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STARS

Shared mobility opporTunities And challenges foR European citieS

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Automotive sector potential impact on vehicle sales and substitution patterns

Deliverable D6.1

Version n° 01

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Acronyms

APV	alternatively-powered vehicles	**ICE**	Internal combustion engine
CATI	Computer Assisted Telephone Interview	**PHEV**	Plug-in Hybrid electric vehicles
CAWI	Computer Assisted Web Interview	**PT**	Public Transport
CS	Car Sharing	**SB**	Station-Based
ECV	Electrically-chargeable vehicles	**SoC**	State of Charge
EV	Electric vehicles	**WP**	Work Package
FF	Free Floating		

Summary

The objective of this deliverable, final result of Task 3.1 (Projected impacts on the automotive sector) within WP6 (Future Industrial impacts), is to review relevant existing European trends, research results, business cases and projects to identify if car sharing service has an impact on automotive sector and beyond.

New mobility services are changing the transportation sector, either by providing entirely new mobility solutions or by reshaping traditional transportation means with technology (e.g. ridesharing with carpooling, micro transit with bus shuttles). As a result, there is more diversity in terms of transportation solutions and a greater offer of individual mobility, as opposed to collective mobility (public transit). From the point of view of the user, these services contribute to a shift from one solution to every mobility need, the privately-owned vehicle, to many customized solutions, involving different means of transport used seamlessly in daily journeys.

Emerging trends in mobility technology, such as the rise of ride hailing and car sharing services, have led many industry analysts to offer their views on how these trends will affect the automotive industry (C.A.R., 2016)

After determining in D3.1 an Analysis of business models for car sharing, in D3.3 it is concluded that any substantial impact from car sharing will only emerge when and if the industry simultaneously adopts other key innovations around connectivity, autonomy, and electrification as part of a radical re-design of business models to suit circular economy concepts. At present, vehicles are not being designed explicitly for car sharing, but in the meantime, there are positive signs in terms of connectivity, autonomy and electrical vehicles

As car sharing continues to grow, it is possible that its relative effect may expand. In the future, car sharing could be headed for a significant scaling up, also through a new business model called “transport-as-a-service” (TaaS), with on-demand autonomous electric vehicles owned by fleets, not individuals.

In this Deliverable, we evaluate the potential impact on vehicle sales and substitution patterns. Will Car Sharing lower the number of passenger motor vehicles required to provide the same level of car-based mobility? This and other many questions remain, regarding the nature and magnitude of the future impacts of car sharing, especially given its expected convergence with ride sharing in the future, facilitated by the advent of autonomous vehicles. Given the enormous impacts of motor vehicles, and with the use of car sharing potentially growing, it is of critical importance to clarify questions related to the expected future impact of these changes in car-based mobility.

To answer these questions, we present here an analysis of the impact of the diffusion of Car Sharing service both on the automotive sector (Car sharing and ICE and EV sale) and on cities, showing the different scenarios between urban and rural areas.

After this, we have carried out an assessment of desired characteristics of the vehicles that will form Car Sharing fleets and substitution patterns between privately owned and shared vehicles, through a picture of current vehicle characteristics and services, an analysis of changes in cars ownership levels of car sharing users and the compliance of electric vehicle characteristics to car sharing operations.

At the end of the study, there's a prevision of future scenarios: a possible Car sharing business evolution, where the key of the success will require automotive players to anticipate market trends sooner and to explore new mobility business models as well as their economical and consumer viability.In this scenario, the automotive sector will probably have to modify its strategy, e.g. not only investing in car sharing fleets, but also experimenting in peer-to-peer sharing (examples are Maven from General Motors and ReachNow from BMW) as well as considering federative solutions in which several "mobility providers" join to satisfy the users requests.

Finally, the current impression is that car sharing can help in postponing a new car purchase, not in replacing it in a definitive way. For sure, this sophisticated level of scenarios will require OEMs and carmaker a bigger agility and flexibility, to identify and scale new, attractive business models.

In a nutshell, OEMs need to find the right strategy for differentiating their products and services, evolving their value proposition from "hardware provider" to "integrated mobility service provider."

Introduction

One of the most remarkable developments of the 21st century global marketplace is the rapid growth and evolution of the sharing economy. Today, ordinary people can rent, short-term, everything from luxury handbags to houses, and also cars (BCG, 2016).

Car sharing actually covers multiple modes of sharing, including both B2C offerings and largely informal peer-to-peer (P2P) arrangements. Cars may be available at fixed stations—in effect, dedicated parking spots—located around a city, or on a free-floating basis, which allows users to park their vehicle at any legal spot, where it awaits the next user. Moreover, Car sharing is taking hold in large urban areas, and more shyly in rural spaces; it's more capillary in certain areas than in others.

Concerning Europe, car sharing (from now on CS) diffusion is not homogeneous among different countries: the scenarios present strong differences from Eastern to Western Europe, from North to South, from countryside to cities.

However, we can register a growing interest across the continent: a study led by ING (ING Bank, October 2018)) underlines that 30% of Europeans with a driving licence and a private car show interest in car sharing. Interest rises among people who do not own a car and/or use public transport as their main mode of travel. People living in metropolitan areas, where parking spaces are limited, also show high interest. Most car sharing services have effectively been developed in high-density metropolitan areas, allowing users to accomplish several transportation goals and avoid congestion, parking and pollution problems.

What specifically could induce drivers to abandon private ownership? For example, Car Sharing services will have to offer value by providing vehicles that meet users' needs at a fair price. Other aspects can be that Car Sharing providers must ensure extensive coverage; cars will have to be readily available when users want them. In addition, users will have to trust the ability of car-sharing services to provide reliable vehicles.

Concerning OEMs (Original Equipment Manufacturers), car sharing can represent an opportunity for the implementation of trends such as e-mobility and autonomous driving and can therefore be a key-enabler to significantly increase the acceptance of future mobility concepts through the population (Deloitte, 2017).

In this deliverable, we will present potential impacts of car sharing on vehicle sales and substitution patterns through the analysis of CS studies led in Europe and worldwide, and through a survey whose key topics are described here below.

The current deliverable is structured in 4 main sections:

- Methodology: different methodologies that have been followed by STARS WP6 partners
- Impact of the diffusion of CS on car sales (ICE -Internal combustion Engines- and Electric vehicles.) and impacts on cities and differences between cities & rural areas,
- Evaluation of the desired characteristics of CS fleet vehicles and substitution patterns between private and shared vehicles;
- Futures scenarios.

The document concludes with main findings and a short of list of recommendations to better understand CS phenomenon and its impacts.

1 Methodology

This deliverable is part of Work Package 6 (WP6) that consists in the "Future industrial impacts". This work package has a role in the STARS project to explore the impact of car sharing services in different areas: from car sales to automakers, from city to usage patterns, leveraging previous STARS findings, in particular from WP3 and WP4.

In addition, the methodology used for this first WP6 deliverable and its findings will be used and adopted also for the completion of the second deliverable (D6.2) due at M28.

Different methodologies have been used to collect data:

- ★ General Motors, CU and LGI have conducted interviews, in order to collect data. More than 20 interviews have been done from the three partners.
- ★ Politecnico of Turin designed a mobility survey, aimed at understanding the impacts of car sharing on mobility habits, changes in car ownership and in the use of public spaces (please see section 1.2 of this paper and D5.1 for more details)

The interviews were conducted with the following categories of stakeholders:

- ❖ Car Sharing operators: 7
- ❖ Cities: 4
- ❖ Local stakeholder: 1
- ❖ Car makers: 3
- ❖ Public transport operator: 1
- ❖ Mobility Aggregator: 1
- ❖ External experts: 3
- ❖ Venture Capital: 1
- ❖ Mobility agencies with a public ownership: 1

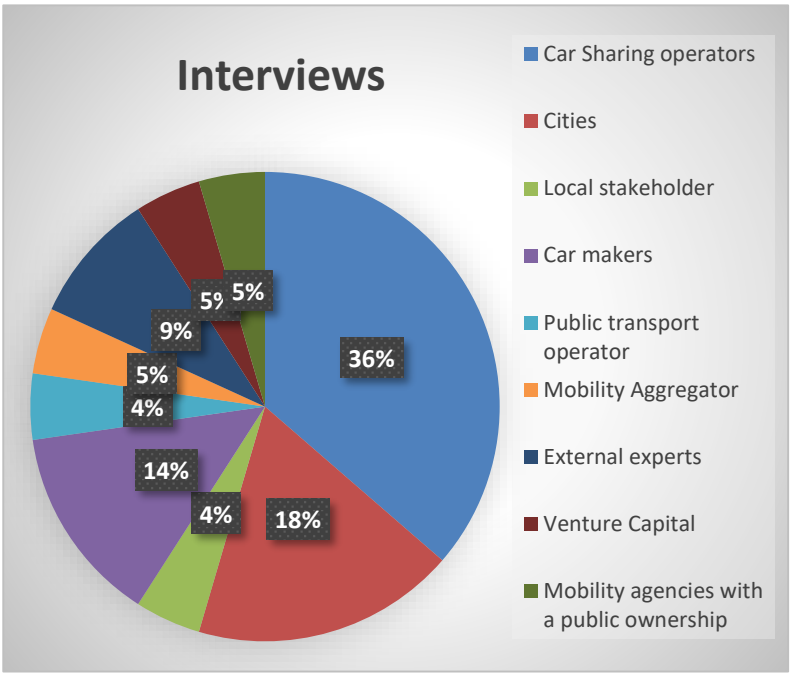

Figure 1: Interviews by categories of stakeholders

Regarding car sharing operators, LGI focuses on two types of factors (the range of vehicles and the value) by investigating the existing vehicle attributes and complementary services that car sharing schemes are currently offering. The information presented hereafter has largely been gathered from desktop research.

In particular, seven interviews were carried out and with the following car sharing providers profiles:

- Nicolas Fraise, Chief Development Officer for Europe at Communauto (October 2019);
- Jean Baptiste Schmider, Chief Executive Officer of Réseau CITIZ (October 2019);
- Cédric Lacour, Business Development Director at New Mobilities Europe Renault (November 2019);
- Malcolm Stewart, CEO and founder of SPOPIN (October 2019),
- Charlotte de Vilmoril, CEO & Founder of Wheeliz (October 2019);
- Jaume Suñol, Drivy's Country Manager for Spain (February 2019);
- Enterprise Car Club (October 2019)

In total, there were 22 interviews and 1474 respondents to the survey collected by POLITO (focus on the city of Milan and Turin). In term of geographical distribution, we had a large predominance of people from EU Western and Southern countries, and a few contributions from Eastern Europe (see details in the chart below):

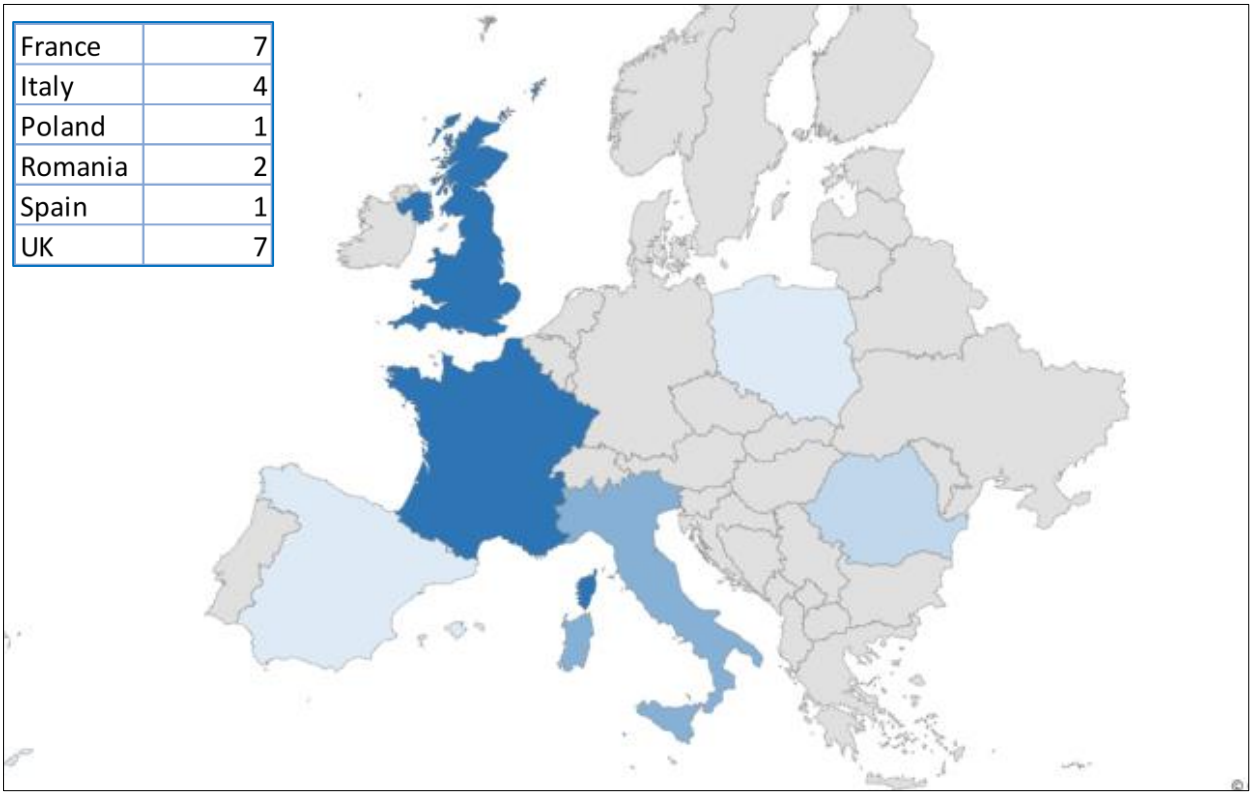

Figure 2: geographical distribution of WP6 interviews and surveys

The interview was composed by a list of questions (see Appendix 1) which were in some cases common to all the categories interviewed, in others specifically addressed to a stakeholder mentioned above. For example, the cities/public stakeholders were interviewed about their experience with the impact of CS on car ownership in their area of competence, which is the best practice to promote CS versus car ownership and their opinion on how the CS can help mobility in weak demand areas such as rural contexts. The questions addressed to CS operators referred to the composition of the fleet, the interaction of public bodies and the choices between EV or "traditional ICE vehicles". In order to complete the next deliverable (D6.2), all interviewees were then addressed

about CS possible future scenarios and were asked to give an opinion about the best available and less efficient car sharing business model.

1.1 Interviews

Some key findings of the interviews are summarized here. Car sharing is a reality strictly related to cities (generally medium-large municipalities), where it can help to solve three main problems:

- traffic congestion
- lack of parking
- access to restricted areas in the city centre.

For the moment, CS has not a disrupting effect on vehicle sales, as it appears to be a too restricted phenomenon. However, the situation could change in the future, since cities are experiencing a digital transformation and the connected technologies could bring to a broad range of new mobility services, also known as "smart mobility".

Most of the interviewed agree that shared mobility services will become effective only when integrated into a MaaS (Mobility-as-a-Service) framework, that includes public transport and other forms of shared mobility. This kind of integration can lead to a transformation on the way people move.

If this situation will take place, there are possibilities for CS to expand also in rural areas but for sure public support will be crucial in this scenario.

Public administration can play a fundamental role also in supporting CS: if car sharing can be considered somehow a way to improve citizens' life and can be integrated with public transport, then national governments should help its diffusion with tax benefits, financial aids (e.g. a part of the fees to be paid should be in charge to public administration) and other forms of support (like free parking lots). In some areas, public bodies are already supporting CS and MaaS projects (such as in northern Italy and Germany), but especially in Eastern Europe the "silos structure" is still prevailing, thus making very difficult the interaction both within different mobility stakeholders and within cities/different areas. In this context, car ownership is still important, also among younger generations. In some Eastern EU areas, mobility solutions are market-initiatives: the lack of regulation makes it quite easy to launch new services.

The vehicle manufacturers interviewed (which actually belong to two premium brands -Bentley & Jaguar Land Rover- and Renault) are of the view that car sharing doesn't represent a threat to future business: the majority of their customers were likely to prefer a traditional ownership and usership model. However, one of the brands interviewed is supporting a venture capital business that invests in the future of transport and mobility: the investments made are seen as enhancing or complementing the brand values of JLR (Jaguar Land Rover) cars. The invested projects are usually

established rather than pure start-ups, but with growth potential. This company also uses these investments as a means of learning about the evolution of the market for travel and transport, and the ways in which new services can be developed and deployed.

Another interesting finding is the business model created by a sharing operator, that considers car sharing as part of a portfolio of services rather than just a stand-alone operation. They secure agreements with the owners of parking spaces (corporate or individual) and then recruit customers who have a need for a parking space, in a classic intermediary platform approach.

Their proposal includes a sort of 'one-stop shop' of mobility services across a spectrum from traditional leased business cars through to occasional and short-term car sharing. In so doing, they claim it's possible to tailor the portfolio of mobility options to suit the needs of the local authority or business, and thereby enable reduced expenditure on mobility. Again, such a service could be customized to suit specific car brands, or indeed to specific car sharing operations.

Conclusions

The success or otherwise of car sharing in part depends upon the contextual setting. Crucial to this is the approach to mobility and transport adopted by government at national and local levels – particularly in terms of urban planning.

Car sharing does not appear to be very significant in future planning considerations in the examples that were examined, in contrast to cities such as Manchester (GMCA, s.d.) and Bremen where local governments have planned and are planning around electric, shared and autonomous cars.

1.2 Experimental settings: the mobility survey from WP5

One of the main activities of WP5 was the design of a mobility survey, aimed at understanding the impacts of car sharing on mobility habits, changes in car ownership and in the use of public spaces. In the following we only summarise the main outline of the survey and the related data that will be analysed for this deliverable. For more information on survey contents, analyses and statistically differences between users and non-users, please refer to another document (Chicco et al.) in progress.

The survey was structured in four main sections:

1. *travel behaviour and mobility habits:* questionnaire contents focus on the use frequency of different travel modes, changes in travel habits after the registration to a car sharing service, etc.;
2. *travel diary focused on the last trip performed:* information about the last trip performed with car sharing (for users) and with any other travel mode (non-users) were asked in this section;

3. *changes in car ownership:* the number of cars owned at the household level was investigated in three different periods for car sharing users. The main motivations about the occurred change/changes were asked;
4. *socio-economic characterisation:* both individual and household information were investigated.

