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Electric vehicle adopters' motivation, utilization patterns and environmental impacts: A Lisbon case study

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Abstract

This work aims was to assess electric vehicle (EV) user's motivations, daily patterns and vehicle operation and management. The project was promoted by EMEL – Lisbon's mobility and parking management company, and was publicized among Lisbon's EV user's, who were offered, as an incentive, a green permit which allowed them to park for free in the city's metropolitan central area.

Data was gathered over a period of one year from 25 users (private and fleet drivers) with interviews and on-board diaries, comprising a total of 5132 trips, 49785 km travelled and a total of 8529 kWh charged related to 831 charges. Private users mention environmental and economic (lower running costs) factors as main reasons for adoption, while fleet drivers also stand out the company's image as a motive to deploy this technology in fleets. EV reveals considerable reductions in both energy consumption and CO2 emissions in a Well-to-Wheel life cycle approach, reaching 35-43% and 58-63%, respectively, when compared with conventional internal combustion engine vehicles (gasoline and diesel).

Keywords: Electric Vehicle, driver behavior; mobility patterns; environmental impacts

1 Introduction

Over the last decades, the development of alternative vehicle technologies, such as the full electric vehicle (EV) and plug-in hybrid electric vehicle (PHEV) has risen, and has been regarded as a way to respond to the transportation sector dependency on fossil fuels. The users will face new challenges when adopting these alternative technologies, such as vehicle recharging and management. In this sense, it is essential to understand how and what will change in peoples' mobility and driving patterns. The potential impacts that these changes can have in energy consumption and emissions are also important to assess. The United Kingdom [1], the USA [2], France and China [3] developed strategy plans concerning the adoption of alternative vehicles, focused on who are the potential consumers, a better understanding of the consumer, his preferences and behavior. A strong incentive in EV's has been applied in Portugal with the development of the Electric Mobility Plan/"Plano de Mobilidade Eléctrica" [4], which has led to the deployment of a recharging infrastructure composed of 1300 slow and 50 fast public recharging points spread out across the country. Users are charged with, in addition to the electricity cost, a fee of 0.07 €/kWh for slow charging and 0.20€/kWh for fast charging [5].

Early adopters have already embarked on the adoption of EV, and companies are invested in promoting and introducing them in their fleets [6], but they are still not the first choice when considering vehicle purchases. Taking this into consideration, transport systems will need to be flexible enough in order to integrate and foster these technologies building electric vehicle friendly eco-systems but also the foundations for widespread adoption [7].

Electric vehicle early adopters and potential buyers share the same demographic characteristics over the world, mainly presenting high education levels, high incomes, ages between 30 and 50 years old, are environmentally conscious and live near large cities[8][9][10]. The attitude towards electric vehicles has been assessed with several surveys. A study conducted in six European countries (France, Germany, Italy, Poland, Spain and United Kingdom) concluded that 84% of the 3723 drivers surveyed consider government incentives essential for the widespread distribution of electric vehicles, while 40% defend that the market share will rise rapidly, with Italy and Spain being the more optimistic countries in terms of the future [11].

1.1 EVs users profile

Electric vehicles are also slowly being introduced in companies' fleets. The benefits they convey involve four main aspects, environmental (e.g. less energy spent), financial (e.g. lower running costs), operational (e.g. driving comfort) and company status (associated with the business image contributing to enhance its reputation) [12][13]. The adoption of electric vehicles will bring new challenges, associated with the substantial investments in the technology and the deployment of a charging infrastructure within the facilities [14] and with the unknown future regarding vehicle life expectancy and robustness that might convey long-term costs [15]. Other challenges are more related with fleet management in terms of type of trips, driving contexts, drivers' willingness to accept and use the vehicle and their expectations and adaptions to it, which requires the development of strategic plans for electric vehicle adoption in the company [16].

