

**The effect of personal cap-and-trade mileage policies on individual activity-travel patterns:
The Activity Locator project**

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ABSTRACT

The objective of this work is to contribute to the debate on sustainable policies aimed at reducing personal carbon emissions from the transport sector. The proposed research describes an experiment extending the cap-and-trade system, employed in manufacturing-based emission curb programs, to Voluntary Travel Behavioral Change (*VTBC*) program. In particular, a *VTBC* program is proposed that relies on opportune changes in individual activity-travel patterns after observing actual behavior recorded using an innovative device.

In this regard, the methodology developed includes: (1) the design of a new behavioral strategy called “Cap and Save” and (2) the implementation of a new device for daily individual activity travel patterns collection called “Activity Locator”. The two aspects are closely interrelated, since behavioral strategies are usually difficult to evaluate; indeed, data regarding individual behavior *before* and *after* policy intervention are rarely collected.

From July to October 2009, both the *Activity Locator* and the *Cap and save* were implemented during a two-week survey involving a group of students of the University of Cagliari (Italy). The students’ activity-travel behavior over two survey weeks and their feedback on both the *Activity Locator* device and *Cap and save* strategy were then analyzed.

Keywords: personal carbon emissions, activity-travel patterns, voluntary travel behavioral changes, Activity Locator

1. INTRODUCTION

Based on recent statistics, worldwide CO₂ emissions during 2005 amounted to 28,051 MMt CO₂eq (Million Metric tonnes of CO₂ equivalents), an increase of 32% over 1990. The United States and Europe are currently responsible for about 37% of the worldwide CO₂ emissions, their emissions increasing by 20% and 7%, respectively, between 1990 and 2005¹. These increases, when considered in the context of the 5% reduction target to be achieved by 2012 as set by the Kyoto Protocol, makes it self-evident that the current practices and policy interventions implemented by national governments need to be re-examined. In particular, existing regulations and anticipated post-Kyoto policy architecture (2013 - 2018) are based almost entirely on the European Union Emission Trading Scheme (EU ETS), which is implemented to curb global market manufacturing-based emissions. Little or no consideration is given to the contribution of individual citizens' behavior in their daily lives. In the transportation sector, for example, which by itself contributes to 30% of global emissions, one billion private vehicles currently on the road worldwide are considered responsible for about 60% of the total CO₂ emitted. If the forecast of two billion cars by 2030 is correct, then it is timely to experiment with policies aimed at promoting more "rational" use of private cars. That is to say, each driver should be helped to increase awareness about the positive effects on the environment and on society of balancing private car use with alternative travel modes (*i.e.* rational use).

It is widely recognized that greenhouse gas (GHG) emissions from the transportation sector are the result of *what* individuals drive (*i.e.* vehicle efficiency and energy source) and *how much* they drive. The majority of current programs for carbon emissions reduction focus on the first issue, almost entirely ignoring the so called "externalities" (*i.e.* congestion, urban sprawl, safety of drivers and non drivers *etc.*) related to private vehicle mileage (Litman, 2009). For example, the Italian Government, in its recently released plan to curb emissions by 2018, states that 30% of emissions cut needs to be achieved in the transport sector. However, the planned practices rely exclusively on increasing vehicle efficiency, improving fuel type and new infrastructures². On the other hand, a recent study conducted by the European Commission reveals that technological advances can only contribute by 50% to emissions reduction objectives³. Further, the widespread adoption of scrappage schemes for replacing old vehicles with more efficient ones (*i.e.* low CO₂ emissions) is likely to increase both the number of vehicles on the roads and the number of miles traveled per capita, as a result of the greater comfort and safety perceived by drivers of new vehicles (Litman, 2009). Specifically, replacement of older vehicles with newer ones will likely reduce cognitive dissonance about environmental concerns, but perception of lower travel costs may stimulate more travel, added to which even new cars are not very efficient when compared to many alternatives. Generally speaking, private vehicle usage has become increasingly linked to individual daily activities and today represents the core of daily activity travel patterns. Individuals, in fact, schedule their activities and travel and hence life style around car use (Steg and Tertoolen, 1999).