The questionnaire was administered through a web survey, with minor changes in the contents related to local conditions, in three case studies:

1. Milan and Turin, in Italy;
2. Antwerp and Brussels, in Belgium;
3. Frankfurt, in Germany.

Both car sharing users and non-users were interviewed, therefore using the latter as a control group. Since more detailed information was collected within the Italian case study, all the analyses carried out in this document will be referred to this group. In particular, a representative sample of the population living in Turin and Milan (stratified by gender and age) was targeted in the Italian case study. Both computer-assisted web interviews (CAWI) and computer-assisted telephone interviews (CATI) were used to maximise the coverage. Moreover, car sharing users were oversampled in order to obtain a more consistent group.

As a result, 1474 completed questionnaires were collected in the Italian case study; 666 interviewees declared being registered to a car sharing service while 808 did not. A breakdown of the collected answers is reported in Table 1 below.

	Milan	Turin	Total
Users	485	181	**666**
Non-users	553	255	**808**
Total	**1038**	**436**	**1474**

Table 1: Number of completed questionnaires collected in the Italian case study

Despite one of the objectives of the survey was to collect information about users of different car sharing variants (free floating, roundtrip station based, …), at least in Milan where all those variants exist, just nine respondents reported to be unique users of station based services. Thus the results can be referred to free floating services only hereafter.

1.3 Changes in car ownership levels of car sharing users

One of the most detailed sections in the Italian version of the survey was dedicated to getting more insights into the changes in car ownership. This information in particular will be exploited in the present deliverable. Interviewees enrolled into a car sharing program had to state the number of cars owned in three different time periods: at the time of the interview, at the time of the first registration

to a car sharing service and one year before the first registration, in line with (Schreier et al. 2018). Therefore different combinations of changes might happen especially considering before-after registration periods (e.g. one could sell a car within one year before the registration and buy a new one after the registration). Some descriptive analyses, which might clarify the impact of car sharing on the automobility market in terms of car sales, will be reported in the following.

Non-users were asked as well to declare the number of cars owned at the time of the survey. However, given the absence of a corresponding time reference such as the enrolment year to a car sharing service for this group, the number of cars owned before the last car being sold, bought, scrapped or substituted in the respondent's household was rather asked. Given such asymmetry in the information on car ownership levels between users and non-users in the survey, it was decided to rely on official statistics on car stocks trends at the overall city level provided by the Italian Automobile Club[1] to compare users and non-users changes and investigate the substitution patterns between privately owned and shared vehicles.

1.4 Compliance of electric vehicles characteristics to car sharing operations

Lastly, beyond the results coming from WP5 activities, one of the objectives of this document is to understand to which extent car sharing fleets requirements are matching with the current electric vehicles (EVs) performances. In order to do so, car sharing usage patterns of different car sharing variants were collected among different studies available in literature. Therefore, average trip lengths, average stop time and origin-destination location of car sharing trips were compared to EVs currently available in the automobile market. In addition, the existing available literature on car sharing services that are already operating with full electric fleets was considered to look for additional evidence supporting the STARS project findings. Results are reported in section 3.3.

[1] (http://www.aci.it/)

2 Impact of the diffusion of CS service…

2.1 … in automotive sector: Car sharing and ICE and EV sales

The potential of CS in reducing car sales gained considerable attention in automotive industry since CS became popular among users. Considering that each shared car can serve more than one person, a car sharing fleet is expected to replace more private cars than the number of shared vehicles. Consequently, car manufacturers expect a "reasonable share" of their future profits will be coming from car sharing since car ownership will drop as declared by (VW, 2017), but margins are lower than traditional business and main OEMs (Original Equipment Manufacturer) are teaming up as "Nobody knows what the future of mobility is going to be exactly, so people are getting together to lower the risk" said Prof Peter Wells at BBC News (Thomas, 2019)2. However, car cost may not be the only consideration in foregoing a car purchase or shedding a current car: people do not necessarily use car sharing to replace private car trips but also in car sharing's potential in reducing pollution, CO2 emissions, parking pressure, etc. (Carsten Nathani, 2004) (Momo, 2009)

However, the current European car market is showing a different scenario on both ICE and EV segments.

Car sales in most European countries were lower during the first half of 2019 except for Germany and Poland. Germany remained the largest car market in Europe and sales expanded by +0.5%. In effect, the German new car market was only 10,000 sold units bigger than during the first six months of 2018. The UK remained the second largest new car market in Europe in 2019 despite a 3.4% contraction, followed by France with a contraction of 1.8% (see table 2 below). Brexit and future emission regulations are the main causes of the decline in new car sales but in Italy and Spain the contraction was even stronger. Poland (+1.9%) was, apart from Germany, the only of the ten largest new car markets in Europe showing a growth. The Swedish new car market contracted by a quarter. Regarding the most performing markets, Lithuania (+47.1%) and Romania (+19.2%) registered a new record.

Countries	Jan-Jun 2019	Jan-Jun 2018	%Change 18/19
AUSTRIA	175,909	192,861	-8.8
BELGIUM	310,488	331,369	-6.3
BULGARIA	18,323	18,082	+1.3
CROATIA	38,216	38,279	-0.2

[2] Examples are: Daimler and BMW JV on "mobility services"; Ford and Volkswagen agreed to investigate ways of working on electric and autonomous vehicles together, while Honda invested $2.75bn in General Motors' driverless unit Cruise with a view to launching a fleet of unmanned taxis.

CYPRUS	6,578	7,651	-14.0
CZECH REPUBLIC	128,498	143,784	-10.6
DENMARK	122,245	120,726	+1.3
ESTONIA	13,933	14,19	-1.8
FINLAND	60,277	69,612	-13.4
FRANCE	1,166,442	1,188,150	-1.8
GERMANY	1,849,000	1,839,031	+0.5
GREECE	65,557	62,312	+5.2
HUNGARY	74,543	70,748	+5.4
IRELAND	80,707	87,116	-7.4
ITALY	1,082,197	1,121,649	-3.5
LATVIA	9,485	9,07	+4.6
LITHUANIA	23,491	15,966	+47.1
LUXEMBOURG	31,123	30,655	+1.5
NETHERLANDS	226,482	252,988	-10.5
POLAND	278,332	273,045	+1.9
PORTUGAL	128,595	134,561	-4.4
ROMANIA	71,62	60,068	+19.2
SLOVAKIA	52,075	51,891	+0.4
SLOVENIA	39,847	41,677	-4.4
SPAIN	692,472	734,671	-5.7
SWEDEN	167,882	225,543	-25.6
UNITED KINGDOM	1,269,245	1,313,994	-3.4
EUROPEAN UNION	**8,183,562**	**8,449,689**	**-3.1**
ICELAND	7,283	11,883	-38.7
NORWAY	78,209	76,745	+1.9
SWITZERLAND	157,136	157,91	-0.5
EFTA	242,628	246,538	-1.6
EU + EFTA	**8,426,190**	**8,696,227**	**-3.1**

Table 2: European Sales 1st Semester 2019 vs. 2018 (Source: ACEA)

Considering the propulsion, 2018 diesel's share of the market fell from 44.0% in 2015 to 35.9%, while petrol continued to further expand its share of new car registrations (from 50.3% in 2015 to 56.7%) (ACEA, 2019). As already demonstrated in STARS D3.1, ICE sales still dominate EU new passengers' car market while (B)EV sales are representing a 2.97% market share only (see Table 3 below), while

all alternatively-powered vehicles (APV) combined made up 9.2% of the EU market. Moreover, there are major differences at national level. Even though Germany is the first ECV market in term of sales (47.684 e-vehicles with an improvement of 40%), its market share is lower that the European average. Other major European markets (France, UK, Italy and Spain[3]) are performing similar scores or even worst -Italian case. The only European exception is represented by Norway where ECV represents more than half of new car sales (56%) followed by Iceland, Sweden and Netherlands.

	Q1-Q2	Q1-Q2	%	ECV %	ECV %
	2019	2018	Change	Jan-Jun 2019	Jan-Jun 2018
AUSTRIA	5.811	4.447	30,7	3,30%	2,31%
BELGIUM	8.776	7.671	14,4	2,83%	2,31%
BULGARIA	167	79	111,4	0,91%	0,44%
CZECH REPUBLIC	494	497	-0,6	0,38%	0,35%
DENMARK	4.350	2.177	99,8	3,56%	1,80%
ESTONIA	54	51	5,9	0,39%	0,36%
FINLAND	3.399	3.229	5,3	5,64%	4,64%
FRANCE	28.911	21.500	34,5	2,48%	1,81%
GERMANY	47.684	33.980	40,3	2,58%	1,85%
GREECE	229	168	36,3	0,35%	0,27%
HUNGARY	1.246	1.019	22,3	1,67%	1,44%
IRELAND	2.787	962	189,7	3,45%	1,10%
ITALY	7.542	4.377	72,3	0,70%	0,39%
LATVIA	50	51	-2,0	0,53%	0,56%
LITHUANIA	75	65	15,4	0,32%	0,41%
NETHERLANDS	22.896	10.842	111,2	**10,11%**	**4,29%**
POLAND	1.357	685	98,1	0,49%	0,25%
PORTUGAL	5.988	3.673	63,0	4,66%	2,73%
ROMANIA	456	297	53,5	0,64%	0,49%
SLOVAKIA	189	203	-6,9	0,36%	0,39%
SLOVENIA	312	360	-13,3	0,78%	0,86%
SPAIN	8.958	5.021	78,4	1,29%	0,68%
SWEDEN	18.971	12.755	48,7	**11,30%**	**5,66%**
UNITED KINGDOM	27.111	29.392	-7,8	2,14%	2,24%

[3] The 70-75% of all European (EU+EFTA) car sales are made in the following 5 markets (Germany, UK, France, Italy and Spain).

EUROPEAN UNION	**197.813**	**143.501**	**37,8**	**2,42%**	**1,70%**
ICELAND	*1.052*	*1.378*	*-23,7*	14,44%	11,60%
NORWAY	*43.976*	*35.789*	*22,9*	**56,23%**	**46,63%**
SWITZERLAND	*7.473*	*4.479*	*66,8*	4,76%	2,84%
EFTA	*52.501*	*41.646*	*26,1*	21,64%	16,89%
EU + EFTA	**250.314**	**185.147**	**35,2**	**2,97%**	**2,13%**
EU15 + EFTA	**245.914**	**181.840**	**35,2**		

Table 3: European ECV sales 1st semester 2019 vs 2018 and ECV market share on the same period (Source: ACEA)

The above results depend on national/governmental incentives but purchase incentives for electrically-chargeable vehicles (ECVs) differ greatly across the European Union. Most EU member states allow only tax reductions or tax exemptions (related to acquisition and ownership) for electrically-chargeable vehicles. Some merely offer an exemption from the annual circulation tax for electric vehicles. Three members' states (Estonia, Lithuania, and Poland) still do not offer any benefits or incentives for ECVs at all. Below in Figure 03 and in Appendix 2 a detailed overview of purchase incentive -in green (ACEAb, 2019) (EAFO, 2019)

Figure 3: Electric vehicles: tax benefits and incentives in the EU (adapted from EAFO and ACEA)

Another element that limits EVs sales in Europe is the correlation between EVs sales and charging points; of the 174,000 public charging points available across the European Union[4] today (EU28), the 76% are located in 4 countries: over 26% in the Netherlands (37,037), 19% in Germany (27,459), 17%

[4] According to EAFO (European Alternative Fuels Observatory) on 2019 there are 20'077 Fast charge points (>22KW), and 154'023 normal charge (<=22KW). Sources: https://www.eafo.eu/countries/european-union/23640/infrastructure/electricity.

in France (24,850) and 13% in the United Kingdom (19,076). By contrast, the same four countries only cover 27% of the EU's total surface area (ACEAc, 2019).

From the above tables and figures, we cannot affirm that car sharing services are impacting car sales nor EV adoption. In addition, in interviews run by GM and Cardiff University, experts and stakeholders underlined that CS is still too small and polarized in medium-large municipalities. In particular in term of fleet, CS service as a whole has small fleet compared not only to car sales (roughly 16 mil cars), but also to the overall car stock circulating in Europe with 308.3 million vehicles in use (ACEA, 2018).

Cardiff University interviewed Bentley and Jaguar Land Rover car manufactures; both did not see CS as a threat to future business. Bentley took the view that the majority of their customers were likely to prefer a traditional ownership and usership model. With annual production volumes of some 12,000 units, and with the best-selling Bentayga (with about half of annual total volumes) starting at £130,000 it is clear that Bentley serves a global niche market with highly customised vehicles. Bentley reported that even in China there has been a strong switch away from chauffeur-driven cars towards owner-driven cars.

The case of Jaguar is more interesting. Along with the sister brand Land Rover, the group combine (JLR) has endured a difficult recent past in the market arising from the switch away from diesel and the uncertainties associated with the decision by the UK to leave the EU. As a result, the business is under severe financial pressure. However, despite this pressure JLR has established and continues to support InMotion Ventures. This is essentially a venture capital business that invests in the future of transport and mobility (see Appendix 3 for investments undertakes by InMotion Ventures). According to InMotion, "…*Companies in the InMotion Ventures portfolio are united by their single-minded drive to improve the way we move. They are re-imagining the future of travel, and stopping at nothing to transform the face of transportation and mobility.*"

Nonetheless, governments need information about the real impact of car sharing on car ownership, and they have to know what factors affect people's intentions of private car trip replacement and car ownership reduction. Among all potential factors, CS services are of high interest since their management and future integration may be a solution. Moreover, deploying EVs in shared fleets provides an easier access to EVs for many users who still have doubts in buying/adopting a pure electrical vehicle or who still consider them too expensive. From CS operator perspective, EVs may also be a better option because of their lower operational cost and positive environmental image compared to ICE.

Car sales (both ICE and EV) may not be the most reliable data to verify a real change in term of car use. The following section 2.b will focus on cities and differences between cities and rural areas

(outskirts or city sprawls): these differences may provide more inputs and a different scenario about the real impact of car sharing services.

2.2 … on cities & differences between cities and rural areas.

Today, CS is generally accepted in large cities. According to (McKinsey, 2017) CS services are not economically viable in cities with fewer than 200-300 thousand inhabitants, or even in bigger urban areas with low population density. Nonetheless, there are cases of CS services in "small" urban or rural areas (e.g. in Switzerland or in Germany[5]): the conditions in smaller cities are indeed more challenging. In addition, CS and shared mobility solutions are regulated at local level: each municipality has its own legislations and approaches to sharing operators. Several articles and studies estimated that the number of private cars replaced by each shared car vary from 2.5 to 20 (BCG, 2016) (Barbora Bondorová, 2017) (Martin, 2010); therefore these numbers are likely to be overestimated or too optimistic.

2.2.1 City Analysis

On the other hand, if we focus our attention at local level, we can register different realities.

A few surveys have been conducted on CS impact on cities:

1. in Basel - Switzerland 8% of FF users and 19% of SB users would have bought a car if the respective CS service did not exist[6] (Becker, 2015) ;
2. in Lisbon – Portugal, after 6 months after joining CS service, 42% of members started managing trips in a different way, 21% started using other transport modes and 8% no longer own a vehicle (Baptista, 2014).
3. (Fanchao Liao, 2018) explores the potential of CS in replacing private car trips and reducing car ownership in Holland. Liao et al. research[7] shows that 40% of car drivers are willing to replace some of their private car trips by CS, and 20% indicated that they may forego a planned purchase or shed a current car if CS becomes available near to them. Further considerations may suggest that people vary significantly with these two stated intentions, and that a higher intention of trip replacement does not necessarily correspond to higher intention of reducing car ownership.

Findings from DriveNow and Flinkster in the cities of Berlin and Munich showed that both SB (station-based) and FF (free-floating) CS lead to car ownership rate reductions but at different rates (DriveNow 7%, Flinkster 15%). The reduction of cars (shed) is influenced by the frequency of use of CS, and the increasing membership of SB providers. In addition, for users of both systems CS is an

[5] In Switzerland https://www.mobility.ch/en or http://www.carsharing-vaterstetten.de/ in Germany.
[6] SB system attracts more "car-Free" users compared to FF system as showed in STARS WP4 survey.
[7] 1003 respondents.

important reason not to buy a car; on the other hand, several other users have planned to purchase a new car. More generally in Germany, the main transport mode is still the car (50% and more), even in mid-larger cities (more than 100 thousand inhabitants) with good public transport services. Car sharing is now counting more than 20 thousand shared vehicles in Germany (BCS, 2019) and the effects on mobility and ownership are varied and versatile (Flemming Giesel, 2016).

In D4.3 STARS deliverable, together with car sharing profiles detected in D4.1 (see paragraph 2.3.3 of the STARS D4.1 report), several data have been presented related to car ownership within CS users: 4 (+1) profiles[8] have been compared among Germany, Italy and Sweden as presented in the table 04 below:

User profile: FFOA [◊]		
Germany	**Italy**	**Sweden**
No Car (31.6%)	No Car (6.2%)	No Car (52.9%)
User profile: FFPS [*]		
Italy		**Sweden**
No Car (17.2%)		No Car (38.5%)
Combined*	**User profile: MultiOC [†]**	
Germany	**Germany**	**Italy**	**Sweden**
No Car (78.3%)	No Car (75%)	No Car (20.8%)	No Car (83.3%)
User profile: RTSB [‡]		
Germany	**Italy**	**Sweden**
No Car (80.7%)	No Car (26.3%)	No Car (80.5%)

Table 4: user profiles comparison adapted from Tables 9, 10, 11, 12 D4.3 STARS

Car availability differs among user groups:

- ★ It is interesting to observe that MultiOC in Sweden is mainly composed by FFOA + RTSB users (84%): the integration of the two service typologies gets the best results in term of car ownership reduction.
- ★ In Italy most of the users belong to FFOA group (65%) while in Germany and Sweden the highest percentage of users belong to the RTSB profile

[8] The 4 user profiles that have been compared in D4.3 (paragraph 3.1.1.2 "Car sharing user profiles within each operational scheme"):
FFOA, the user profile constituted by people uniquely registered to free floating with operational area car sharing services
FFPS, the user profile constituted by people uniquely registered to free floating with pool stations car sharing services
MultiOC, the user profile constituted by people registered to multiple car sharing services with different operational characteristics in parallel
RTSB, the user profile constituted by people uniquely registered to round trip station based car sharing services
*Combined group next to the MultiOC group for Germany are users of one car sharing offering different CS schemes (e.g. FFOA + RTSB

- It is interesting to observe that MultiOC users from all three countries have a higher percentage of car free households than FFOA unique users
- The users belonging to RTSB have the highest percentages of car free household in all three countries. However, it is interesting to observe the strong difference among countries: while in Germany and Sweden the number of households without a car lies at almost 80%, in Italy this value falls to 26.3%.