A survey conducted in the USA to 2302 drivers revealed that only 35% would buy a plug-in electric vehicle, an indicator that the interest in adopting such technologies is shaped predominantly by the perceptions of their disadvantages [8][9]. Results from an on-line based survey developed in Portugal to assess plug-in vehicle acceptance revealed that from the 852 respondents, 13% and 25% are willing to buy an EV and PHEV, respectively. However, when information regarding fuel price is provided, the willingness to buy increases to 57% and 67% for EV and PHEV, respectively [10]. Early adopters and potential buyers have identified several disadvantages mainly related to high acquisition costs, limited driving range and long recharging hours [8][9][11][12] . On the other hand, high fuel economy and lower energy costs are acknowledged as main advantages of adopting these types of vehicles, as well as environmental considerations [8].

As motives to buy an electric vehicle, results from a survey performed in California indicate being in synch with lifestyle (71.6%), economic and environmental reasons (62.35% and 56.17%, respectively) as main motives [17]. However, even though the vehicle is used mainly as a replacement of the conventional vehicle, users still own more than one internal combustions engine (ICE), and the vehicle is used for several types of trips (local errands, visiting family and friends, personal recreation, etc.) with and average daily number of trips of 3.89 [17]. Commuting from home to work rises as the main reason for using the electric vehicles, and users indicate adjustments in trips management and the adoption of a smoother driving style [9].

Results from a Portuguese survey to assess plug-in vehicle acceptance and probable usage patterns, indicates that 70% of potential buyers would preferably recharge the vehicle at home, and 70%-73% would recharge during night-time [10].

Fleet drivers participating on a study developed by Cenex in the United Kingdom in 2011, have scored their driving experience as the same or better when compared to conventional vehicles, essentially in aspects such as environmental performance and braking and acceleration performance [13]. The study developed in California with NEV's, reveals that companies main reasons to adopt the vehicles were the need for a vehicle that fit the company's travel needs, the need for an environmental friendly mode of transport, need for a more affordable fleet vehicle and fuel savings. Small fleets also claim that the EV is mainly used to deliver goods, provide personal mobility at work and transport business clients and associates [17].The charging patterns from the 5 organizations that participated in the Cenex study, reveals that only 11.6% of charging time is related to cheap night rates. An expected result since the vehicles are mainly charged at the company's facilities, and therefore the vehicle will be plugged-in multiple times throughout the day and for short periods of time [13].

1.2 EVs energy consumption and emissions

EV stands out as the best option in comparison to other technologies in terms of CO_2 emissions, when performing the New European Drive Cycle, and considering only low and medium CO_2 charging intensity. However PHEV emit less in high CO_2 intensity scenarios [18]. When considering different EV market penetration scenarios, results indicate that the low scenario is the most likely to occur in the near future with potential CO_2 emission reductions of 3% [19]. Even though results from a Portuguese study reveal that the introduction of alternative vehicle technologies has the potential to originate reductions of energy consumption and CO_2 emissions between 2 and 6% and 7 and73% in 2050, when considering a full life cycle analysis, in the near future, these impacts are not so obvious. The need to understand more deeply the functioning and challenges of these new vehicles and to develop policies and incentives to the user stand out as a main concern [20]. Also, a study regarding the full life cycle analysis of the Portuguese flee, indicates that alternative vehicle technologies, such as those powered by hydrogen or electricity, have substantial lower Well-to-Wheel (WTW) results in both energy consumption and CO_2 emissions when compares to conventional technologies. However, when considering only the fuel production stage, Well-to-Tank (WTT), these vehicles present higher values [21]. Considering its performance and range capacity it is possible to assert that EVs are better suited to urban driving contexts, where they achieve larger reductions in CO_2 and other tailpipe emissions per km travelled. In an urban context EV's can present CO_2 emission reductions between 25 and 40%, a pattern found not only in Ireland, but also in the UK and USA [22]. In Australia, the potential impacts of the introduction of EV's in cities such as Adelaide and Sydney were addressed and results stand out that this technology has the ability to exert an effect on journeys lower than 100km, revealing that each city could obtain reductions of CO_2 emissions by 5%, since most trips made with conventional vehicles are within this range [23].

