand (Pass*Km)	LMA	PMA
Car	14 520,3	9 828,1
Mass Transport	3 106,7	1 194,7
Soft modes	254,8	287,9
Total	17 881,82	11 310,70

This table aggregates, per mode of transport, the values for Passengers*Km, considering only the effects of the reduction in population, presented in *Table 18.*

Table 22: Percentual changes in Mass and Soft modes for 2030

Percentual increase in Mass Transport	40%
Percentual increase in Soft modes	8%

This table presents the expected increase in Mass and Soft modes' demand for 2030. It was assumed, based on current demand, that Mass Transports will increase 5 times more than Soft modes. See Reference list 28).

Table 23: Demand in 2030, considering population effect and Mass Transports increase in demand

Demand (Pass*Km)	LMA	PMA
Car	13 244,4	9 322,1
Mass Transport	4 362,1	1 677,5
Soft modes	275	311
Total	17 881,82	11 310,70

This table aggregates, per mode of transport, the expected values for demand for 2030

Table 24: Reduction in cars' demand for 2030

LMA	PMA
14%	10%

This table gives the expected reduction in cars' demand for 2030.

Table 25: GHG Emissions in 2030

CO2 eq. Emissions (Tonnes CO2 eq., thousands)	LMA	PMA
Car	1 031,69	752,77
Mass transport	175,01	88,87
Soft modes	0	0
Total	1 206,70	841,65

This table aggregates GHG emissions per mode of transport in both LMA and PMA, using the new expected values for demand in 2030, resented in *Table 23.*

Appendix 6 – Transport mix scenarios and respective GHG emissions

Table 26: Demand in 2050, considering only the effect of the reduction in population

	LMA	PMA
Car	13 612,8	9 213,8
Mass Transport	2 912,6	1 120,1
Soft modes	238,8	269,9
Total	16 764,2	10 603,8

This table aggregates, per mode of transport, the values for Passengers*Km, considering only the effects of the reduction in population, presented in *Table 18.*

Table 22: Percentual changes in Mass and Soft modes for 2050

Percentual increase in Mass Transport	40%
Percentual increase in Soft modes	8%

This table presents the expected increase in Mass and Soft modess' demand for 2050. It was assumed, based on current demand, that Mass Transports will increase 5 times more than Soft modess and that the increases will be of the same magnitude as in 2030.

Table 27: Demand in 2050, considering population effect and Mass Transports increase in demand

	LMA	PMA
Car	10 743,3	8080,39
Mass Transport	5 741,9	2 208,1
Soft modes	279	315
Total	16 764,2	10603,8

This table aggregates, per mode of transport, the expected values for demand for 2050

Table 28: Reduction in cars' demand for 2050

LMA	PMA
29%	**21%**

This table gives the expected reduction in cars' demand for 2050.

Table 29: GHG Emissions in 2050

CO2 eq. Emissions (Tonnes CO2 eq., thousands)	LMA	PMA
Car	854,09	658,86
Mass transport	246,44	125,15
Soft modes	0	0,00
Total	1 100,53	784,01

This table aggregates GHG emissions per mode of transport in both LMA and PMA, using the new expected values for demand in 2050, presented in *Table 27.*

Appendix 6 – Transport mix scenarios and respective GHG emissions

Table 30: Share of each Mass transport in total demand

	LMA	PMA
Train	41%	52%
Bus	33%	22%
Metro	25%	26%

This table presents the share of each type of Mass transport in total demand, given the values in *Table 4.*

Table 31: Increases in demand of each Mass transport given the share in *Table 30*

	LMA	PMA
Reduction in Car	15 125,4	10 237,6
Increase in Mass Transport	12 100,3	8 190,1
Train	5003,5	4285,2
Bus	4018,4	1790,0
Metro	3078,4	2114,8
Increase Soft modes	3 025,1	2 047,5

This table aggregates the increase/decrease in demand for each type of transport using the shares in *Table 30* and assuming that 80% of demand would be for Mass transports and 20% for Soft modes.

Table 32: Demand in the utopic scenario of no cars

	LMA	PMA
Car	0,0	0,00
Mass Transport	15 336,5	9434,59
Soft modes	3 290	2347,40

This table aggregates, per mode of transport, the expected values for demand in the utopic scenario.

Table 33: GHG emissions in the utopic scenario

CO2 eq. Emissions (Tonnes CO2 eq., thousands)	LMA	PMA
Car	0,0	0,00
Mass transport	815,6	480,42
Soft modes	0,0	0,00
Total	815,58	480,42
Total reduction in %	39%	47%

This table aggregates GHG emissions per mode of transport in both LMA and PMA, using the new expected values for demand in the utopic scenario, presented in *Table 32.*