STARS surveys gave some evidence that trends registered by (Flemming Giesel, 2016) in Munich and Berlin on the differences between FF (DriveNow) and SB (Flinkster): Station-based CS, in particular, contributes to the abolition of private cars. By contrast, FF has hardly any traffic-relieving effect. It is noteworthy that combined systems, which offer FF and SB from a single source, also have a clearly positive effect on car ownership reduction. The downside is that in Germany there are 2,46 million CS users (FF and SB together) (BCS, 2019), while both FF & SB users are 1.86 million in Italy (Osservatorio Nazionale Sharing Mobility, 2019)[9]. Several STARS findings are in line with Flemming et al.: SB users tend to shed more cars due to car sharing than FF users, and that the combination of the two systems has the biggest impact on car ownership.

As showed in the methodology, WP6 partners had run different interviews with various stakeholders such as external experts, car manufacturers, but also cities. Concerning CS impacts on cities and rural areas, we collected different experiences and opinions.

Cities behave and manage CS services differently, but they are experiencing the same problems: traffic and congestion during peak hours, and lack of parking spaces are the most frequently cited issues. In particular, "*cruising for parking*" can lead to a 30% on average traffic increase (Chase Dowling, 2017).

Among the cities interviewed, the only city that is verifying and analyzing the impact of sharing mobility (not only CS) is Milan. The city of Milan has a target of 460 vehicles per thousand inhabits. In 2013, when CS started its operation in Milan, the number of vehicles was 518 vehicles per thousand inhabitants; in 2018 they registered 496 cars. This means a reduction of 22 cars every thousand inhabitants[10]. This figure is in contrast with POLITO findings on CS (non) users survey presented in section 3. Anyway, this result cannot be associated to CS only, but to a multitude of factors that impacted the way Milan moves:

1. <u>Mobility factors:</u>
   - Creation of Area C and B (restricted traffic area);

[9] The common element in both countries is that in 2018 users of SB services grown at a faster pace (21.5% Germany and 37% Italy) than FF users (14.9% and 27% respectively).

[10] Considering city of Milan total population (1,3 million inhabitants), sharing mobility removed from streets roughly 28.600 cars. On the other hand, based on what AMAT shared during the interview, we cannot affirm and calculate how many cars have been replaced per each shared car.

- Improved Public transport service and Metro;
- Longer operational hours for Public Transport operator;
- New sharing operators in general (scooter sharing, kickscooter sharing, and bike sharing)

2. Urban Mobility Plans: CS did not come in Milan just as an additional mobility service but is an integrated element of a larger mobility strategy that wants to improve Milan mobility in order to achieve the 460 cars per thousand inhabitants target.

GM met ANFIA[11] in their Turin office regarding the evolution of car stock circulating in four main Italian cities in which car sharing is present. These cities are: Bologna, Milan, Rome and Turin. The discussion between ANFIA and GM had an aim to understand the trend and evolution of the car stocks circulating not only in these 4 cities, but also in their metropolitan areas -M.A. as shown in in figure 04 and 05 below (in section 3.2 an in-depth analysis of Milan and Turin cities).

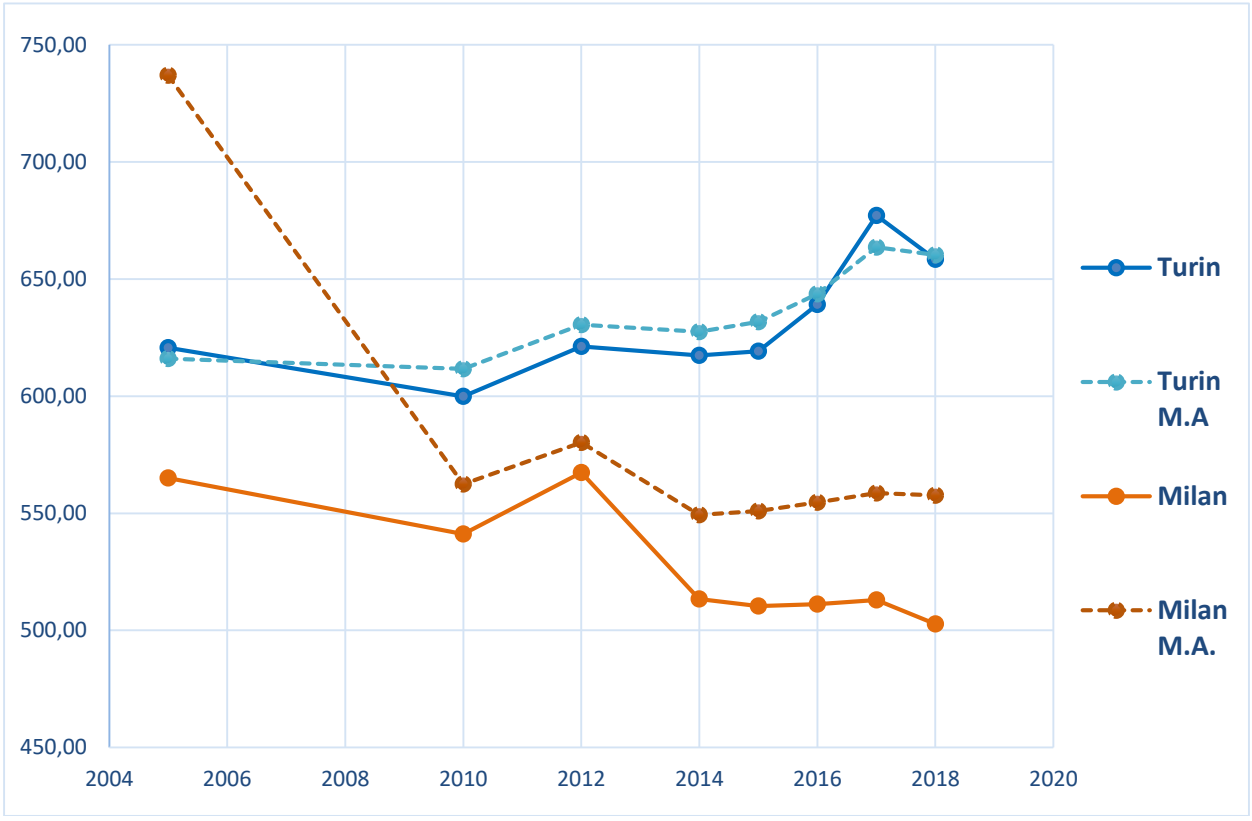

Figure 4: Car per 1'000 residents in Milan & Turin city and metropolitan area

[11] A. N. F. I. A. Associazione Nazionale Filiera Industria Automobilistica defines its vision and mission as follow: "ANFIA - the Italian Association of the Automotive Industry – is one of the leading Italian Trade Associations, members of CONFINDUSTRIA. Born in March 1912, over these one hundred years, ANFIA mission has always been to represent the interests of its associate members and ensure effective communication between the Italian motor vehicle industries on the one hand, and the Public Administration and Italian political bodies on the other, with regard to all technical, economic, fiscal, legal, statistical and quality-related issues referred to the automotive sector". https://www.anfia.it/en/association/vision-and-mission

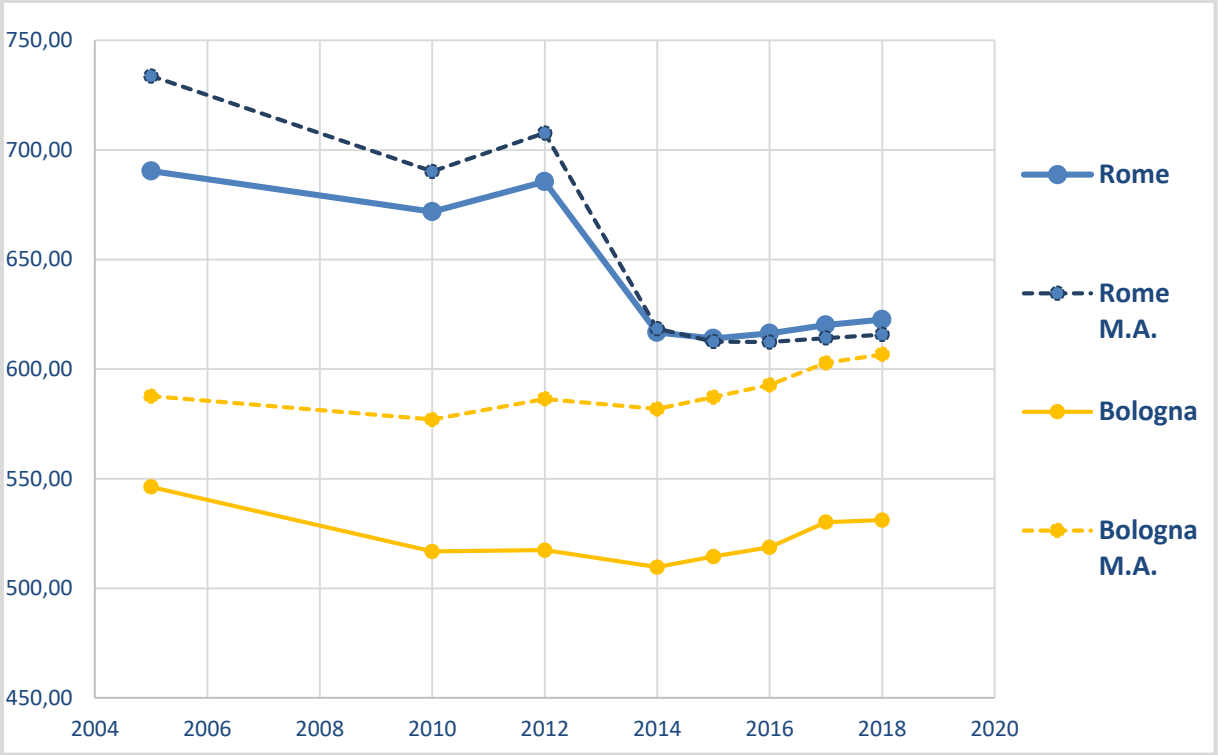

Figure 5: Car per 1'000 residents in Bologna & Rome city and metropolitan area

In term of trends, Milan is registering the highest car stock reduction in both city and metropolitan area; a similar trend is present in Rome, but in a less intensive manner. Turin and Bologna are, on the contrary, showing an increasing number of cars per thousand inhabitants in both city and metropolitan areas. Paradoxically, increasing CS fleets in Turin and Bologna are likely to further limit parking and public spaces for car commuters that every day reach both cities for work purposes.

Other cities are either not evaluating/counting the real impact of CS on car removed from street (lack of resources or CS phenomenon still to young) or CS service is not present in their city yet.

Talking with a PT operator in Barcelona, they underlined that Avancar car sharing (known as Zipcar in other cities) has stooped its operation last February 2019, after almost 15 years of operations. Officially Avancar did not disclose the reason why they left Barcelona (Cordero, 2019). According to the PT operator interviewed by GM team, one reason could be that the city is over-congested and even with roundtrip business model, people prefer to use a combination of Metro, PT, personal or shared scooters, and bike.

CS is considered not the optimal mobility solution within Barcelona city center, while it might be a viable solution for external areas and in connecting rural communities/cities where PT has a more dispersed presence and a less regular operational scheduling. Considering the 4 Italian cities, it is clear that reducing the car in the city alone -proposing car sharing solutions- cannot be a solution if external areas (peri-urban and rural areas) are not integrated in larger and shared mobility plan strategies.

2.2.2 Rural areas analysis

All the interviews done underlined how shared mobility services (not only car sharing) in rural areas is often seen as problematic, because of a low/insufficient availability of public transport, too big distances and related high dependency on cars, no parking problems and low density of housing or since there's no viable business model for transport in these areas.

For this reason, research and practical experience generally concentrate on urban contexts where the positive outcomes of car sharing and electric car sharing (e-car sharing) have been evaluated intensively and less attention has been paid to the comparison and potential of car sharing in rural areas, facing the different problems mentioned above.

Nevertheless, rural areas have a variety of assets on their side (their natural and agronomic potential, the quality of the living environment they promote, …) that can represent a large, unexploited capacity reservoir for shared mobility solutions (M-Randheloff, 2018), as an alternative or an addition to public transport providers. For PT there's a "critical mass" problem in rural areas: there is neither enough supply nor sufficient demand to justify significant financial expenditure and the age demographics of people in rural areas (with less school-age children, but more pensioners) has a strong effect on decreasing rural population density. Classical bus traffic routes simply cannot be performed cost-effectively, particularly in the early morning, in the late evening or at night.

At the same time, many essential services are spread out in such a way that walking or cycling is arduous or impossible – running a vehicle is all but essential (The Conversation, 2014).

For all these reasons, shared mobility options can play a future role, but, to make a CS business model profitable in rural areas, the following conditions need to be considered and guaranteed (Jean, 2017):

- Ensure regular use of cars through partnerships
- Secure a viable economic balance with a financial participation
- Facilitate the use of the service for the entire population and communicate regularly, through the support of public bodies
- Right position of the station to maximize its visibility and the intermodality

Among all these conditions, the most important is the support of local governments because of their decision-making power, shaping public space, setting up of parking standards, networking with firms and so on.

Europe actually provides more and more examples of CS programs in rural areas, even from the beginning of the 21st century: f. e. in Austria many villages with a population as low as 1000 people are served by CS (Koch, 2002), in Sweden rural car sharing cooperatives serve towns of a similar size, such as Färnebo. In the UK, already in the early 2000s, the UK Countryside Agency unregistered pilot projects in rural areas, such as CarPlus (Carplus, s.d.).

Within our interviews, we also asked what cities are doing in term of outskirts or rural areas integration. All cities are experiencing huge traffic problems coming also from external areas, and they aim to better connect the city center to external areas (and vice versa), but nothing of concrete was done or has been already implemented. To better integrate rural areas with city centers, cities shared different propositions and projects:

- Reinforced public transport during peak hours and extended operational hours;
- New parking areas in the peripherical area or at the train or public transport stations. These parking are usually free in case of seasonal PT ticket or if a train/PT ticket is purchased;
- The City of Milan, in the future grants on CS mobility, has foreseen some conditions in favor of external cities or communities. Currently, every CS pays 1'200€/y per car to operate in Milan. The current discount is 30% if CS is present in at least 3 "*external*" cities, but this incentive did not work as expected. Some CS operators enlarged their operational area, but reluctantly. In the new grant, the city of Milan and external areas aim to create the following:
  a. Mobility areas where almost all operators are doing their operation and this Mobility area covers the city of Milan
  b. Ad hoc Hub ("*stalll*") for mobility: also called "Service Areas" in those communities or small cities not included in the "Mobility (central) area", in which FF is not the most suitable business model, but in a Mobility Hub CS can offer the One-way model (the city of Milan is imposing a hybrid CS model de facto), and here the new conditions and offers:
     - CS operators are obliged to cover and service external cities that create these Hub;
     - CS operators are obliged to use only those Hub (normally at bus-metro-train stations)
     - If so, the CS operator that goes in "*n*" cities (not yet defined the minimal number) will benefit a discount of 30% on the annual fee (1'200€) on its fleet
     - Users get a little discount (taken in charge by the city);
     - The Hub is also a logistic point for CS operators in order to plan a better and more efficient operation and maintenance service.

As a result of what's written above, due to mainly car-based travel patterns and relatively low density, introducing car sharing in small towns and cities is more challenging than in big cities. This challenge is multiplied when the relatively new concept of electric cars is added to the equation. On the other hand, it is quite possible that there are those in small towns or cities who would be glad to downsize to one car from two if attractive alternatives are offered.

Car sharing operators in Europe are adding electric cars to their car sharing fleets for a variety of reasons: the total costs of ownership can be spread among many users and as a part of the public transport system it can offer a complement for local and long-distance travel by bus or train. This double integration can compensate the high costs of ownership and the limited range and therefore provide new green mobility options in an intermodal trip chain (Sandra Wappelhorst, May 2014).

While it is not reasonable to expect car sharing operators to carry the financial burden for those who would like to try out electric cars, there is however a range of possible actions that a small town or

city can take to make (electric) car sharing more attractive to its citizens and to make the town an attractive location to car sharing providers.

For example, an E-car sharing project in rural areas has been realized in the Municipality of Tarmstedt (between Hamburg and Bremen) with the e-Golf (Volkswagen, 2018). Volkswagen dealer Warncke organized favorable leasing rates for the e-Golf through a sponsorship project. They installed charging stations on their properties and a quick-charging station ("80 percent charge in 20 minutes") using free green energy from the regional utility company EWE. At the same time, they (Warncke dealer) offered their cars as rentals. The business model behind the scheme was and is simple: the lessees pay the installments and in return, they receive the revenue for the rental. The e-car sharing users have traveled a total of more than 210,000 kilometers between 2015 and 2018. Routes taken in the countryside are no fewer in number than the ones in urban areas: trips to the doctor, to go shopping, to various authorities, birthday parties, sports events or workouts, to visit friends, to go to work, school or to day care. Moreover, the e-car sharing users can also use the e-Golf to drive to the North Sea or to Bavaria upon request: in this case, they are provided with free additional information on where in Germany charging stations are available during the trip.

Other successful examples (Jean, 2017) come from CLEM' in Tinchebray and Citiz Alpes-Loire in Pélussin.

Car sharing in rural areas can be successful, as showed in the data above, and can also assume a social perspective, tackling social exclusion in the most deprived neighborhoods, in addition to the possibility to move freely for people who cannot afford the costs of a private car.

In summary, to make CS business model in rural areas fruitful and efficient, the following conditions need to be met:

- necessity for CS operators to share ideas and business best practices (to gain logistical advices, data from users, …)
- Encouraging public and local bodies to establish agreements with CS partners, to optimize territorial economic initiatives
- organizing intermodality and multimodality (Mobility-as-a-Service -MaaS)
- mixing with an increasing number of new rural shared services as studied by HiReach project. Several new form of sharing mobility (ride/car sharing, social bus, and other on-demand business models) are operating either in urban, peri-urban areas or exclusively in rural areas[12].
- In perspective, combining CS/EV CS with autonomous driving, because autonomous shared vehicles could spread the offerings also to densely populated suburbs and extend the potential customer base significantly (Deloitte, 2017).

[12] For more details: https://hireach-project.eu/sites/default/files/HiReach_D3.2%20Case%20study%20description%20and%20analysis_v2_20190524_TRT.pdf

According to McKinsey, the growth of shared mobility until 2030 will depend on how effective companies are in identifying and resolving users/citizens pain points (McKinsey, 2017). For instance, some pooling services can create uncomfortable dynamics among passengers who are basically strangers, while same dynamics are not present in public transport (metro, bus, train). For a daily use, shuttle sharing programs such as Chariot could have been a solution, but it went out of business (the verge, 2019), while MOIA from Volkswagen specifically designed its +6 e-shuttle also to provide passengers privacy (MOIA, 2019a) (MOIA, 2019b). The advantage in developing a purpose-built vehicle as done by MOIA can lead up to a 50% cost optimization (such as: lower level of complexity, improved and more efficient assembly process, reduced or eliminated distribution costs) (Roland Berger, 2018)

3 Evaluation of desired characteristics of the vehicles that will form CS fleets and substitution patterns between privately owned and shared vehicles.