EV's rising widespread worldwide, and considering the evidence that these vehicles have a high potential to contribute to the transport's system dependence on fossil fuels, they will therefore contribute to a more sustainable mobility. In this sense, the main objective of this study is to assess early adopters' adaptation to EV, considering both private and fleet users, in the city of Lisbon, analyzing their motivation to adopt the vehicle, satisfaction and disappointments with the vehicle, adaptations and changes in lifestyle routines, considering aspects such as driving behavior, mobility management, charging routines, interaction with the charging infrastructure, among others. An assessment to energy consumption and CO_2 emissions is also performed. This analysis is done in a Life-Cycle Approach (LCA), considering a Well-to-Wheel (WTW) analysis, which includes the Tank-to-Wheel stage (TTW) that refers to the fuel consumption and emissions resulting from moving the vehicle during the driving cycle, and the Well-to-Tank (WTT) which accounts for the fuel production stage [21][24]. A comparison between technologies is performed: EV, conventional internal combustion engine running on gasoline (ICE Gas) and Diesel (ICE Diesel).

2 Methodology

This project was promoted by EMEL – Lisbon's mobility and parking management company and developed in collaboration with IDMEC – Mechanical Engineering Institute of the Technical University of Lisbon. The main objective was to evaluate Lisbon's EV early adopters adaptation to the EV, reaching a sample of 25 users both private and fleet users. The project was publicized by EMEL among Lisbon's EV users aiming both private users as well as companies that recently acquired the vehicles for their fleets. The project involved initial interviews with users, as well a survey conducted at the end of the project that members agreed to be part. Private users also authorized to have their mobility patterns monitored for a year, filling a daily on-board travel diary. Both private and fleet users were given a green permit, an incentive created by EMEL, which allowed users to park the vehicles for free in the Lisbon metropolitan area during the duration of the project. Thirteen private users (10 male, 3 female) and 12 fleet drivers (11 male, 1 female) with and average age of 49.2 and 36.7 years, respectively, agreed to participate on the project. Fleet drivers belong to 3 Portuguese companies. Private users presented an average driving experience of 29.9 years and fleet users an average driving experience of 19.6 years. At the beginning of the project, private users owned the vehicle for an average of 5.7 months, using it seven days a week and owned at least one conventional vehicle, while fleet users use the EV as a working instrument every day or specifically for working trips which require the use of a vehicle.

Each participant took part on an interview, composed by 28 open-ended questions for private users and 20 open-ended questions for fleet users, which were taped in order to create a transcript of each interview. The questions focused on aspects such as motivation to acquire the vehicle and use it, vehicle advantages and disadvantages, driving behavior, mobility management, charging routines, improvements necessary and expectations towards the future. The daily on-board diary that private users filled for the course of the project, asked users to collect information such as day, number of trips, kilometers travelled and energy-recharged (kWh). The information gathered was collected monthly from 7 vehicles, since the remaining participants were not able to collect data. This allowed performing an assessment of the vehicle's operation and charging management, considering the Tank-to-Wheel stage (TTW) regarding users' energy consumption and CO_2 emissions while driving the vehicle. The Well-to-Tank (WTT) stage was also taken into consideration, in order to allow a fair comparison between technologies since it concerns the fuels production stage. Reference values for Portugal were used for electricity, standard ICE Gas and ICE Diesel [21][24].

3 Results

3.1 User's perception characterization

The results presented in this section focus mainly on the analysis of user's profile regarding expectations and motivations towards vehicle usage. Results regarding important aspects for buying and EV are presented in Table 1 for both private and fleet users.

Table1: Important factors for buying the EV for private and fleet users (percentage of participants).