All these things considered, implementing behavioral strategies aimed at reducing the need for individuals to drive (or reducing the mileage driven) represents one of the most topical

¹ Transportation Energy Data Book (2009): Edition 28, Center for Transportation Analysis: Energy and Transportation Science Division <http://cta.ornl.gov/data/index.shtml>

² Direttiva 2003/87/CE – Schema di Piano Nazionale di Assegnazione, Ministero dell' Ambiente - Italian Government.

³ EU TRKC (2009), Transport and The Environment, Policy brochures of Transportation Research Knowledge Center, Directorate-General Energy and Transport, European Commission.

challenges of current transportation research⁴. Unfortunately, as psychological and sociological studies have shown, behavioral strategies are difficult to realize (RAC, 1995; Steg, 1996); they require greater effort and involve some degree of discomfort, as opposed to technology strategies that require an initial investment but are definitely less restrictive of personal freedom. Further, an individual usually doubts that his/her own contribution can make the difference, and is suspicious of others' willingness to change (Steg and Tertoolen, 1999).

The objective of this work is to contribute to the sustainable debate through the design of a behavioral strategy based on appropriate changes in the motorists' decision context (*Structural strategies*) and enhancing public awareness (*Cognitive-Motivational strategies*) (see Steg and Vlek (2009) for a review of Structural and Cognitive-Motivational strategies). This combination of strategies belongs to the so called "Voluntary Travel Behavioral Changes" (VTBC) approaches (Ampt, 2003; Rose and Ampt 2003; Stopher, 2005). VTBC programs are also called "liberal paternalistic", as opposed to compulsory measures (*i.e.* taxes, restrictions *etc.*) that are poorly accepted and unable to produce lasting effects (Brög *et al.*, 2009, Sperling and Gordon, 2009). Each individual should be free to choose what he/she likes, even if ultimately this means choosing something not desirable (*liberal*). The *paternalistic* adjective refers to an individual's ability to choose while being guided in a particular direction. Basically, through these approaches, the policy maker attempts to influence people and their behavior to encourage them to live and travel in a more efficient and environmentally friendly way without limiting individual freedom (Thaler and Sunstein, 2008).

In particular, since travel decisions and car use are strictly related to daily activity-travel patterns (Steg and Tertoolen, 1999) an effective behavioral strategy should primarily rely on providing car users with opportune suggestions for minor changes to habitual schedules (structural features). Additionally, general information about the effects of private car use on personal and societal well-being, especially climate change-related issues need to be provided (cognitive motivational aspects).

In this context, the proposed work involves (1) the design of a new behavioral strategy called "Cap and Save" and (2) the implementation of a new device for daily individual activity travel patterns collection called "Activity Locator". The two aspects are closely interrelated. The *Cap and save* strategy is based on the belief that car use reduction can be achieved by suggesting minor voluntary changes in daily activity-travel patterns. The *Activity Locator* is an efficient and low cost system for daily individual routes and time use data collection, which allows the creation of a set of personalized alternatives to car use.

The rest of the paper is organized as follows. The next section describes the existing voluntary travel behavior change approaches and the contribution of the current study. Section 3 describes the methodology employed in terms of strategy design (Cap-and-save) and device implementation (Activity Locator). Section 4 analyzes the data collected using the Activity Locator. Section 5 describes the initial results of the Cap and Save implementation drawn from a pilot survey, in terms of activity-travel pattern rearrangement resulting from travel behavioral changes, since an evaluation of the strategy would require larger samples. Finally, Section 6 contains the conclusions and further research opportunities.

⁴ CCAP (2009) Cost-Effective GHG Reductions through Smart Growth & Improved Transportation Choices An economic case for strategic investment of cap-and-trade revenues, Center for Clean Air Policy Washington, DC

2 EARLIER APPROACHES AND THE CURRENT STUDY

A voluntary travel behavior change (*VTBC*) is defined as the change that occurs when an individual makes decisions based on personal remuneration, without mandatory rules or external obligations (Ampt, 2003). Although part of travel demand management (TDM) policies, *VTBC* programs rely on available resources and social-urban changes, more than directly on travel demand interventions. To this extent, *VTBC* would be especially desirable for decision makers, enabling them to improve community mobility with few financial resources. In a general sense, the ultimate intent of these interventions is to increase sustainable mode shares, endorse car use reduction, car pooling, and trip chaining, and finally encourage the use of public and non-motorized transport (*i.e.* walking and biking). There are several underlying reasons for these changes in travel behavior: dissatisfaction with current lifestyle, the desire to change behavior, someone well known and respected who has already changed, an important change in life (*e.g.* new job, new house, new partner *etc.*), or ultimately just because it is the “in-thing” and “the cool thing” to do. In order to bring about voluntary behavioral change it is crucial to emphasize individuals’ values such as health (through physical exercise), environment, independence, family and money. Further, it is important to highlight the additional benefits to be gained from improved behavior (*e.g.* incentives, tax reductions, infrastructure improvements *etc.*) (Ampt, 2003).