3.1 Evaluation of vehicle characteristics and services of car sharing fleets

Car sharing will need to fulfil consumer needs if it is to replace car ownership. In all regions in Europe, the largest pool of potential users are the owners of city and compact cars (see tables in section 3.2 for further details). These users represent indeed the typical target group for car sharing, mostly for short trips with limited radius[13]. However, not all of these people will actually forgo car ownership.

But what will induce drivers to forgo private ownership?

According to research conducted in WP3 and WP5, there are five main characteristics that could convince some owners of private vehicles to make the switch:

- **Availability of cars:** There are many potential users that still prefer the certainty of having a car at their disposal whenever they need it. Therefore, car sharing schemes must ensure extensive coverage; cars will have to be readily available when users want them, and the booking process must be easy to negotiate. This observation applies to both, day-to-day activities and for more occasional or unpredictable trips. It should be noted that scheduled public transport services and the mobility offered by private vehicle ownership confer upon the user a relatively high degree of certainty over travel arrangements. Extent research has identified that time constraints, the need to book ahead, and a larger variation in travel times have significant negative effects on people's intention to use a shared car (Kim et al., 2017a; 2017b). In a study carried out by the Berlin Institute *Team Red*[14] in 2017 under contract with

[13] BCG - What's Ahead for Car sharing? https://www.bcg.com/publications/2016/automotive-whats-ahead-car-sharing-new-mobility-its-impact-vehicle-sales.aspx
[14] Team Red http://sm.team-red.de/

the City of Bremen (Germany)[15], it was revealed that the reliability of the offer and close proximity and density of stations are very important building blocks (for user satisfaction). The survey results showed that Bremen's mobil.punkte (car-sharing stations on public street space often placed on close gaps between stations on private property) create a close proximity of stations to the residential areas of the users. This was stated as a fundamental success factor of car-sharing in Bremen.

- **Operational effectiveness of the organisation:** The operational effectiveness of the car sharing scheme is crucial for long-term use and acceptance. Ideally, a car sharing scheme is easy to understand, has clear pathways to join and subsequently to book, use and return cars, and is able to manage the stock of cars in use relative to demand. There may be operational service levels defined (e.g., a car may be guaranteed if booked a certain period in advance). There are multiple dimensions to operational effectiveness, including the functionality of the website or other interface; the resilience of the data management system; the management of the vehicle stock, with all the complications of service intervals, impact damage, vandalism or other abuse; a good tariff structure and the acquisition and disposal of stock.
- **Trust**: Users will have to trust the ability of car sharing services to provide reliable vehicles, deliver on their promise and resolve insurance issues.
- **Range and quality of the vehicles available:** The range and quality of vehicles in use for a car sharing scheme can also be significant to the appeal of the scheme. As will be seen in this chapter, some car sharing schemes may be tied to a specific manufacturer and even to a single car model. Others may wish to attempt to emulate the overall stock of vehicles in use. There may be deliberate bias (e.g., to offer only EVs or only "city" vehicles). Historically, the market for new cars has been very sensitive to issues of brand value, but individual vehicle manufacturers may regard car sharing schemes quite differently. One manufacturer may consider car sharing schemes as an opportunity to expose potential customers (i.e., those who might buy a new car) to its brand. In this case, the manufacturer might supply highly-specified vehicles to the car sharing scheme, which in turn will grow customer response.
- **Value:** Finally, car sharing services will have to offer value by providing vehicles that meet users' needs at a fair price. Complementary services are increasingly seen as a key factor to increase the value of car sharing schemes.

Finally, the importance of these various aspects was revealed in the same study conducted by Team Red in the City of Bremen[16]. In terms of priorities, three categories were highlighted: from the users' perspective, straightforward booking ('very important': 79 %), the availability of vehicles when desired (68 %), and the proximity of the nearest station (60 %) are of decisive importance. Easy-to-use vehicles (46 %), accommodating arrangements in case of damages etc (42 %), and 24-hour availability of the provider by telephone (41 %) have relatively high relevance. All the other aspects

[15] Analysis of the impacts of car sharing in Bremen https://share-north.eu/2018/05/results-of-impact-analysis-of-car-sharing-services-and-user-behaviour-delivers-interesting-results-in-bremen/
[16] Analysis of the impacts of car sharing in Bremen https://share-north.eu/2018/05/results-of-impact-analysis-of-car-sharing-services-and-user-behaviour-delivers-interesting-results-in-bremen/

in the survey are less important to the car-sharing users overall (but were as well highlighted). They include: cleanliness, large variety of vehicle models, accessibility by public transport, information on new services and changes to terms of use, availability of child seats, vehicle features, and topics relating to parking spaces Design and appearance of the vehicles or desires for trendy, sporty vehicles were mentioned only very rarely (in this case study).

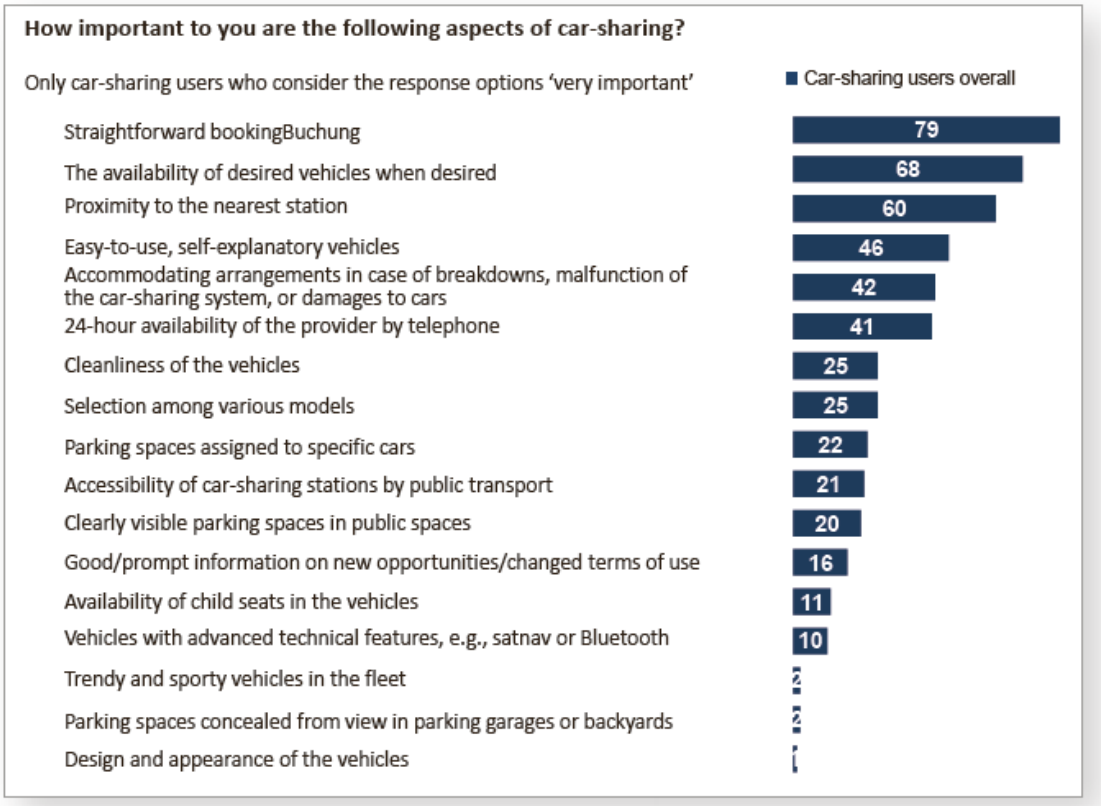

Figure 6: Important aspects for car sharers in the City of Bremen

3.2 Picture of today's vehicle characteristics and services

As examined in D3.1, car sharing organisations can be classified into five general business model frameworks. These five frameworks were developed based upon the work completed in D2.1, combining organisations' operational characteristics with business model variables. They include: 1) free-floating with an operational area; 2) free-floating with pool stations; 3) roundtrip, home-zone based; 4) roundtrip, station-based; 5) Peer-to-peer (P2P).

Regardless of whether it is for-profit or not-for-profit, each business model has its own car models, usage tendencies and complementary services. How the above fleet characteristics and services tend to combine for each business model will now be explored. For ease of analysis, within those five business models we have made three main divisions: 1) Free floating (FF), 2) Roundtrip (RT) and 3) P2P.

★ **Free floating**

Free floating services allow members to go from point A to point B, thereby enabling one-way trips. Vehicles can be picked up and dropped off anywhere within the provider's business area. The operating areas are mainly compact urban areas (and in some cases like London only neighbourhoods), the distance travelled is therefore usually short and the type of commuting is spontaneous. Today, in FF is systemically impossible to allow in advance reservation as long as the cars cannot get around autonomously. Free floating providers charge based on the time travelled rather than distance. Sociodemographic data for free-floating business models shows that they tend to attract younger members (33 years old), with roughly 70% of them male; 17% of the overall membership lives in a household with children, and the attitude towards a car is that, "Driving a car is fun" (Nehrke, 2018).

Table 5 presents a list of some of the leading providers of free-floating carshare. Information on the fleet characteristics in terms of car models and fuel type is also given. As may be seen, many free-floating providers are owned by car manufacturers such as Daimler, BMW, Renault, PSA and Volkswagen. In general, they view their investment in car sharing as being purely strategic (it is part of the evolution of the automotive industry) and not for financial reasons. It is a channel to gather information about customers, their needs, their mobility habits, peak hours of use/requests; to test the technology embedded in a shared fleet; and to promote new categories of services.

Most free floating providers offer city and subcompact cars (A & B car segments). These cars, which ensure relatively easy parking for users, are well-suited to life in the city with easy handling and room for two to five people (Monitor Deloitte, 2017). As may be seen, the fleet variety is limited in terms of models, except for ShareNow. ShareNow[17], which was formed in early 2019 as part of the joint venture between the BMW Group and Daimler AG, joined indeed their services to offer a larger selection of vehicle models at more locations. Today is the world's leading provider of free-floating carshare and manages a fleet of more than 20,000 cars across Europe and North America.

Given the strict city regulations in terms of emissions and the short distances travelled, free-floating car fleets are turning into electric. An interview with Cédric Lacour, Business Development Director at New Mobilities Europe Renault, revealed that one central component of their free floating's strategy is to be fully electric (personal communication, November 2019). He also commented that Renault is indeed talking to city representatives and regulators to push this idea. Finally, he pointed out that with current EV battery performances, Renault will continue to defend the Renault ZOE as the best free-floating car model (today the group does not see an interest in offering a C-segment free floating e-car). The fleet of both Moov'in Paris and Zity (Madrid) is entirely electric.

[17] SHARE NOW is the name of the new free-floating carshare company that brings car2go and DriveNow together under a single roof.

Similarly Zipcar, which launched a free-floating scheme last year (Zip Flex), claimed in a separate interview that free floating is easier to electrify because it's for urban trips and it's not pre-booked, so you don't have the concern around whether a person turning up for a booking has enough range to be able to do what they want to do. However, electric vehicles still make up a third of Zipcar's free-floating fleet[18].

All in all, 100% of the free-floating fleet in Paris is fully electric (including car models like Smartfortwo, Renault Twizy, Renault ZOE, Peugeot i0n and Citroën C-Zéro). In London, there are more than 450 free floating electric cars (including car models like BMW i3s and VW e-Golfs). Moreover, in Madrid, there are 658 free floating Renault ZOEs operated by ZITY.

Free Floating providers	Owned by	Vehicle Manufacturer	Fleet characteristics by car segment, model and fuel type	
SHARENOW	Joint venture between car2go and DriveNow	DAIMLER BMW	A- City car	BMW Mini (petrol) Smart fortwo (petrol)
			B - Subcompact	BMW i3 (electric)[19] Mercedes-Benz A (petrol) Mercedes-Benz B (petrol) Mercedes-Benz CLA (petrol)
			C - Compact	BMW 2 Series (petrol)
			SUV	BMW X1 (petrol) BMW X2 (petrol) Mercedes-Benz GLA (petrol)
moov'in.pari by Rena	Renault	Renault	A – City car	Renault TWIZY (electric)
			B- Subcompact	Renault ZOE (electric)
ZITY	Renault[20]	Renault	B- Subcompact	Renault ZOE (electric)
FREE2 MOVE PARIS	PSA	Peugeot Citroën	B - Subcompact	Peugeot i0n (electric) Citroën C-Zéro (electric)

[18] Zipcar UK chief Q&A: Why it's 'challenging' operating in London https://www.ns-businesshub.com/business/zipcar-uk-general-manager-qa/ (NS Business)
[19] 20% of the total ShareNow fleet is fully electric;
[20] Moov'in operates in Paris and Zity in Madrid;

bluetorino[21]	Bolloré Group	Vehicule Électriques Pininfarina Bolloré	A- City car	Bolloré Blue car (electric)
bluecity	Bolloré Group	Vehicule Électriques Pininfarina Bolloré	A- City car	Bolloré Blue car (electric)
zipcar FLEX[22]	Avis Budget Group	VW	B - Subcompact	VW Polo (petrol) VW e-golf (electric)

Table 5: Free floating providers and fleet characteristics (LGI)

★ **Roundtrip**

Roundtrip services are more traditional, in that they require cars to be returned to the zone or station from which they started. Their operating areas are both cities (including outer suburbs) and rural areas. They tend to have longer on-average booking times lasting for several hours or a day[23], and they cater to trips of much longer distances, such as for leaving a city to visit the surrounding rural areas. Utilisation is usually panned (Nehrke, 2018). These services are therefore usually charged based on the distance travelled rather than time (however, we see the more and more combined tariff models with mileage and time elements) Sociodemographic data for roundtrip business models shows that they tend to attract slightly older members (44 years old), with a more equal split along gender lines (56% male, 44% female); 35% of the membership lives in a household with kids, and the attitude towards a car tends to be that, "A car is a means to an end" (Nehrke, 2018).

Table 6 presents a list of some of the leading providers of roundtrip carshare. Information on the fleet characteristics in terms of car models and fuel type is also given. As may be seen, roundtrip car sharing services are offered by car makers (e.g. GM, Seat, Volvo or Toyota), specialised car sharing operators (like Enjoy in Italy, Mobility Car sharing in Switzerland, Cambio in Germany and Belgium, Communauto and Citiz in France) and short-term car rental companies (e.g. Zipcar, owned by Avis Budget Group and Ubeqoo owned by Europcar).

[21] Both BlueTorino and Bluecity are free floating providers with pool stations;
[22] Zipcar Flex is the one way service of Zipcar operating at the moment only in London;
[23] Users appreciate the reliability in such operational model;

Moreover, roundtrip providers make up for fleet variety in terms of brands, models and sizes, catering from every need. The fleets go from city cars (like Fiat 500, BMW Mini, Renault Zoe) over subcompacts and compacts (e.g. Ford Focus, Toyota Prius, VW Golf)) to the executive range (e.g. Volvo V60, Cadillac Escalade). Multi- purpose vehicles (MPV) like the VW Transporter, Citroën Jumpy or Opel Vivaro, are also offered.

Unlike free floating services, a large share of roundtrip cars is classic ICE cars using petrol as a fuel. Depending on the city regulations, there are also diesel car models (a minority), which tend to be vans (like Citroen Berlingo and VW Transporter). Hybrid cars like Toyota Prius and Toyota Yaris, on the other hand, are growing in numbers. This is particularly true in bigger cities adopting low emission zones (LEZ).

An interview with Nicolas Fraise, Communauto's Chief Development Officer for Europe, revealed that roundtrip business models are not pushing the e-car further due to the high upfront costs (business model), the limited autonomy of the battery and the range anxiety that drivers still experience in longer trips (personal communication, October 2019). He also commented that several tests using hydrogen fuel-cell vehicles were run in Paris and Vancouver, but this is still very expensive for the low margin of roundtrip business. Consequently, their fleet in urban areas has turned away from diesel and is turning into hybrid. The ending of diesel era in car sharing is indeed a great economic effort for smaller operators, as the Chief Executive Officer (CEO) of Réseau CITIZ Jean Baptiste Schmider pointed out in a separate interview. As such, the car fleet of Réseau CITIZ was 80% diesel five years ago (personal communication, October 2019). Today, 15% is already hybrid.

Roundtrip providers	Owned by	Vehicle Manufacturer	Fleet characteristics by car segment, model and fuel type	
[24] MAVEN	GM	GM	Eco	Chevrolet Volt (hybrid)
			Sedan	Chevrolet Malibu (petrol) Buick Regal (petrol) Cadillac ATS (petrol)
			C - Compact	Chevrolet Cruze (petrol) Chevrolet Spark (petrol)
			SUV	Chevrolet Tahoe (petrol) GMC Yukon (petrol) Cadillac Escalade (petrol)
		Several:	B-	Ford Fiesta (petrol)

[24] Currently only in the US and Canada: Ann Arbor and Detroit (MI), Los Angeles and S. Francisco (CA), and Toronto (Canada).

zipcar wheels when you want them	Avis Budget Group	BMW Audi VW Hyundai Ford	Subcompact	Mercedes-Benz A (petrol) Hyundai i20 (petrol)
			C- Compact	Ford Focus (petrol) Audi A3 (petrol) Hyundai i30 (petrol) VW Golf GTE Auto (hybrid)
			Multipurpose cars/Vans	VW Transporter (petrol) VW Touran (petrol)
ubeeqo	Europcar	Several: BMW Renault Toyota PSA VW Ford	A- City car	Renault Zoe (electric) Fiat 500 (petrol) BMW Mini (petrol) Smart fortwo (electric)
			B- Subcompact	Toyota Yaris (hybrid)
			C- Compact	Toyota Prius (hybrid) VW Golf 7 (petrol) Skoda Octavia (petrol)
			Multipurpose cars/Vans	Citroen Berlingo (petrol) VW Touran (petrol) Ford Transit (petrol)
Communauto	Communauto[25]	Several: Toyota Citroen	B- Subcompact	Toyota Prius (Hybrid) Toyota Yaris (Hybrid)
			SUV	Citroen C4 Cactus (petrol)
			Multipurpose cars/Vans	Citroen Berlingo (diesel)
respiro	Seat (Group VW)	Several: Seat Toyota VW	A – City car	Seat Mii Eco (hybrid) Fiat 500 Eco (hybrid)
			B- Subcompact	Seat Ibiza Eco (hybrid) Toyota Auris (petrol)
			C - Compact	Seat Leon (Hybrid) Toyota Verso (petrol) VW Caddy (hybrid)
			Multipurpose cars/Vans	VW Transporter (Diesel) Toyota Proace (Diesel)

[25] Communauto operates in France and Canada. Car models are from the French fleet.