Importance of EV	**Private users**	**Fleet users**
Environmental	62%	75%
Economic	62%	25%
Professional	8%	0%
Shift personal live	8%	0%
Technology curiosity	8%	0%
Marketing	0%	33%
Type of trips	0%	25%
None	8%	0%

Environmental and economic (energy cost and running costs) stand out as the main motives for private users to acquire an EV, with 62% of drivers mentioning these factors. Regarding fleet users, even though the environmental factor is considered as important (75%), 33% mention Marketing (company's image) as one of the main aspects for introducing EV's in a company's fleet (Table 1).

When questioned about EV's main advantages, economic (85%), comfort (77%) and environmental (46%) factors are mentioned by private user, as can be seen on Table 2. Other aspects with less expression are also mentioned such as fuel independence (23%), design (8%) and safety (8%). However, fleet users responses reveal that for these types of users the vehicle's main advantages are the environmental factor (67%) and comfort while driving (50%), and disregarding the economic factor (25%) in comparison to private drivers (Table 2). Autonomy stands out as the EV's main disadvantage for both private and fleet users, mentioned by 77% and 83%, respectively, as seen on Table 3. Drivers also mention existing infrastructure as being a negative aspect, mentioned by 15% of the private users and 25% of fleet users. While 33% of fleet users mention the vehicle's acquisition cost as a disadvantage only 15% of private users mention this aspect, as can be seen in Table 3.

Table 2: EV advantages for private and fleet users (percentage of participants).

Advantages EV	Private users	Fleet users
Economic	85%	8%
Comfort	77%	50%
Environmental	46%	67%
Fuel independence	23%	0%
Design	8%	33%
Safety	8%	0%
Vehicle Power	0%	25%

Table 3: EV disadvantages for private and fleet users (percentage of participants).

Disadvantages EV	Private users	Fleet users
Autonomy	77%	83%
Infrastructure	15%	25%
Cost	15%	33%
Design	15%	0 %
Safety	8%	8%
Speed	0%	17%
EV silence	0%	17%
None	8%	8%

As can be seen on Table 4, the presence of the autonomy indicator (31%) in the vehicle and the fact that there is no need to use gas stations to fill up (31%), followed by driving smoothness (23%) and vehicle power (23%), are mentioned by private users as the main differences between driving and EV or a conventional vehicle powered by gasoline or diesel. On the contrary, fleet drivers either mention that driving is smoother when driving the EV (33%) or that there are no differences (33%) between technologies (Table 4).

Table 4: Differences between driving EV and ICE for private and fleet users (percentage of participants).

Differences EV and ICE	Private users	Fleet users
No trips to gas station	31%	25%
Autonomy indicator	31%	8%
Driving smoothness	23%	33%
Vehicle power	23%	8%
Automatic vehicle	15%	8%
Less cost	15%	0%
Type of fuel	8%	0%
Smaller vehicle	8%	0%
Trips management	0%	17%
Search for charging station	0%	8%
None	0%	33%

Regarding expectations for the future of the EV in Portugal, both groups of users mention that the vehicle is the car of the future (46% and 33%, for private and fleet users, respectively). Fleet drivers also believe that the market will start rising (42%), as well as 23% of private drivers, but, 31% of private users consider that at the moment there are no buying incentives and 8% that there is still no market available in the country. Fleet drivers indicate they would recommend the deployment of electric vehicles in other fleets, mentioning that the type of trips (50%) and services (8%) should be taken into consideration.

As can be seen on Table 5, autonomy was mentioned as the main improvement necessary to enhance EV experience for both groups (77% and 67%), followed by enhancements on the infrastructure (69% and 33%). Vehicle design (25%) and acquisition cost (25%) were also indicated by fleet users as aspects as in need of further improvements. These factors were also mentioned by private users but with less expression (8%). Issues such as vehicle performance/agility (17%) and vehicle management (8%) and promotion (8%), were also indicated by fleet drivers (Table 5).