Under various names and different details - Travelsmart (Department of Transport, Western Australia 2000), Starter Choice (UK) and Travel Feedback Programs (in Japan) (Taniguchi et al. 2003; Taniguchi and Fujii, 2007), Individual Marketing (Brög, 1998; Jones, 2003, Stopher, 2005, Socialdata 1991, 2006), Personalized Travel Planning PTP or Personal Journey Programs PJP (Halden, 2008), Travel Blending (Ampt, 1997) - the *VTBC* programs share a central idea to provide individuals with appropriate information, assistance, motivation and incentives to encourage them to adopt travel habits that have positive effects on themselves and on the community as a whole. In particular, *VTBC* programs recognize the influence of cultural and social values on car use and suggest using them as a basis for bringing about change, instead of trying to counteract them (Ampt, 2003).

In this work we refer primarily to two *VTBC* programs. The first, labeled as “Tradable Emission Permits”, which is under debate mainly in the United Kingdom, extends the concept of EU ETS to curb personal emissions. The key concept is that the cost of emission is borne by emitters. Thus, those who (voluntarily) decide to reduce personal car use pay less (Raux, 2008; Raux and Marlot, 2005; Vlek, 2007). The second approach, called “Personal Journey Planning”, originated primarily in Australia. It relies on the idea that improving the level of information helps people to decide to change their travel behavior. Based on a *Tradable Emission Permits* system, each country would be required to establish a maximum amount of personal or household carbon emissions (cap) and the price of each additional permit used. In this type of system, governments play a crucial role by ensuring supervision and sanctioning where needed (Bruneau, 2005). On the other hand, *Personal Journey Planning* strategies are based on (1) social marketing to guide individuals towards environmentally friendly modes, without necessarily altering the number of out of home activities or the time spent traveling (*i.e.* *IndiMark*), and (2) approaches seeking to offer households with personalized alternatives to reduce travel overall, without necessarily changing the travel mode at all (*i.e.* *Living Change/Living Neighborhoods*) or switching to alternative modes (*i.e.* *Travel blending*) (Stopher, 2005).

In this work, the *Tradable Emission Permits* and *Personal Journey Planning* techniques are weaved together, since such a combination offers three main advantages: (1) the intervention is personalized, (2) the behavioral changes are based on personal remuneration (3) the citizen is informed about the effects of private car usage on climate change. Specifically, in this work the intervention is personalized after one-week observation of activity-travel patterns using an innovative device called “Activity Locator” as opposed to earlier *Travel Blending* programs that rely on traditional 7 day diaries (Rose and Ampt, 2001). Further, “personal remuneration” in this work (see also VTBC program definition by Ampt (2003) does not necessarily refer to reward programs or penalties, but instead to the amount of savings resulting from a reduction in personal car use. In particular, it can be related to the concept of “loss aversion” that has been shown to be stronger than gain opportunity when encouraging travelers towards a specific choice (see Avinery and Goodwin (2010) for a discussion regarding the best approach). Clearly, in both the *Tradable Emission Permits* and *Personal Journey Planning* approaches, data collection constitutes a critical aspect. A deep understanding of individual activity-travel behavior is in fact essential to adjust CO2 permits to individuals’ freedom and comfort, and to identify the relationships between car use and the rest of daily individual decisions. In particular, Stopher (2005) indicates GPS tracking in conjunction with time use data as more appropriate for analyzing daily routes, mileage traveled, activity scheduling, and therefore for supporting soft measures implementation. Recently, activity-travel surveys have seen many changes, mainly because of the advent of new technologies (GPS, Internet etc.) that permit new types of data to be collected, while also reducing costs and improving quality. Application with GPS systems has shown that travel diaries miss about 20% of daily trip making (Wolf *et al.*, 2003); generally, short trips that are potentially more amenable to change under VTBC programs. Similar problems arise with time use diaries, filled in at home at the end of the day, since they rely to some degree on memory recall, and require the individual to concentrate his/her efforts on a single episode (Stopher, 2005).