				VW Caravelle (Diesel)
RÉSEAU citiz	Citiz	Several: Renault Fiat Toyota	A – City car	Renault Twingo (petrol) Fiat Panda (petrol) Toyota Aygo (petrol)
			B- Subcompact	Renault Clio (petrol) Peugeot 207 (petrol) Toyota Yaris (Hybrid) Renault ZOE (electric)
			Multipurpose cars/Vans	Renault Kangoo (petrol) Peugeot Partner (petrol) Fiat Doblo (petrol) Renault Trafic (petrol/diesel)
sunfleet[26]	VOLVO	VOLVO	B- Subcompact	Renault ZOE (electric)
			C - Compact	Volvo XC40 (petrol) Volvo V40 (petrol) Volvo V40 Cross Country (petrol) Volvo XC40 AWD (petrol)
			E- Compact executive	Volvo V60 (petrol) Volvo V60 Nya (petrol) Volvo V60 Twin engine AWD (hybrid) Volvo S90 (petrol) Volvo V90 (petrol)
			Multipurpose cars/Vans	Renault Kangoo (petrol) Renault Master (petrol) Renault Traffic Medium (petrol)
YUKÕ TOYOTA Car Club	Toyota	Toyota	B- Subcompact	Toyota Yaris (hybrid) Toyota Prius (hybrid) Toyota C-HR Prius Plug (Hybrid) Toyota Auris (petrol)
	Cambio	Several: Renault	A – City car	Toyota Aygo (petrol) Fiat 500 Cabrio (petrol)

[26] Currently only in Sweden.

cambio		Fiat Toyota Ford VW Citroën	B-Subcompact	Ford Fiesta (petrol) Toyota Yaris (Hybrid) Renault ZOE (electric) Ford Courier (petrol) Citroën C3 (diesel)
			C - Compact	Ford Focus Kombi (petrol) Citroën Berlingo (diesel) VW Caddy (petrol/diesel)
			Multipurpose cars/Vans	Ford 9sitzer (petrol/diesel) Ford Transporter (petrol/diesel)

Table 6: Roundtrip providers and fleet characteristics (LGI)

- **P2P**

P2P model is a marketplace that that allows drivers to rent cars from private car owners, and owners to rent out their cars for payment. P2P services tend to be for the longest trips distance-wise. An interview with Jaume Suñol, Drivy's Country Manager for Spain (now Getaround), revealed that P2P business models compete with daily car rental companies (and recently cooperates as shown the last tender in the city of Paris – see next ZommBox) and also roundtrip services, particularly when it comes to tourists and young people (personal communication, February 2019). He also commented that the organisation focuses on trips lasting an average of two days, as ride hailing services inside cities are more convenient than car sharing services, and therefore too competitive

As P2P organisations do not have to provide a vehicle fleet or stations, this business model

alleviates upfront costs (Hampshire & Gaites, 2014). This also enables lower-density communities, such as suburbs and smaller towns, to partake in car sharing as well (Hampshire & Gaites, 2014; momo, 2009).

Given the decentralised fleet from different owners, P2P providers make up for fleet variety in terms of brands, models and sizes. Similarly to roundtrip schemes, fleets go from city cars over subcompacts and compacts to the executive range and even multi- purpose vehicles. In P2P schemes there are however more diesel cars and fewer hybrid and electric.

Malcolm Stewart, CEO and founder of SPOPIN, a P2P startup based in Paris, commented in an interview that their car offer includes different models, but they prioritise national car brands. Indeed, 80% of SPOPIN's car fleet is French with some exceptions like Fiat 500 (for its design) and SMART (design and high range segment). Getaround (ex Drivy), which is the world's P2P leader, offers for instance all range of car models and brands.

Other P2P players are: Travelcar (free2move), CarUnity, Toosla, GoMore and Wheeliz.

Table 7 maps where each business model falls in terms of car segment, fuel type and operating area, enabling a general comparison of the car sharing models. FF refers to free-floating, R to roundtrip and P2P to peer-to-peer.

Car sharing Model features								
Vehicle model			Vehicle fuel type			Operating area		
FF	R	P2P	FF	R	P2P	FF	R	P2P
Small city cars			Electric			Inner city		
								X
Compact cars			Hybrid			Broader city area		
						X		
SUVs & MPVs			Petrol			Regional		
			X					

Table 7: High level classification of vehicle characteristics with regards to their business model (LGI - adapted from Deloitte)

Zoom Box: City regulations impacting car sharing fleets

In France, car sharing exists since 1999 and is especially popular in Paris which perceives a strong municipal support. Today, there are two different offers available in the city: Free- floating and roundtrip (Mobilib').

The free-floating offer: There are three operators today offering this service:

- ShareNow (former Car2go)
- Moov'in Paris (Renault)
- Free2Move (PSA)

As mentioned before; the free-floating offer in Paris is fully electric in order to meet the requirements of the Clean Air Plan. The offer includes 400 Smartfortwo, 20 Renault Twizy, 500 Reneault ZOE, and 500 vehicles Peugeot i0n and Citroën C-Zéro.

Mobilib' - the Roundtrip offer:

To create its Mobilib service, the City of Paris launched a call for tenders in 2019. The city has allocated 1213 parking spots for Mobilib' cars. 500 of which are reserved for ICE and hybrid cars and 713 others are dedicated only for electric or plug-in hybrid vehicles (these are the former parking spots of Autolib).

Within these two offers, these were the awarded operators:

Parking spaces with charging stations: The 713 parking spaces are attributed to Ubeeqo. As mentioned before, only rechargeable. electric or plug-in hybrid vehicles were elegible in this category (Eco-Vignette Crit'Air EL and 1 only hybrid ones, and A class energy label).

Parking spaces without charging stations: The City of Paris selected four independent service providers to operate this Mobilib service:

- **Ada**: which offers 56 cars;
- **Communauto**: which offers 152 cars, of which 75% are hybrid;
- **Getaround** (ex Drivy): The fleet dedicated to Mobilib' comprises 154 vehicles owned by the company. The P2P sharing service will remain outside of the city's service;
- **Ubeeqo**: which offers 137 shared cars.

When looking more in detail at the tender characteristics, one could see that local regulations are impacting the type of car sharing vehicles offered in a city. On one hand, the only vehicles eligible in this category were the N1 category complying with the Eco-Vignette Crit'Air EL (Hydrogen and Electric Vehicles) and Crit'Air 1 (gas powered vehicles, rechargeable hybrid vehicles and petrol vehicles with Euro standard 5 and 6)[27]. In addition, cars must be equipped with an A class energy label, i.e models emitting 75g CO_2/km or less. Diesel cars were banned from the tender.

Moreover, as may be seen in Figure 7 and Figure 8, within the range of eligible vehicles, points were awarded according to their air polluting emissions performance and their size.

	Véhicule PTAC ≤2,5t	Véhicule PTAC >2,5t et <3,5t
Famille des redevances « C »	3 points	3.75 points
Famille des redevances « B »	2 points	2.5 points
Famille des redevances « A »	1 point	1.25 points

Figure 7: Points awarded for each group of licence fees and per size of vehicle[28]

Motorisation	Famille de redevances A	Famille de redevances B	Famille de redevances C
Électrique titulaire d'un Certificat Qualité de l'Air CQA EL et une Classe Énergie CO2 A	100€	200€	300€
Hybride rechargeable titulaire d'un Certificat Qualité de l'Air CQA EL et une Classe Énergie CO2 A	600€	700€	800€
Véhicule hybride non-rechargeable titulaire d'un CQA 1 et d'une Classe Énergie CO2 A	700€	800€	900€
Véhicule hybride non-rechargeable titulaire d'un CQA 1 et d'une Classe Énergie CO2 B ou C Véhicule thermique titulaire d'un CQA 1 et d'une Classe Énergie CO2 A, B ou C	1100€	1300€	1500€

Figure 8: Points awarded for each group of licence fees and per size of vehicle[29]

- **Complementary services offered by car sharing schemes:**

As mentioned before, car sharing services will have to offer value by providing vehicles that meet users' needs. Therefore, complementary services are increasingly seen as a key factor to increase the value of car sharing schemes.

[27] CRIT'AIR https://www.lez-france.fr/en/information-about-the-critair-vignette/the-french-vignette-critair/who-will-get-which-critair-colours.html
[28] Appel à candidature pour l'atribution et l'exploitation de stations de véhicules utilitaires partagés en voirie à Paris https://cdn.paris.fr/paris/2019/07/24/e774af1d93ef15b7712d23c63261809c.pdf
[29] Appel à candidature pour l'attribution et l'exploitation de stations de véhicules utilitaires partagés en voirie à Paris https://cdn.paris.fr/paris/2019/07/24/e774af1d93ef15b7712d23c63261809c.pdf

The infographic hereafter pictures some services that try to capture specific user needs. As may be seen, target users include families, university students or people with mobility issues. All interviewees agreed on the need to develop complementary services but in turn pointed out the difficulty of equipping and adapting their fleets (especially in terms of business model). The big question for car sharing operators is the share of cars to be equipped and with which type of equipment. They are currently collecting data to adapt their business model accordingly to user needs. Finally, several operators commented that their decision of equipping their fleets relies on user demands.

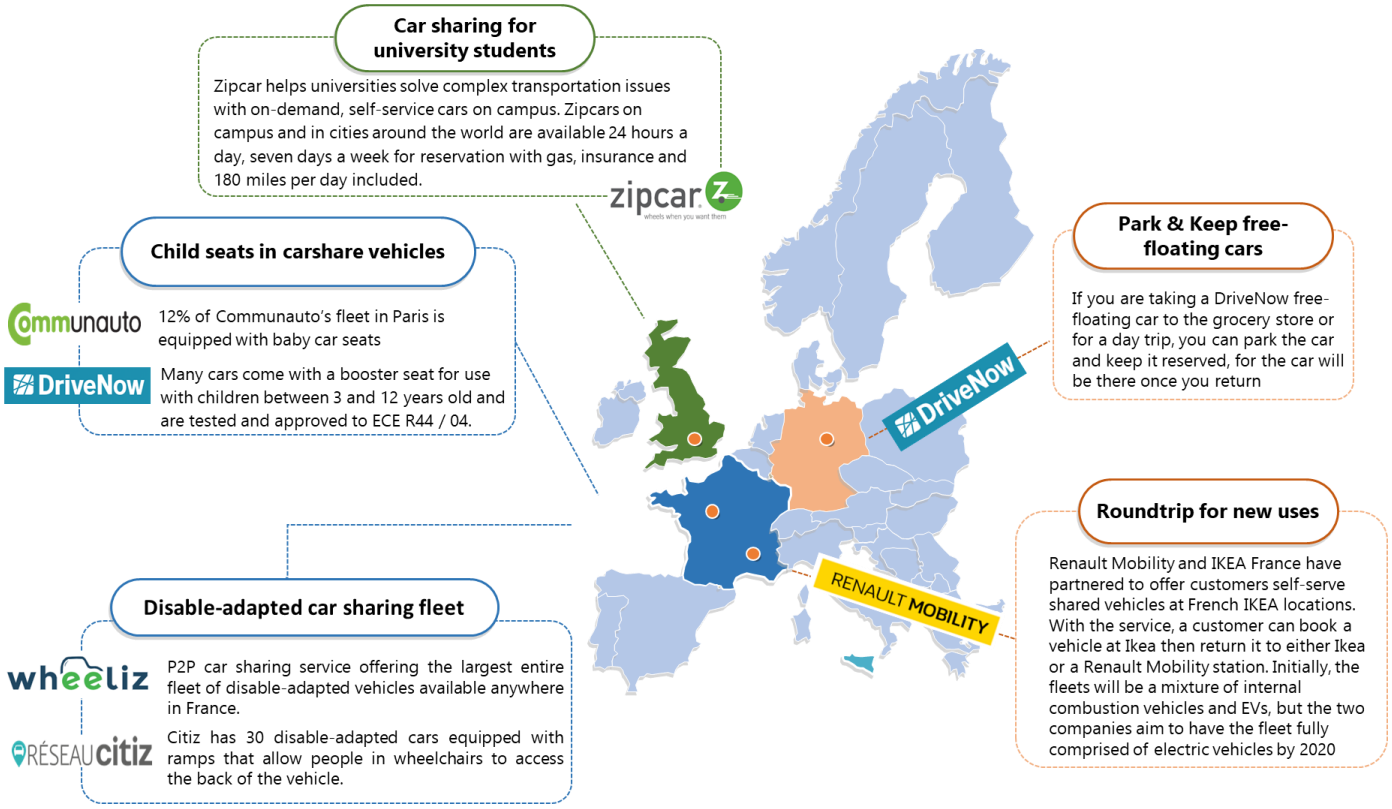

Figure 9: Examples of services offered by car sharing operators in Europe (LGI)

3.3 Changes in cars ownership levels of car sharing users

Users' interviewees (observations) in the city of Milan and Turin through the survey presented in section 1.2 were cross-tabulated according to the different possible combinations of changes in car ownership (decrease, increase or invariance in the number of cars both before and after the subscription to a car sharing service). Table 8 and Table 9 present the related contingency tables following this classification for both cities, by showing the number of observations falling in each case both in absolute value (bold) and as a percentage evaluated over the grand total (italic) along with the identifier the corresponding case (C1 to C6) or combination of cases (see STARS, in progress for a detailed presentation of such cases). As it can be noted, the total number of observations in both tables is different from the total number of interviewees of Milan and Turin reported in paragraph 1.2 (485 and 181 respectively); indeed the excluded observations belong to car sharing

users who stated having registered to a car sharing service before its official start date. It is worth recalling that those **observations come from free floating users**, and that the operations of the first service started in 2013 in Milan and in 2015 in Turin. Related to this, since the survey analysed the number of cars owned also one year before the first registration, Table 8 shows changes in car ownership over a period of 7 years (2012-2019) while Table 9 shows changes during the last 5 years (2014-2019).

n = 457		AFTER CS subscription			Total BEFORE
		Decreased	Unchanged	Increased	
BEFORE CS subscription	Decreased	**3** *0.6%* C2+C4	**12** *2.7%* C2+C5	**16** *3.3%* C2+C6	31 *6.6%* C2
	Unchanged	**39** *8.2%* C4	**322** *70.5%* C1	**39** *8.2%* C6	400 *87.0%*
	Increased	**9** *2.5%* C3+C4	**15** *3.5%* C3+C5	**2** *0.4%* C3+C6	26 *6.4%* C3
	Total AFTER	51 *11.3%* C4	349 *76.7%*	57 *12.0%* C6	457

Table 8: Number of interviewed users in the city of Milan split according to changes in car ownership

n = 168		AFTER CS subscription			Total BEFORE
		Decreased	Unchanged	Increased	
BEFORE CS subscription	Decreased	**1** *0.6%* C2+C4	**8** *4.8%* C2+C5	**5** *3.0%* C2+C6	14 *8.3%* C2
	Unchanged	**10** *6.0%* C4	**121** *72.0%* C1	**15** *8.9%* C6	146 *86.9%*
	Increased	**2** *1.2%* C3+C4	**5** *3.0%* C3+C5	**1** *0.6%* C3+C6	8 *4.8%* C3
	Total AFTER	13 *7.7%* C4	134 *79.8%*	21 *12.5%* C 6	168

Table 9: Number of interviewed users in the city of Turin split according to changes in car ownership

Looking at Table 8 and Table 9, it is possible to note that in both cities the majority of the observations falls in the cell at the centre of the table, at the crossing of the "unchanged" rows and columns. Thus, **most households have not changed the number of cars owned** over the whole period spanning from one year before at least one household member has registered to a car sharing service until the day of the interview.

Comparing the situation before and after registration, where the former is reported in the last column and the latter in the last row, more changes occurred after the first registration to a car sharing service in both cities. In particular, in Milan 12% of the interviewees increased the number of owned cars while the 11.3% sold one or more. In Turin 12.5% of the interviewees bought one or more car while the 7.7% sold one or more. **In both cases, the number of cases in which the number of cars increased is higher than the number of cases in which the number of cars decreased**.

Based on the previous classification, it was possible to build the following Table 10 and Table 11 where the number of cars is reported instead of the number of observations. Each cell reports the changes before the first registration (small number on the left), the changes after the subscription (small number on top) and the algebraic sum of these two scenarios (in bold). Once again, a label identifying each case is reported in the bottom side of each cell.

When it comes to analyse the change in the number of cars, there was a higher number of cars decreased compared to the ones increased before the subscription to a car sharing service. For example in Milan there was a decrease of 36 cars and an increase of 29, as reported in the last column of Table 10 The same happened in Turin (Table 11). On the contrary, **in both cities the number of cars reduced is lower than the number of cars increased after the registration**: a decrease of 58 cars against an increase of 69 in Milan (last row of Table 10), -15 and +23 respectively in Turin (last row of Table 11). Therefore, **overall changes in car ownership of free floating users seem to be less determined by the subscription to the service rather than by other factors**.

The algebraic sum of the before and after registration situations is reported in bold in the lower right corner of Table 10 (Milan) and Table 11 (Turin). These values are obtained as a sum of the number reported on the left side, which represents the sum of the before registration car changes, and of the number on the top, which represents the sum of the after registration car changes.

# of cars…		AFTER CS subscription			Total BEFORE
		Decreased	Unchanged	Increased	
BEFORE CS subscription	Decreased	-4 -3 **-7** C2+C4	0 -13 **-13** C2+C5	+25 -20 **5** C2+C6	+21 -36 **-15** CASE 2
	Unchanged	-43 0 **-43** C4	0 0 **0** CASE 1	+42 0 **42** C6	-1 0 **-1**
	Increased	-11 +11 **0** C3+C4	0 +16 **16** C3+C5	+2 +2 **4** C3+C6	-9 +29 **20** CASE 3
	Total AFTER	-58 +8 **-50** CASE 4	0 +3 **3**	+69 -18 **51** CASE 6	+11 -7 **4**

Table 10: Changes in the number of cars within car sharing users' households of Milan

# of cars…		AFTER CS subscription			Total BEFORE
		Decreased	Unchanged	Increased	
BEFORE CS subscription	Decreased	-1 -1 **-2** C2+C4	0 -8 **-8** C2+C5	7 -5 **2** C2+C6	+6 -14 **-8** CASE 2
	Unchanged	-11 0 **-11** C4	0 0 **0** CASE 1	+15 0 **15** C6	+4 0 **4**
	Increased	-3 +3 **0** C3+C4	0 +5 **5** C3+C5	+1 +1 **2** C3+C6	-2 +9 **7** CASE 3
	Total AFTER	-15 +2 **-13** CASE 4	0 -3 **-3**	+23 -4 **19** CASE 6	+8 -5 **3**

Table 11: Changes in the number of cars within car sharing users' households of Turin

Accordingly, an increase of four cars within 457 interviewees representing 1226 people was estimated in the city of Milan during the whole period of analysis. On the other hand, an increase of three cars within 168 car sharing users interviewed (representing 435 people) was estimated in Turin.