Table 5: EV improvements for private and fleet users (percentage of participants).

Improvements	Private users	Fleet users
Autonomy	77%	67%
Infra-structure	69%	33%
Design	8%	25%
Acquisition cost	8%	25%
Agility	0%	17%
Management	0%	8%
Vehicle promotion	0%	8%

Tables 6 and 7present results concerned with the impacts of the EV on user's everyday routines and driving style. When stating that the EV had an impact on routines (46% of private users), these are mainly related with more trips (67%), changing the type of road driven (50%), different trip management (50%) and on the number of persons on board the vehicle (17%), as can be seen in Table 6. Fifty per cent of fleet drivers remark that the EV has impacted their daily routines, but only in terms of different trip management (100%). Regarding impact on their driving style, seen on Table 7, 69% of the private drivers consider that their driving style has changed, mentioning that they speed less (78%), are less aggressive (22%) and have a more efficient driving style (17%). Where fleet drivers are concerned, 67% observed changes in driving style, but, as opposed to private users, 38% consider that their driving style becomes more aggressive when driving the EV (Table 7).

Table 6: Impacts on everyday routines (percentage of participants).

Impacts on everyday routines	Private users	Fleet users
No	54%	50%
Yes	46%	50%
More trips	67%	0%
Type of road	50%	0%
Trip management	50%	100%
Number of persons on board	17%	0%

Table 7: Impacts on driving style (percentage of participants).

Impacts on driving style	Private users	Fleet users
No	31%	33%
Yes	69%	67%
Less speed	78%	17%
Less aggressive	22%	25%
More efficient	17%	25%
More aggressive	0%	38%

Regarding mobility patterns, 85% of the private drivers use the vehicle every day to commute to work or drop kids at school and 62% to run small errands, mainly on urban areas (62%) or on inter-urban routes (38%), as can be seen on Table 8. In fleets, drivers use the vehicle essentially for short trips, mainly (92%) in an urban context, for periods of one day (83%) or several days (42%) (Table 8).

Table 8: Private and fleet users mobility patterns (percentage of participants).

Mobility Patterns	Private users	Mobility Patterns	Fleet users
Work/School	85%	Short trips	100%
Errands	54%	Medium trips	8%
Urban	62%	Urban	92%
Inter-urban	38%	Inter-urban	17%
Every day	100%	One day use	83%
		Several days	42%

Users charging routines are presented in Tables 9 and 10. Concerning private drivers charging routines, 92% charge their vehicles at home, during the night (100%) due to a special fee from the Portuguese electricity supplier (Table 9). The vehicle is charged everyday by 33% of the participants, two times a week by 17% and 4 times a week by 42%. Only 38% of private drivers charge the vehicle on the street, doing it during the day (100%) and at night (20%) using both the slow (80%) and fast charging (40%). Street charging occurs every day (60%) and two times a week (20%), as seen in Table 9.

Table 9: Private users charging patterns (percentage of participants).

Charging patterns			
Home	92%	Street	38%
Day	17%	Day	100%
Night	100%	Night	20%
Everyday	33%	Slow Charge	80%
2 Times a week	17%	Fast Charge	40%
4 Times a week	42%	Everyday	60%
		2 Times a week	20%
		4 Times a week	0%

As can be seen in Table 10, 42% of fleet drivers don't charge the vehicle after using it, and when they do, it's done by drivers who use the vehicle for several days at a time, and only at work (42%). Also, 25% mention charging in slow-charging stations in the street (Table 10).

Table 10: Fleet users charging patterns (percentage of participants).

Charging patterns	
Doesn't charge EV after use	42%
Work (one day use)	33%
Work (several days use)	42%
Home (several days use)	17%
Street	25%
Slow charge	100%
Fast charge	67%

3.2 User's mobility profile

As mentioned previously, private users authorized to have their mobility patterns monitored for the course of the project. For this purpose drivers filled an on-board diary, collecting data regarding km travelled, number of trips and kWh charged. Table 11 presents the total sample electric mobility usage profile. From a global point of view, 1243 days of driving were monitored, corresponding to 5132 trips and 49785 km travelled. User's made a total of 831 charges, charging 8529 kWh.

Table 11: Total sample electric mobility profile (percentage of participants).

Days	km	Trips	Charges	kWh
1243	49786	5132	831	8529

Regarding user's usage patterns presented on Table 12, drivers made, on average, 3.5 trips per day and travelled 39.9 km per day making 0.6 charges per day and consuming 6.3 kWh. This usage corresponded to 10.3 kWh consumed per charge and 0.157 kWh per km. Due to the sample small size and its heterogeneity, the results reveal high standard deviations (STDEV) for most of the variables, indicating that a larger sample is necessary in order to have more statistically relevant results. A confidence level analysis reveals that, for a level of confidence of 90% and a deviation level of 20%, a sample of 5 to 24 participants would be necessary to reach more robust results in the variables presented in Table 12.

Table 12: User's electric mobility profile, deviation and level of confidence.

	km/ day	Trips/ day	Charges/ day	kWh/ day	kWh/ km	kWh/ trip	kWh/ charge
Av. EV	39.9	3.5	0.6	6.3	0.157	2.2	10.3
STDEV EV	24.4	2.3	0.2	3.1	0.1	1.2	3.3
Sample (90% CL, 20% Dev.)	21.05	24.58	8.19	13.87	6.42	16.66	5.71

3.3 Environmental impacts

A life cycle analysis approach was used to assess energy and environmental impacts of the technology, considering the Well-to-Wheel (WTW) stage, which includes the Tank-to-Wheel (TTW) and Well-to-Tank (WTT) stages. A comparison between technologies was performed: EV, conventional internal combustion engine running on gasoline (ICE Gas) and Diesel (ICE Diesel). Table 13 presents standard ICE Gas and ICE Diesel values [21].

Table 13: Full life cycle (WTT and TTW) energy and CO_2 results for conventional gasoline and diesel internal combustion engines.

	WTT (MJ/km)	WTT (g/km)	TTW (MJ/km)	TTW (g/km)
ICE Gas	0.27	25	1.96	143
ICE Diesel	0.27	24	1.67	124

Regarding the energy consumption, results show that for the electric vehicle, the TTW has a smaller contribution (0.62 MJ/km) than ICE Gas and ICE Diesel, 1.96 and 1.67 MJ/km, respectively. Even though the opposite is observed when considering the WTT stage, which incorporates the electricity production values for Portugal in 2007 (Figure 1), the EV presents lower WTW results, with an energy consumption of 1.27 MJ/km. Of the three technologies, ICE Gas presents higher consumption results of 2.23 MJ/km.

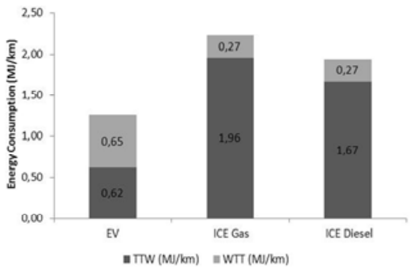

Figure1: Well-to-wheel energy consumption (MJ/km) comparison between technologies (EV, Gas and Diesel ICE)

Concerning CO_2 emissions results the same pattern can be observed, as can be seen in Figure 2. In TTW the electricity input is zero, but in WTT electricity contribution is substantially higher (62 g/km) than that of fossil fuels. Globally, EV exhibits reductions between 35 and 43% in energy consumption and between 58 and 63% in CO_2 emissions.