By separately considering row and column totals (i.e. before and after registration) a strong difference it is noticeable in the magnitude of changes in car stocks. Clearly, the larger time frame of the after

registration situation can be one of the possible reasons why more changes were registered. In fact, before registration time frame is one year while the after registration time frame is, on average, three years for Milan users and two years for Turin users. However the change in purchase and sale trends is interesting and it might be related to more general trends, such as the car market trend.

For this reason, information about the changes in the number of cars of the overall population living in the two cities was considered, as a mean of comparison. The trends of car stock (in blue) and of the motorisation rate (in red) of the city of Milan and Turin are respectively reported in Figure 10 and Figure 11 below. In both figures the time interval considered to observe users' changes is delimited by yellow lines, which are referred to the year before the average subscription year and to the year of the survey (2019). No complete information about car stock and motorisation in 2019 are available yet, thus the two trends end in 2018.

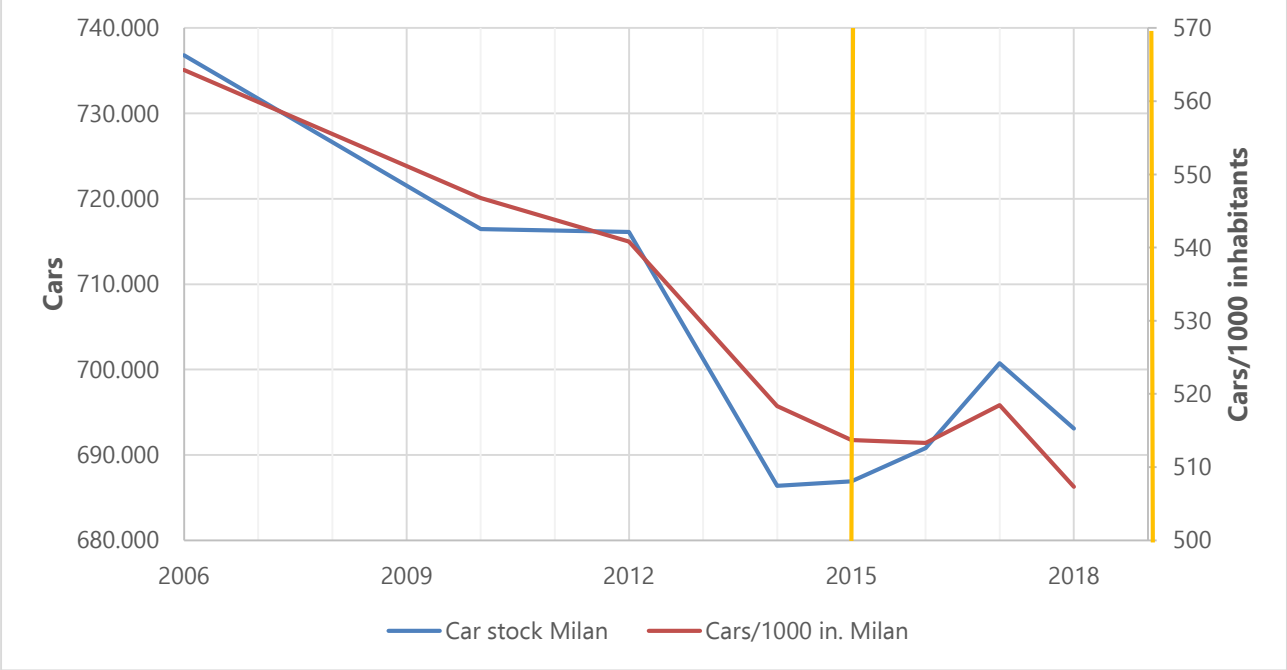

Figure 10: Overall changes in car stock and motorisation rate in the city of Milan (data source: http://www.aci.it/laci/studi-e-ricerche/dati-e-statistiche/annuario-statistico.html, Chapter 3, Tab 28-29)

Looking at the situation in the city of Milan, it can be observed that the car stock decreased until 2014. Then it increased between 2014 and 2017, decreasing again during 2017. It is worth stressing that this trend is resulting from the combination of new cars registered and cars scrapped.

The trend of the motorisation rate is similar to the car stock one, meaning that the population has not changed substantially. However, **during the period under analysis (2015-2018)** there was an inversion of the two curves: the motorisation ratio, which represents **the number of cars per 1000 inhabitants, decreased from 514 to 507 albeit the number of cars increased from 686,000 to 693,000**. This can be explained by a higher growth of the population compared to the number of cars.

On the contrary, according to our **survey the motorisation rate of car sharing users interviewed in Milan slightly increased from 454 cars per 1000 inhabitants in 2015 to 457 in 2019**. Such rates were computed on the basis of the overall number of interviewed car sharing users household members, namely 1226 people. In fact, the overall increase of four cars as recorded in the grand total of the above Table 10 over 1226 people can be re-proportioned into an increment of three cars per 1000 people.

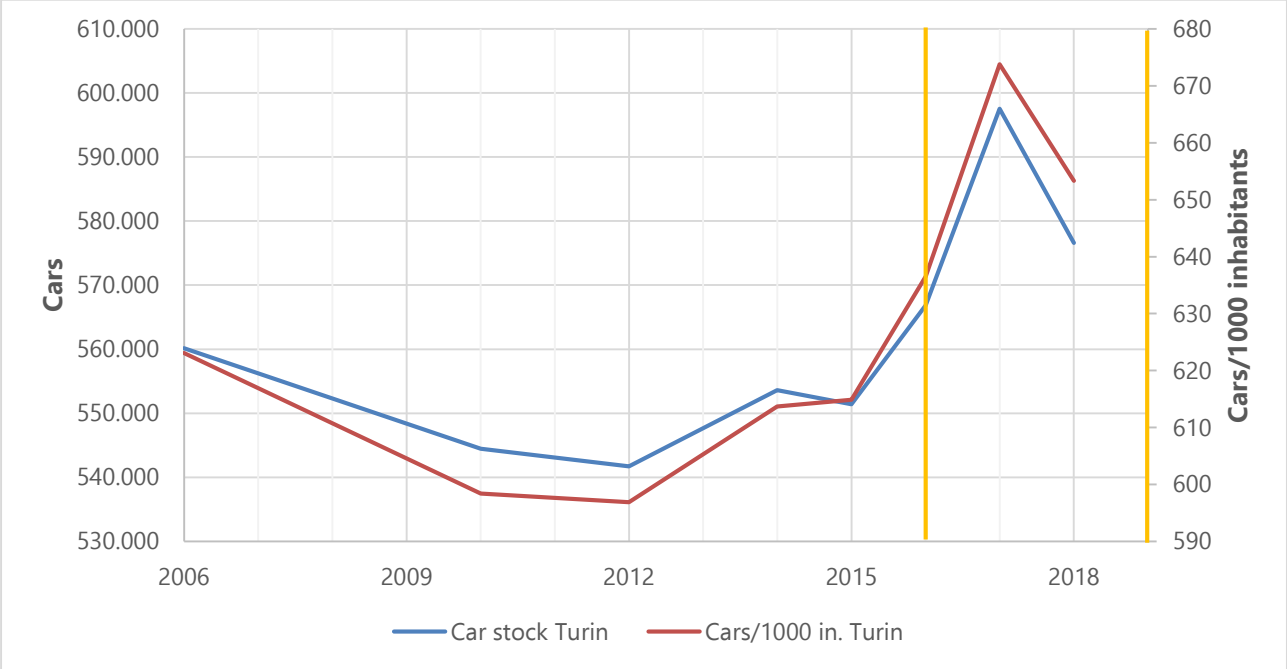

Figure 11: Overall changes in car stock and motorisation rate in the city of Turin (data source: http://www.aci.it/laci/studi-e-ricerche/dati-e-statistiche/annuario-statistico.html, Chapter 3, Tab 28-29)

The situation in the city of Turin, reported in Figure 11, is a bit different. The car stock decreased until 2012. Then it increased between 2012 and 2017, decreasing again during 2017. Within our reference period (2016-2018), **the motorisation rate increased from 637 to 653 (+16 cars every 1000 inhabitants) and the number of cars increased from 566,000 to 576,000**.

On the other hand, **the motorisation rate of car sharing users interviewed in Turin slightly increased from 478 cars per 1000 inhabitants in 2016 to 485 in 2019**. Again, the overall number of interviewed car sharing users household members, namely 435 people, was considered to perform a proportionality calculus projecting the increase of three cars recorded in Table 11to a base of 1000 people.

3.4 Compliance of electric vehicle characteristics to car sharing operations

In order to evaluate to what extent EVs can satisfy the needs of different car sharing variants, especially in terms of ranges and charging performances, data available in literature and car sharing operational data (coming from a free floating service) were jointly analysed.

There is evidence in several studies within European cities that car sharing trips performed through free floating services are short, inner-city trips, which typically last 30 minutes and cover 4-5 km (Ciociola et al. 2017; Cocca et al. 2018; Habibi et al. 2017; Schmöller et al. 2015; Nehrke et al. 2018). On the other hand, roundtrip station-based services are usually used for longer trips, around 50 km on average (Rodenbach et al. 2018; Chicco et al. 2018).

Concerning the user experience and travel behaviours, different usage pattern have been found when electric vehicles were available in car sharing fleets: despite trip distances were well below the range of electric vehicles, users seemed to use EV car sharing for slightly shorter trips (Sprei et al. 2019). However, human perceptions and behaviours will not be considered in the following analyses, which instead will be based on operational data.

These data come from a free floating service operating in the city of Turin since April 2015. The data were collected between January and February 2016 and they report information about the availability of each car in the fleet every minute. It was then possible to derive both the amount of time the cars were idling in a parking position between two consecutive rents and the GPS positions of the origin and destination of each rent. For privacy issues, no routing information of rents was available, thus the Google Directions API was used to estimate travelled distances through the shortest path. Travel distances estimated are, on average, in line with the above-mentioned values found in the literature concerning free floating services.

Starting from the travelled distances and knowing the energy consumption of electric cars in traffic city conditions, it was then possible to simulate the energy consumption within each rent, if an electric vehicle rather than an internal combustion engine vehicle had been used. Then, the time necessary to recover the initial state of charge (SoC) was calculated on the basis of the charging speed. Since energy consumption and charging speed depend on the vehicle characteristics, four types of electric cars belonging to different segments and with varying number of seats and performances (battery capacity, charging power, …) were considered. All these models were available on the automobility market in November 2019. A summary technical data sheet based on publicly available data (https://ev-database.org/) is reported in Table 12.

Three different car segments, which can be usually found in e-car sharing fleet, were considered. In addition, two cars both belonging to the segment A were picked up, differing in terms of number of

seats and ranges. In terms of speed and acceleration, all electric cars reported have performances comparable to the internal combustion engine cars.

Different vehicle categories were also chosen because of their performances in terms of battery capacity, charge power and charge time. Even though some of them have similar battery capacity, the charging time is influenced by the charge power, which is the maximum power tolerated by the onboard charger.

	Car 1	Car 2	Car 3	Car 4
Car model	Smart EQ fortwo	Volkswagen e-Up!	Renault Zoe	Nissan Leaf
Segment	A - mini	A - mini	B – small	C - medium
Seats	2 people	4 people	5 people	5 people
Price (in Germany)	22'000€	21'975€	33'990€	36'800€
Acceleration 0-100 km/h [s]	11.6	11.9	14.5	7.9
Max speed [km/h]	130	130	135	144
Range [km]	105	200	320	220
Energy consumption [kWh/100km]	15.9	22	16.3	16.4
Battery capacity [kWh]	17.6	36.8	55	40
Battery usable [kWh]	16.7	32.3	52	36
Charge port	Type 2	Type 2	Type 2	Type 2
Charge power [kW]	4.6 (AC)	7.2 (AC)	22 (AC)	3.6 (AC)
Charge time [h]	4.5	5.5	3	11
Charge speed [km/h]	25	38	110	19

Table 12: EV characteristics and performances according to their market segmentation (source: https://ev-database.org/)

Two main assumptions were driving the estimation of the charging time that is needed to recover the SoC:

- ★ Public charging stations can provide charging power up to 22kW (over that threshold norms are referring to fast charging station (Nicholas and Hall 2018)). Consequently, each vehicle reported in Table 12 above can be charged at the fastest speed.
- ★ The charging speed, evaluated as a ratio between the usable battery and the charge time, is considered constant although this is true until the SoC reaches almost 80%, then it is slower.

The above mentioned dataset included almost 40,000 rents and related parking events were identified. The average parking time (or stop time) was 446 minutes (about 7 hours), while the average recharging times evaluated for each of the above defined categories of EV car are much

smaller. In particular, the average recharging time if a Smart EQ would have been used to serve these trips would have been equal to 10 minutes. This figure is almost 9 minutes for the e-Up, 12 minutes for the Nissan Leaf while it drops to 2.2 minutes for the Renault Zoe.

Low values of charging time are clearly related to the low energy consumption during car sharing trips, which in turn is related to short travel distances performed with free floating services. On the contrary, high values of parking time might be related to the low fleet usage (the service opened almost a year before), the overnight parking and the use of car sharing in peripheral zones of the operative area (not densely populated).

The daily frequency distributions of parking time and of recharging time for the four models is reported in Figure 12 and Figure 13 respectively. The density reported on the vertical axle is related to the use of a continuous representation of the frequency, where the number of observations falling in each timeframe is divided by the total number of observations.

Figure 12: Distribution of parking time of a free floating car sharing fleet in Turin (2016)

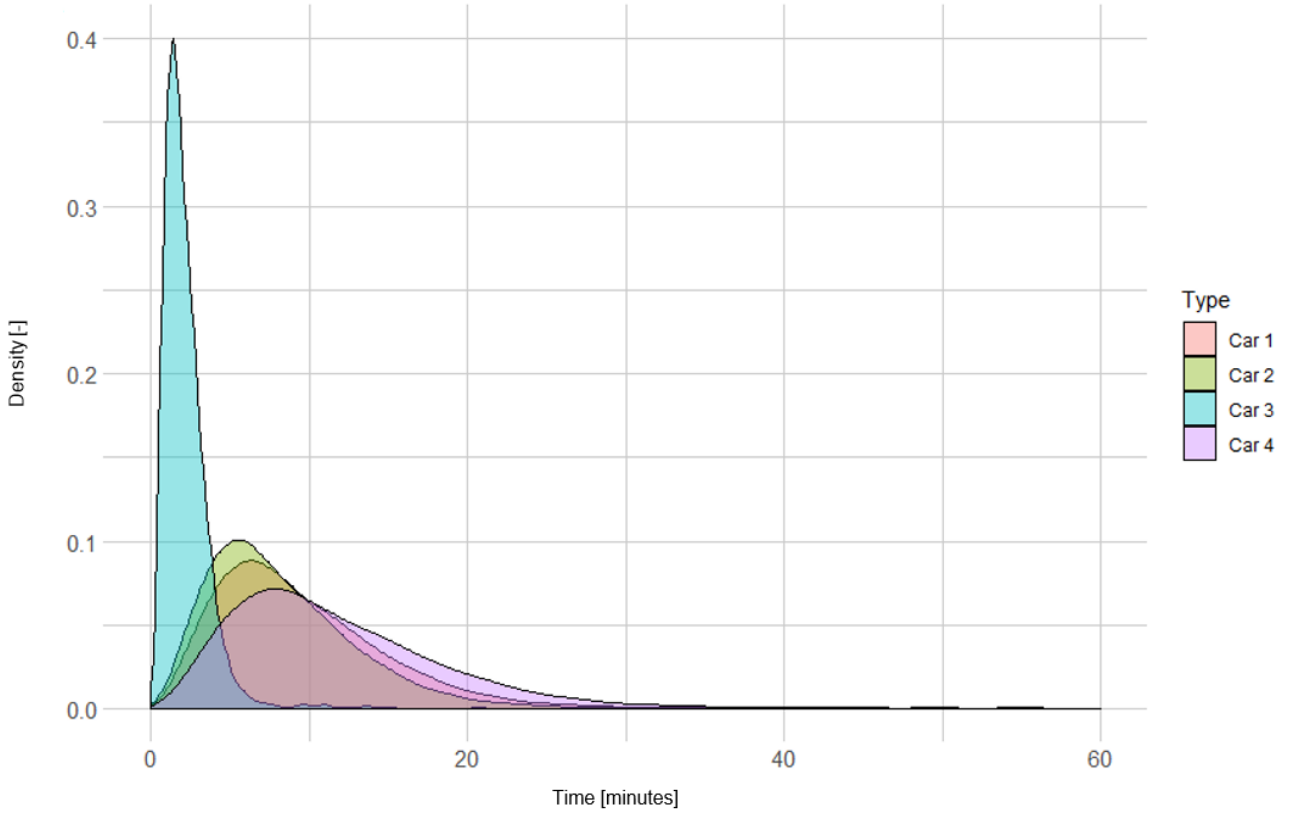

Figure 13: Distributions of charging times required to recover the energy spent in one car sharing rent

Due to the big differences in average values of parking time and charging time, it is difficult to make a comparison of the distribution in the two above figures. Looking at Figure 12Figure 12, parking times are more dispersed, with a first peak for values around 60-70 minutes and another peak at 1440 minutes (some vehicles were parked all day). On the contrary, recharging times showed in Figure 13 Figure 13 are concentrated within a time frame of 60 minutes (there are not trips that require more than 60 minutes of charging time to recover the battery at the previous level). This might rise some charging poles availability issues, especially in those areas where car sharing vehicles are parked for long times. Indeed, cars occupying the charging poles when they are already charged, might prevent other cars to use the pole. According to (Cocca et al., 2018) charging stations should be placed in areas were parking events last less and are more frequent.

Comparing the differences between different car types, what is influencing the distribution's peak is the charge power: higher is the charge power, more the peak move on the left side (the recharging time is lower).