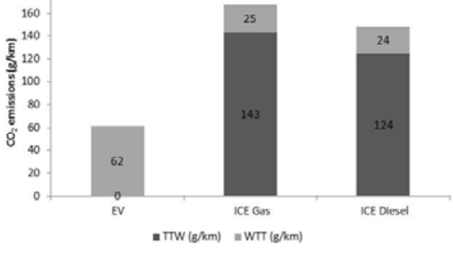

Figure2: Well-to-wheel vehicle CO2 emissions (g/km) comparison between technologies (EV, Gas and Diesel ICE).

4 Discussion and conclusions

Results from a long-term project that monitored a group of EV early adopters of the city of Lisbon are presented. The aim of the project was to assess user’s motivation as well as perceptions towards this alternative technology. The project was promoted by EMEL, Lisbon’s mobility and parking management company and a green permit was offered to the participants as an incentive, allowing them to park for free in the Lisbon metropolitan area. A sample of 25 private and fleet users agreed to participate on the project. The participants’ demographic characteristics follow the trend found in the literature regarding early and potential adopters that indicate that drivers are relatively young, environmental conscious and live in metropolitan areas [8][10].

Participants took part in an initial interview where aspects such as motivation to acquire the vehicle, perceptions towards vehicle usage, driving behavior, mobility patterns, charging routines, among others were addressed. Results revealed that private drivers indicated the economic and environmental aspects associated with the vehicle as the main reasons to buy an EV, which is in accordance with results found in other studies where lifestyle, environmental and economic factors (energy and running costs) stand out as reasons to adopt and EV [8][17]. Image status is mentioned by fleet users, along with environmental factors, as one of the reasons to deploy electric vehicles in fleets. This tendency is corroborated in other studies developed in the USA and in Europe [12][13]. Regarding vehicle advantages, the main three positive aspects indicated by private users focused on economic, comfort and environmental variables, while autonomy and infrastructure are considered the main vehicle disadvantages. These findings are also consistent with those found in the literature [3][8][9][11][25].

When private users consider that their everyday routines suffered changes after adopting the vehicle, these changes are mainly related with travelling more and on different roads. However, fleet drivers mention that a different trip management is necessary when driving the vehicle for working purposes. Overall, most drivers consider that the use of the EV had an impact on their driving style, with private drivers stating that they speed less, are less aggressive and adopt a more efficient driving style. On the contrary, fleet users indicate that their driving style becomes more aggressive, which might be explained due to the novelty of the vehicle and to the fact that they use the vehicle only sporadically, which can lead the drivers to test the vehicle in terms of its performance. From the data collected with the on-board diaries, private users mobility patterns reveal that they made an average of 3.5 trips per day, travelling 40km daily, which are in accordance with finding from a study performed in with early adopters in the USA [17]. Even though Portugal has invested considerably in the deployment of a recharging infrastructure across the country, charging at home appears as private users' ideal place to charge the vehicle, which is done mainly during the night. Such charging patterns are consistent with literature findings in which potential adopters state that they would recharge the vehicle at night instead of charging whenever the vehicle is parked, an indicator that they would manage their trips in a different way and establish a recharging routine [10][25][26]. Fleet users reveal a different usage pattern, also consistent with other findings [13][17]. Drivers use the vehicle mainly for small trips and specifically to work related trips (e.g., meetings, delivering goods, etc.), charging the vehicle during the day, mainly at the companies premises.

Concerning the environmental performance, when compared to the conventional technology, in a life cycle analysis approach, EV reveals considerable reductions in both energy consumption and CO_2 emissions (35-43% and 58-63% respectively). The results are in accordance with other findings that indicate potential CO_2 emission reductions of 25 to 40% in urban contexts [22].

An inside perspective regarding a group of Lisbon's EV early adopters motivations, expectations, adaptations and behaviors towards the use of EV is presented. This analysis allows understanding not only the user's perceptions towards vehicle usage, but also what are barriers and advantages of this rising technology for contributing towards sustainable mobility within the transport sector, considering two different types of users, a group of drivers that use the vehicle for every day for all purpose trips (private users) and those who use the vehicle sporadically for work related trips.

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