The results showed are indicated that **there are wide possibilities for the application of EV in free floating car sharing fleets**. In part this margin will be reduced if the use car sharing services will intensify, since the parking time will become shorter. Charging times presented in Figure 13 might also explain the decision to use more compact vehicles **in existing free floating services**, where the

operator looks for a **solution with smaller investment and operations cost that is anyway fit to their typical travel demand patterns under the battery charging viewpoint**.

Cars like the Renault Zoe might on the other hand be more adaptable to station-based services, thanks to its higher range and faster charging process. Traditional roundtrip station-based systems are indeed used for longer trips, on the other hand the related fleet management is simpler and it should enable an easier control the battery charging level. There might be a problem for very long trips (the same that can occur with a private car), but the price structure could discourage those trips.

It is finally worth mentioning that there are other factors that might influence the feasibility of setting up an electric car sharing service:

- Geographical factors such as city dimensions (in the case analysed the city is 130km2, with longer trips of 30km on average), and the density of mobility attractors;
- Climate conditions that might influence the energy consumption (cold weather increases battery consumption, whereas hot weather requires better thermal management of the battery pack);
- Charging opportunities (Sprei et al. 2019), both in terms of number of charging stations and on their localisation. Operational data analyses might help to identify optimal areas for charging stations;
- Returning policies which regulates the connection to a charging station after car sharing rents. For example, users might be obliged to connect the shared car to a charging pole after each rent or just when the SoC is below a defined threshold.

4 Future scenarios

In this last section, the consortium will evaluate future scenarios based on previous discussion and STARS H2020 findings.

The first scenario is car sales and EVs forecast. As already underlined in Section 2, the European Car market dropped by 3,5% on the first semester 2019. The drop registered is more important on monthly basis (YoY) as illustrated in the Figure 14 below: the European car market reported a 7.9% year-on-year drop in sales for June 2019. According to Bloomberg, this result is due to a growing nervousness among European households about a car purchase (Bloomberg Business, 2019). Other factors are the Brexit nebulous negotiation, German export decline, risk of further trade war. It seems clear that CS has not a real impact on car sales.

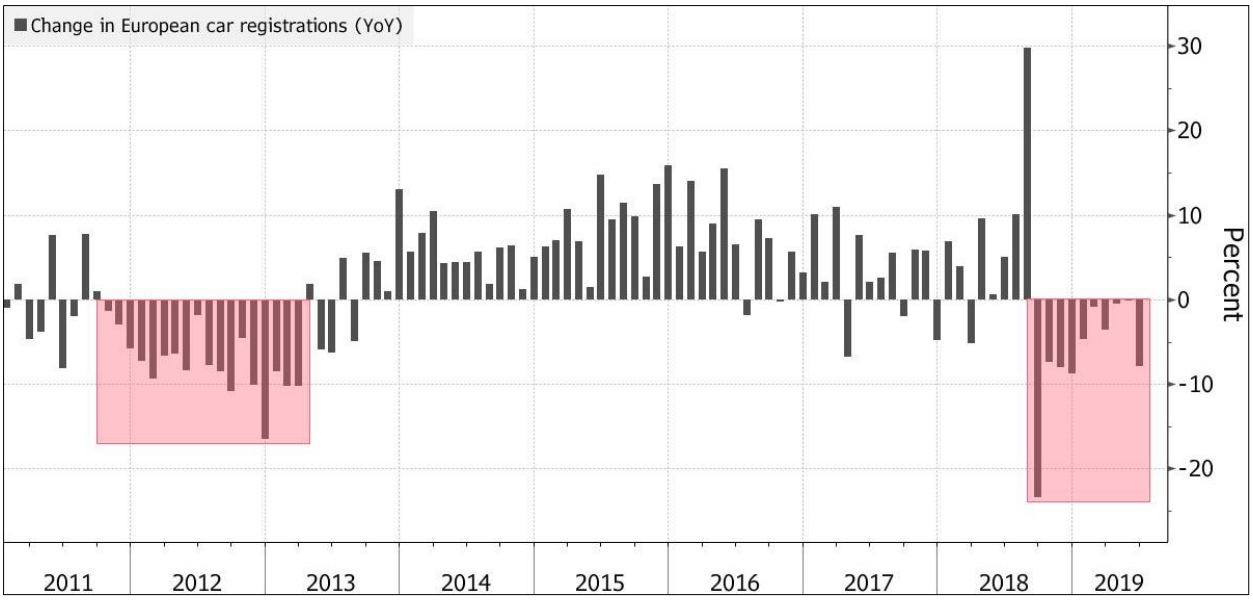

Figure 14: European Car sales % change per months YoY (Source: ACEA)

Within this context, the consortium has verified the performances and forecasts regarding car sales in Europe. If Bloomberg foresees a difficult 2019 for the automotive sector, other sources are more optimist in term of car sale performances. ING Bank forecasts a slow growth of units sold till 2030, then car sharing effect will generate a decline of 1 million less sold car by 2035 (ING Bank, October 2018). Scotiabank is forecasting a stagnant market with Eastern EU markets supporting Western EU markets decline, while Statista is much more confident with a 2-2.5% CAGR until 2023 (driven by Eastern EU countries market growth) as shown in Figure 15 below.

During the ECG conference in Berlin (17-18 October 2019), PwC underlined that, while German sales are expected to increase by 2.9% to a total of 3.54m units, sales declines are expected in Italy (-4.5%), UK (-3.7%) and France (-1.5%) in 2019.

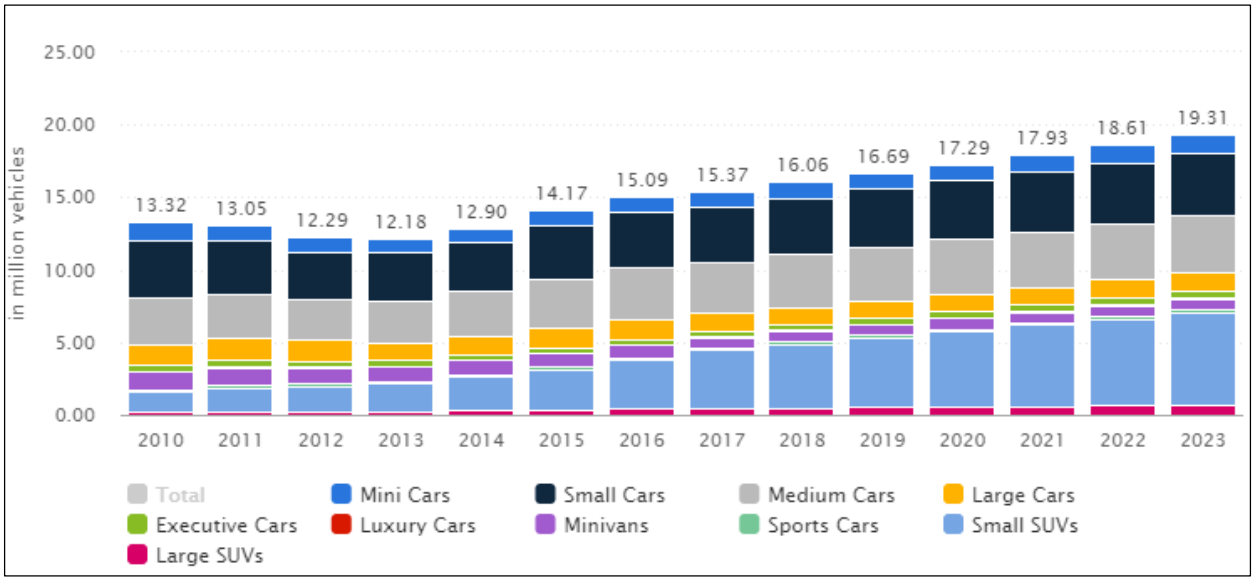

Figure 15: Vehicle Sales by Segment in Europe (EU+EFTA) - Forecast 2023[30]

It is worth mentioning a different point of view provided by PwC. According to them, Europe car stock is expected to drop from 280 million to 200 million vehicles by 2030[31]. Car sales will be almost the same, even a slight growth but (CS) fleets will be replaced at a faster pace due to higher mileage. Paradoxically, this lower stock is expected to coincide with a climb in registrations which, by 2030, will increase in Europe by 34% (from 18 to 24 million units) (Liceras, 2019).

Starting from PwC statement, and based on the inputs shared during the second STARS *Webinar 2 with Uptake Cities* organized by ICLEI on September, the 20th 2019[32], GM has simulated a best-case scenario of the impact that car sharing might have in the 4 Italian cities -and their metropolitan areas (M.A.)-, replacing (part of) used cars. Knowing the car stock circulating in all 4 cities and M.A., we can estimate that (roughly) **38'150 to 45'450 cars** can be **removed from streets** (see Appendix 4 for full details); as declared by Autodelen during the webinar, car sharing can be a good option for households replacing their second cars instead of focusing exclusively on the first car.

Considering, EV and/or alternative propulsions, if the extremely ambitious 2025 and 2030 CO_2 targets set by the EU are to be achieved, sales of all types of alternatively-powered vehicles will have to pick up rapidly in all member states. According to McKinsey, by 2021 the (B)EVs sales should reach 2.2 million vehicles sold -representing 12/15% of new car sales market share (Tschiesner, 2019). PwC predicted that in 2025 EVs will represent more than 10% of total production (and 55% of global sales by 2030) (Johns, 2019) (PwC, 2018). Although the reality is that in total there are less than 175

[30] Source : https://www.statista.com/outlook/1000000/102/passenger-cars/europe#market-volume
[31] The same effect is expected in US as well: from 270 to 212 million vehicle. While in China, the car stock circulating should reach 280 million from the 180 currently circulating.
[32] The webinar was organized by ICLEI (Marko Horvat) on September the 20th, 2019 with 5 panelists and 15 attendees.

thousand public charging points available in Europe today (EAFO, 2019), a figure which still falls far short of what is required. Indeed, according to conservative estimates by the European Commission, at least 2.8 million charging points will be needed by 2030 (Quartier, 2019). That means there should be roughly a 20-fold increase within the next decade. So, there is much work to be done in the coming years, hoping for a proper geographical distribution of charging infrastructure within the European area (DW, 2019). Several OEMs, European energy and grid utilities are actively participating in the installation of public fast and ultra-fast charging networks across Europe. EC (European Commission) has also (co)funded several projects: E-Via Flex-E[33] (Enel, EDF, Nissan, Renault, Ibil), Mega-E[34] (Allego), CEUC[35] (Verbund, Enel X, Greenway, OMV, CEUC), NEXT-E[36] (E.ON, MOL, PETROL, Nissan, BMW), E.ON x Clever[37] (E.ON and Clever). Other initiatives with a larger OMEs engagement are Ultra-e[38] and IONITY[39] projects.

The collaboration among mobility actors and regulators can mitigate EV charging infrastructure problems and car sharing may have a pivotal role if properly supported. The following paragraphs list the main facts and insights collected in the interviews in relation to future perspectives. We have structured them into four main groups: (1) Car sharing business evolution, (2) The role of cities (3) Added value services and (4) Shared and autonomous vehicles.

1) Car sharing business evolution (for car manufacturers and specialised car sharing operators)

- ★ Car sharing is part of the evolution of the automotive industry. Although these new mobility services can let them gain access to new customer groups, this is not their main reason when investing in this sector. All in all; the trend toward car sharing does not make car manufacturers consider reconceiving their mission, at least in part.

[33] E-VIA Flex-E: The "*E-VIA FLEX-E mobility in Italy, France and Spain*" project begins, for the study with pilot of 14 ultra-fast charging stations in Europe (https://www.eviaflexe.com/en/megamenu/project.html)
[34] MEGA-E: aiming at installing 322 ultra-charging (UC) stations in 20 European countries. The Action itself encompasses the deployment of 202 UC stations (up to 350 kW) in 30 greater metropolitan areas within 13 countries along the Core Network corridors and the Core Network itself. (https://trimis.ec.europa.eu/project/metropolitan-greater-areas-electric#tab-outline)
[35] CEUC (Central European Ultra Charging) project aims to install 118 HPC (high power charging) stations are to be installed by the end of 2020 in Austria, Czech Republic, Italy, Hungary, Romani, Bulgaria and Slovakia (https://www.electrive.com/2018/04/26/ceuc-new-fast-charge-corridor-for-europe/)
[36] NEXT-E: the project will install 222 multi-standard fast chargers (50 kW) and 30 ultra-chargers (150-350 kW) along TEN-T core corridors and core network (https://next-e.eu/map.html)
[37] E.ON x Clever: by 2020 the project will establish a network of 180 ultra-fast charging stations for EVs from Norway to Italy.
[38] Ultra-e: 25 ultra-E charging stations through Europe which connect the Netherlands (5 sites), Belgium (4 sites), Germany (12 sites) and Austria (4 sites). (https://www.ultra-e.eu/)
[39] IONITY project: to deploy 400 fast-charging stations (350KW) by 2020 in 24 different countries. IONITY is a joint venture of BMW Group, Daimler AG, Ford Motor Company, and VW Group with Audi and Porsche. https://ionity.eu/en/where-and-how.html

- Car sharing has potential related to real estate developments even though there is still a significant unexploited opportunity for rethinking real estate in partnership with car sharing services. Real estate & CS synergies may reduce the cost of an apartment[40], as in urban areas new developments consume 10 -15% of construction costs for underground parking (Burke, 2019). An example is Toyota: the car maker partnered with a real-estate developer to offer electric vehicle carsharing in condominiums in Tokyo (Clark, 2011).
- Understanding where car sharing future opportunities lies requires a more granular view of mobility markets. Specifically, car sharing operators will need to segment these markets by city types (and not by countries or region). The population density is not the only indicator. Literature also points out the economic development, consumer preferences and behaviour, policy and regulation.
- In the case of free floating, it stands a much better chance of catching on in densely populated areas with more than 1 million inhabitants. The turnover of free floating is higher than in roundtrip, but the upfront investment is very high at the same time. That is why we see bigger players in free floating than in roundtrip (often car manufacturers). Moreover, the availability of cars and the coverage is key for increasing the utilisation rate of cars. Several key players like ShareNow (Car2Go and DriveNow) and Getaround (ex Drivy) had made strategic alliances in the past year.
- In medium size cities (400K<inhabitants<1M), free floating is less developed as a high utilisation rate is not guaranteed. The strategy of car manufacturers to play in this type of cities is to partner with well-established medium-size car sharing operators.
- In cities with less than 400K inhabitants, car manufacturers could see an interest to develop roundtrip services. Renault, for instance, is developing roundtrip services through its network of regional car dealers. As such, Renault mobility offers in Nice 60 cars and has 25 spots
- Free floating is turning its fleet all electric. Today, city cars are the car segments offered but with increased battery performance, compact cars (C-segment) will be as well offered.
- Roundtrip will be electric by 2030, provided that local authorities make moves to increase charging points and that battery performance improves.

2) The role of cities:

- Cities should open the car sharing market to several operators as this will improve the user experience[41]. Extent research shows that mass is important and that in big cities, the car sharing offer should be ideally provided by 2-4 operators. In fact, in a city with another car sharing system present, many inhabitants are already familiar with car sharing which may lower the barriers to offer and use shared cars through the other platform as well.

[40] In other region of the world the cost of underground parking affects real estate costs: In Los Angeles, the cost may represent up to 39% of the real estate price. In Australia, based on typical affordable housing development costs, one parking space per unit increases costs approximately 12.5%, and two parking spaces by up to 25%.

[41] There are some best practices -such as the City of Bremen- that can be taken as a model in order to improve user experience even if customized on specific local needs.

- If car sharing aims to be developed, cities should offer advantages to car sharing operators, such as preference lanes (like in Madrid), or dedicated parking spots in very compact areas where parking is a real issue.
- The availability and use of different transportation modes are very influential for car sharing development. If there is a strong public transport system and a good cycling infrastructure and service present in the city, it is easier to live without a car or multimodal travel might be easier. However, car sharing is proved to be very useful in cities with a weaker public transport system (but still a good one), since a car is needed more frequently to get to locations. As such, the mean utilisation rate per vehicle and day for free-floating in Paris is 3-4 and in Madrid is 8-10.
- The integration model for car sharing and public transport is still an issue. Interviews revealed that the type of agreement is still under discussion. The main questions rely on who brings the business to the other one. One option in progress is that the city develops the MaaS and service providers integrate in it. If it is a private operator that develops the MaaS, the revenue model should be carefully defined.

Zoom Box: Catapult Connected Places

The success of car sharing in part depends upon the contextual setting. Crucial to this is the approach to mobility and transport adopted by government at national and local levels – particularly in terms of urban planning.

Car sharing does not appear to be very significant in future planning considerations in the examples that were examined by CU. Interviews regarding the longer term were conducted with the 'Transport Systems Catapult' (see https://ts.catapult.org.uk/). This entity was recently merged with the Future Cities Catapult to create 'Catapult Connected Places'. According to the new organisation: "*Mobility in the future will be built on the needs of the traveller rather than the mandates of the operator. It will be multi-modal, meaning that you don't have to worry about added complications even if your journey is a mixture of cars, buses, trains or planes. It will be smarter, more efficient and less harmful to the environment. It will be powered by data and enabled by the latest technological advances in a wide range of fields that have traditionally been distinct from the world of transport. In short, it will be based on 'Intelligent Mobility' – the name for the global £1.4 trillion industry that is taking shape at the intersection of traditional transport and new technologies.*"

The **Catapult** was created by government as a mechanism to identify and invest in R&D opportunities for this emergent mobility future. As can be seen, the approach is heavily technological in bias. To date car sharing has not featured in the analyses undertaken for funding decisions, nor has it featured in any funding proposals. It was claimed in interview that there was an awareness of the potential contribution of car sharing, though so far nothing material has been done regarding this topic.

At a more local level, the transport planning priorities of the **Cardiff City** region and the **adjacent Vale of Glamorgan** (sub-urban and rural hinterland to Cardiff) also had no consideration of car

sharing, or indeed much scope for other alternatives such as active travel. Rather the priorities are with the construction of a new Metro regional tram system; enhancing and updating of the antiquated local railway network; the creation of a new over-arching transport provider in the form of Transport for Wales; and a focus on using bus park-and-ride schemes, while updating the buses themselves. The desire to reduce car travel into the city centre is not attached to any specific numerical score or target. Recent urban developments at the periphery of the city have largely been away from existing mass transit routes, and compel individual car ownership and use.

3) User centred business model:

- Car sharing organisations are diversifying their portfolio of services to target specific groups and increase the value of their car sharing scheme. However, this can challenge their business model.
- Based on WP5 and interviews, most common demands from users include car equipped with child seats, extending the zone of operation, possibility of transporting bikes, more disable-adapted fleets, of vehicles with upgraded technical and technological equipment.
- There is a common difficulty of equipping car sharing fleets. The big question for car sharing operators is the share of cars to be equipped and with which type of equipment. They are currently collecting data to adapt their business model accordingly to user needs.

4) Shared and Autonomous vehicles:

- Car sharing is certainly bringing about changes in urban areas, driver experience, and in the business models of car manufacturers and new players. However, it is not seen as a game changer for the automotive industry. Vehicle automation, on the other hand, is regarded as the next big technological change in transportation.
- One scenario that could bring about revolutionary changes in vehicle ownership, traffic congestion and parking spaces is if AVs are part of a shared network, complementing an efficient, high-capacity public transport system. There are two main ways this could play out: (1) Shared AVs offer services similar to that of the existing one-way car sharing programmes and (2) AVs are used as Robo-Taxis and on-demand shuttles, offering both door-to-door and last mile solutions that feed into public transport hubs. Such a scenario would also provide greater public transport options to citizens, including those living in areas where it is currently difficult or impossible to provide such services.
- A second section is the collaboration between mobility operators with non-mobility actors such as real-estate constructors: shared mobility solutions are (can be) taken into account before a new residential construction starts (Novikova, August 2017). As underlined by Novikova, new AV technology and future self-driving car deployment as a mobility service will bring more flexibility and fluidity in the mobility scenario. This scenario assumes that future mobility will be on-demand and integrated with other services and operators, providing societal and environmental benefits such as a reduction of private cars and private trips, and increasing shared vehicles' saturation.

- However, the path to achieving this scenario is not certain. There are regulation, technical and social issues that need to be clarified. But since AVs will not arrive in the market in force until 2030, there is still an ample time for car sharing market to evolve and for players to prepare for an accelerating change.

Conclusions

As noted in previous sections of the work under STARS, car sharing is one facet of a rapidly changing strategic environment for the automotive industry and market. In view of the complexity and uncertainty of this strategic environment, the interview programme included contributions from academic and consultant experts.

Overall, the consensus was that the automotive industry faced very large financial pressures. The investment requirements of fleet renewal and new technologies (in electric powertrain or autonomous cars for example) were much larger than the industry had previously experienced, while in the immediate future profitability for many vehicle manufacturers was likely to fall substantially. Car sharing and alternative mobility offerings were seen as likely to result in the 'commodification' of car travel for all but the premium brands.

One view articulated a counter argument. It was suggested that the political cost of losing the automotive industry was too high for rapid change to occur. Governments at national and local levels were in this sense locked into the existing structures of production and consumption in the automotive industry. Governments were dependent upon the industry or on car use for revenues both directly (e.g. via taxes on the income of those employed by the industry; by VAT on car and fuel sales; etc.) or indirectly (e.g. via taxes on shopping centre retail outlets that depended upon continued mass car ownership and use).

Experts were sceptical of the ability of the industry to introduce fully autonomous cars in the near term. The vision of fleets of autonomous car sharing vehicles providing mobility for all was therefore seen as unlikely. It was however agreed that electrification of the car fleet has been influenced by car sharing schemes.

Whatever the car-driver of tomorrow looks like, automotive manufacturers need to anticipate consumer demand and respond with the right products and services to meet changing demands. The key of the success will require automotive players to anticipate market trends sooner and to explore new mobility business models as well as their economical and consumer viability. In order to do that, they need to proactively analyze consumer preferences and be aware that there are more similarities across city types than across regions. They also need to pay close attention to the changing demographics in key markets, especially the increasing urbanization and the volatility of the emerging economies. Consumer mobility behavior is changing, leading to up to one out of ten cars sold globally in 2030 *potentially* being a shared vehicle and the subsequent rise of a market for fit-for-purpose mobility solutions. Consumer preferences, tightening regulation, and technological breakthroughs add up to a fundamental shift in individual mobility behavior. Individuals increasingly use multiple modes of transportation to complete their journey, and goods and services are

increasingly delivered to (rather than fetched by) consumers. As a result, the traditional business model of car sales will be complemented by a range of diverse on-demand mobility solutions, especially in dense urban environments that proactively discourage private car use.

While car sharing seems like a threat for OEMs, the reality is that automakers can place themselves in an excellent position to capitalize on these opportunities. They can take car sharing into account during car's design. They can create leasing organizations and dealer networks who specialize in partial ownership and vehicle servicing. And they can reach new drivers and create brand loyalty. Or, in an extreme scenario, within a more complex and diversified mobility industry landscape, OEMs can be asked to cooperate with competitors (Mc.Kinsey) and leverage partnerships and synergies with new players that are likely to enter the market, especially start-ups and high-tech companies.

Car sharing and the new age of mobility may reduce the number of cars on the road, but it will also increase mileage as cars are made available to a larger set of drives. While individual car sales may decrease, larger fleet sales and accelerated car replacement will offer new profitability options.

As we head into a future of car sharing and changing trends in mobility, consumers and OEMs alike can benefit. Drivers have more efficient and more affordable transportation options, and car sharing can open up numerous new ways for OEMs to reposition their brand and implement strategies to maximize the bottom line.

Several policies and suggestion can be derived from D6.1 findings:

- ★ if cities/government stimulate car sharing, it can have substancial societal advantages, for example provisioning dedicated parking facilities, but also increasing paid parking zone in residential areas.
- ★ we registered that EVs has not a negative impact on CS utilization, fiscal/financial aids to "electrify" CS fleet can reduce the enrivomental pressure of car use;
- ★ VAT or other incentives can be explicitly foreseen for car sharing operators. In D3.2 "*Review of the Impacts of the Automobility Market*" (pg 22), the VAT applied to CS is higher than other mobility services (see table 13 below):

	Public transport	Taxi	UBER	Car rental	Car sharing	Bike sharing
Belgium	6%	6%	6%	21%	21%	6%
France	10%	10%	10%	20%	20%	20%
Denmark	0%	0%	N/A	25%	25%	25%
Germany	7%	7%	7%	19%	19%	19%
Italy	10%	10%	N/A	22%	22%	22%
Poland	8%	8%	8%	23%	23%	23%
Portugal	6%	6%	6%	23%	23%	23%
Spain	10%	10%	10%	21%	21%	21%

Table 13: Comparison of VAT rates for competing forms of mobility across Europe

A reduction of VAT level might improve users' utilization rate reducing social stratification. This VAT reduction should also be supported by local/national incentives in supporting (e)-car sharing programs together with a higher flexibliity in shared car availability.

- ★ if the goal of a city is reducing the number of cars, reducing user costs or increasing the availability of car shared seem to have little or no impact. In this context, a crucial role is played by public transport policy encouraing young generation to use sharing services, also for their ecological and health benefits (Marc Prietro, 2017).
- ★ As soon as cities integrate and cooperate with their rural areas into the a larger mobility plan improving mobility solutions to all societal strata, car ownership can shrink at a faster pace;
- ★ Today impact of CS on automotive industry is marginal. On the other hand, as showed in the report, trends on CS adoption show an increasing of users in all form of car sharing (FFOA, FFSB, RTSB…). To be effective and relevant in particular in term of pollution and congestion favorating a better "*traffic fluidity*", EU, governments and local authorities have to change policy in favor of a more shared mobility. CS operators alone cannot have a disruptive effect on car ownership; and also EV sales suffer of a lack of a distributed infrastructure.
- ★ Due to the difficulties in collecting data from cities (or simply cities do not track CS effects), we propose the creation of a specific office within the EU to monitor CS and shared mobility service effects/impacts on both car ownership rates and traffic/congestion.

Finally, the current impression is that car sharing can help in postponing a new car purchase, not in replacing it in a definitive way. For sure, this sophisticated level of scenarios will require OEMs and carmaker more agility and flexibility, to identify and scale new, attractive business models.

In a nutshell, OEMs need to find the right strategy for differentiating their products and services, evolving their value proposition from "hardware provider" to "integrated mobility service provider."

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Appendix 1

Interview (main) questions asked for WP6 deliverables – STARS H2020

Target:	Question	D6.1	D6.2
City	What is your experience about the impact of CS on Car ownership in your town/city/urban area?	X	
City	In your experience, what are the best practice to promote CS vs Car ownership? (e.g. integrating PT and/or synergies with Taxi);	X	X
City	How do you see CS in helping mobility in weak demand areas (rural areas surrounding cities, city outskirts)?	X	X
City	Based on your experience, in 5 years, which are the possible scenarios for Car Sharing?	X	X
Public Transport	What is the impact of the Car Sharing on public transport/your business?		X
Public Transport	Did you activate or are planned any joint program or for common CS and PT users?		X
Public Transport	Based on your experience, in 5 years, which are the possible scenarios for Car Sharing?	X	X
CS operator	- Scenarios in case of city center forbidden to ICE cars/car sharing (contingency plan?) - If CS operator fleet is 100% EV, why that choice? - Composition of the fleet of cars - Environmental awareness of young generations and more attention by public bodies	X	
CS operator	Synergies or not with Local Public transit		X
CS operator	Based on your experience, in 5 years, which are the possible scenarios for Car Sharing?	X	X
General question for all (stakeholders) interviewees			
	The best available & less efficient car sharing business model and why		X

Appendix 2

Country	Incentive Policies
AUSTRIA	Incentive scheme (until end of 2020): ▪ €3,000 for new BEVs and FCEVs ▪ €1,500 for PHEVs and EREVs

BELGIUM	Brussels: financial incentives for companies to buy electric, hybrid or fuel-cell vehicles. Flanders: purchase incentives for BEVs and FCEVs (cars and vans only).
BULGARIA	N/A
CROATIA	Incentive scheme 2019: ▪Plug in hybrid (max 50g/km Co2 emission) up to 40.000,00 HRK (~5.300 €) ▪Full EV (0g/km Co2 emission) up tp 80.000,00 HRK (~10.700,00 €)
CYPRUS	N/A
CZECH REPUBLIC	N/A
DENMARK	N/A
ESTONIA	N/A
FINLAND	Purchase incentive of €2,000 granted for new BEVs, provided value does not exceed €50,000.
FRANCE	▪ Bonus-malus scheme: bonus of up to €6,000 for vehicles emitting 20g CO2/km or less. Vehicles under 117g CO2/km exempt from penalty. ▪ Scrappage scheme: up to €5,000 for purchase of second hand or new BEVs and PHEVs.
GERMANY	Environmental bonus: ▪ €4,000 for BEVs and FCEVs ▪ €3,000 for PHEVs and EREVs
GREECE	N/A
HUNGARY	N/A
IRELAND	Purchase incentives: ▪ Up to €5,000 for BEVs (until 31/12/2021) ▪ Up to €5,000 for PHEVs (until 31/12/2019)
ITALY	Bonus-malus scheme: ▪ Bonus: a one-off amount (max €6,000 for cars emitting 20g CO2/km or less) at registration of the vehicle (between 1/3/2019 - 31/12/2021). ▪ Malus: up to €2,500 for cars emitting more than 250g CO2/km.
LATVIA	N/A
LITHUANIA	N/A
LUXEMBOURG	N/A
MALTA	N/A
NETHERLANDS	N/A
POLAND	N/A

PORTUGAL	N/A
ROMANIA	Scrappage scheme: ▪ €10,000 for BEVs (plus €1,500 for scrapping a vehicle older than eight years) ▪ €4,500 for new HEVs
SLOVAKIA	N/A
SLOVENIA	Incentive scheme: ▪ €7,500 for BEVs (cars) ▪ €4,500 for BEVs (vans and heavy quadricycles) ▪ €4,500 for PHEVs (cars and vans) and EREVs ▪ €3,000 for BEVs (light quadricycles)
SPAIN	Incentives scheme for BEVs, FCEVs, PHEVs, EREVs: ▪ Up to €5,500 for cars ▪ €6,000 for vans ▪ €8,000 for medium vehicles (M2, N2) ▪ €15,000 for heavy vehicles (M3, N3)
SWEDEN	Incentive scheme: ▪ SEK 60,000 for BEVs ▪ SEK 10,000 for PHEVs emitting less than 60g CO2/km
UNITED KINGDOM	Government grants (through dealers): ▪ Cars: 35% of purchase price BEVs, up to £3,500 ▪ Vans: 20% of purchase price BEVs, up to £8,000

Appendix 3

Investement undertaken by InMotion Ventyre are listed below (available on the follwoign website https://www.inmotionventures.com/):

https://www.inmotionventures.com/). The investments undertaken are listed below:

Name	Description
Arc	Arc has pioneered Vector, the world's first fully-electric motorcycle with Human Machine Interface (HMI). Arc Vector is the most advanced electric and most fulfilling motorcycle, wrapped in a futuristic body.
	ourroadis.com/
By Miles	Innovative pay-by-mile car insurance. Rather than buy a traditional policy, sign up for a fixed cost to cover your car while it's parked, then pay-by-mile for any journeys you make.

	bymiles.co.uk/
Dovu	Creating a circular economy through blockchain-powered mobility. Empowering all data owners to share and be rewarded for their mobility and transport data.
	dovu.io
Fatmap	Building a global Outdoor Adventure Platform that brings together consumers with businesses, destinations and brands to enjoy better and safer adventures, using 3D mapping technology.
	fatmap.com
Festicket	Festicket is the world's largest marketplace for music festival experiences. They not only sell tickets to the world's best festivals, but also transport, accommodation and VIP experiences.
	festicket.com
GoKid	Closed community ride-share platform for schools, sports leagues, and families. Carpooling made easy with schedule management and live car tracking.
	gokid.mobi
Lyft	The fastest-growing rideshare company in the US, available in more than 350 cities. Reconnecting people and communities through better transportation.
	lyft.com
Synaptiv	Mobility data marketplace. Using multiple vehicle sensors and advanced data science techniques, Synaptiv powers actionable insights and unique services.
	synaptiv.ai
Transit	North America's number 1 journey planning app, Transit cuts through the complexity of urban transport. Users can find, compare and pay for the best form of transport in real time.
	transitapp.com/
Urgent.ly	The most advanced digital global roadside assistance platform.
	geturgently.com
Validated	Lets shops and restaurants pay for their customers' transportation. Consumers hit spending targets to earn credits they can use for mobility services.
	validated.co
Voyage	Deploying self-driving cars in amazing communities. Voyage is building a world where anyone, anywhere can summon a car directly to their doorstep and travel safely to their destination.
	voyage.auto
WeTrip	A digital platform that makes group travel planning and booking easy. WeSki is their first product, bringing more choice, flexibility and simplicity to ski holidays.
	weski.co.uk/

Wluper	Intelligent personal assistant for navigation and transportation. Natural language processing and machine learning power intuitive journey planning through a conversational interface.
	wluper.com
Zeelo	Pop-up coach service using artificial intelligence to predict demand and identify routes, solving the problem of inconvenient, expensive travel between cities and to and from events.
	zeelo.co

Appendix 4

Regarding the calculation of car sharing impact on car stock circlulating in the 4 italian cities and their metropolitan area, GM leveraged data and statistics from different sources: namely ANFIA, Bain & Co, Deloitte and ISTAT. In addition, we focused on the average number of cars by households in both city and metropolitcan areas.

Metropolitan Area	car stock (2018)	Households (2018)	cars per households	City	car stock (2018)	Households (2018)	cars per households
Turin	1.492.051	1.054.830	1,41	**Turin**	576.571	436.993	1,32
Milan	1.812.743	1.562.804	1,16	**Milan**	693.084	750.051	0,92
Rome	2.703.614	1.994.756	1,36	**Rome**	1.758.890	1.360.156	1,29
Bologna	615.577	487.394	1,26	**Bologna**	207.500	207.586	1,00
Total	**6.623.985**	**5.099.784**			**3.236.045**	**2.754.786**	

All M.A. and the cities of Turin and Rome regiester more than 1 car per households. If the **target** is to have **1 car per household in all cities and M.A**. the car stock circulating should decrease (hypothetically) by more that 2 millions cars:

	M.A	City	TOT
Turin	437.221	139.578	576.799
Milan	249.939	*	249.939
Rome	708.858	398.734	1.107.592
Bologna	128.183	*	128.183
Tot.	**1.524.201**	**538.312**	**2.062.513**

Based od the data provided by ANFIA, the percencetage of the population on the range of 26-60 years old that purchased a second hand car in each area (on 2018) is on average 75-77%. Focusing on this target group (users from 26 to 60 year old), the potentially removable car stock is 1,58 million

cars (1,17+0,41) . In addition, according to ACEA, EEA (European Environment Agency) and Autoalan Tiedotuskeskus, the average age of passenger cars in Italy is 10.8 year. For a more realistic figure, GM Turin estimated that used car will be replaced after this period: on average every year the target group (and removable cars) would be 146.735 cars.

Removable car stock in M.A.		% of population from 26-60-year-old		Av. Car age 10.8 y	
Turin	437.221	75,53%	330.233	10.8	30.577
Milan	249.939	77,70%	194.203		17.982
Rome	708.858	78,50%	556.454		51.523
Bologna	128.183	75,27%	96.483		8.934
	1.524.201		**1.177.372**		**109.016**
Removable car stock in City		**% of population from 26-60-year-old**		**Av. Car age 10.8 y**	
Turin	139.578	76,86%	107.280	10.8	9.933
Rome	398.734	75,26%	300.087		27.786
	538.312		**407.367**		**37.719**

Of these potentially removable car stock from street every year, Bain & Co and Deloitte indicated in their studies on car sharing mobility that the effective utilization rate of car sharing in Italy is still limited. Below the two utilization rates provided by Bain & Co.[42] and Deloitte[43] are applied to both metropolitan areas and cities of Turin and Rome. On average 7/8% of CS users declared to use the service "*always*", while 24% and 18% respectively declared to used it "*often*". A potential of removable cars from circulation may vary from 38.151 to 45.488 cars.

		Bain & Co		Deloitte	
		Always 7%	Often 24%	Always 8%	Often 18%
Turin M.A.	30.577	2.140	7.339	2.446	5.504
Milan M.A.	17.982	1.259	4.316	1.439	3.237
Rome M.A.	51.523	3.607	12.366	4.122	9.274
Bologna M.A.	8.934	625	2.144	715	1.608
Sub. Tot	**109.016**	**7.631**	**26.164**	**8.721**	**19.623**
Turin City	9.933	695	2.384	795	1.788
Rome City	27.786	1.945	6.669	2.223	5.001

[42] CAR SHARING IN ITALIA: SOLUZIONE TATTICA O ALTERNATIVA STRATEGICA?
[43] 2019 Monitor Deloitte | Nuova Mobilità: quali impatti e opportunità

Sub. Tot	**37.719**	**2.640**	**9.053**	**3.018**	**6.789**
Total M.A and City	**146.735**	**10.271**	**35.216**	**11.739**	**26.412**
			45.488		**38.151**