The present work proposes a VTBC program called “Cap and Save” that relies on a new data collection system called “Activity Locator”. The *Cap and save* involves: (1) determination of weekly/annual emissions (cap), and the corresponding remuneration (save), (2) a cognitive-motivational process, (3) the analysis of activity-travel behavior *before* and *after* policy intervention, and (4) the creation of personalized alternatives. Note also that the *Activity Locator* is particularly suitable for supporting a *Cap and save* program since it: (1) identifies habits and requirements related to the entire range of activity-travel decisions, including the exact number of kilometers traveled and related costs, (2) is a user-friendly, low cost, portable device installed in ordinary smart phones with built-in GPS, (3) collects both position information and time use data in real time, and (4) is able to interact with the user.

To test both the *Cap and save* strategy and the *Activity Locator* system, a two-week survey was conducted from July to October 2009 among a group of students from the University of Cagliari (Italy). In the first week of July, the students were invited to carry the *Activity Locator* and report their actual daily activity-travel patterns. In the first week of October, the students were then asked to carry the device for another week, trying to maintain a weekly *cap* of CO2 and *saving* the corresponding resources (*i.e.* carbon emissions and money). In particular, each student was provided with a set of personalized alternatives, and was invited to reduce the kilometers traveled by 20%.

The extended lapse of time between the first and second survey weeks (July - October) was required in order to (1) update and re-test the *Activity Locator* issues encountered during the

first week of survey (remaining weeks of July), (2) analyze the database drawn from first week observed activity-travel patterns (first two weeks in September), (3) build a set of personalized alternatives (third week of September), (4) fill personalized books with sustainable alternatives (last week of September). The reader should note that since in Italy, University facilities are closed during August and classes do not begin until the second half of October, the first week of October for the second week of survey seemed the best choice for comparing activity-travel patterns before and after Cap-and-save implementation. Actually, the first week in July and October can be regarded as fairly similar for students in Cagliari, considering both weather conditions and class schedules. In July, students are preparing for the final exams and continue to study on the campus (library) or with fellow students at home. In October, classes are getting under way (teachers arrange with students classes schedules) but the regular schedule will come into effect in the second half of the month. Further, both weeks are characterized by similar weather conditions for engaging in leisure activities, for instance going to the beach near to the city center.

Finally, the small number of total participants (26 initial respondents and 14 recruited for the two-week program) - dictated by the number of Activity Locator devices available⁵ - does not permit evaluation of either the Cap-and-save or Activity Locator. Evaluating a VTBC strategy as reported by previous studies would require much larger samples (see Stopher *et al.* (2009) and Philp and Taylor (2010) for a discussion regarding VTBC evaluation). However, the analysis conducted can be viewed as an opportunity for researchers and practitioners to discuss the integration of activity-travel studies within purely cognitive-motivational campaigns in terms of (1) providing personalized suggestions for minor changes to habitual patterns after observing actual weekly activity-travel schedules and (2) analyzing rearranged activity-travel patterns resulting from a reduction in kilometers traveled. Activity-based studies (that in fact observe in home, out of home and trips) are crucial in order to reveal how in-vehicle time saved will be re-invested, *i.e.* sedentary time vs. active time. In particular, to the authors' knowledge, this is the first soft measure implementation that relies on a GPS-based data collection tool built into a smart phone equipped with an application for real time activity-travel data collection, instead of traditional 7 day diaries (see Rose and Ampt, 2001).

3. METHODOLOGY

This section describes the methodology employed in terms of the Activity Locator system implementation, Cap and Save program design, and Cap and Save pilot survey.

3.1 Activity Locator System Implementation

The "Activity Locator" system comprises (1) a *client* software installed in a portable GPS-integrated device, (2) a *server* software that transmits and receives information to/from each *client*, and (3) an Internet connection.

The client software is a Java application that can be installed in any smart phone (*Symbian* or *Android* platform) with built-in GPS currently available in the market. The application enables the tracking of individual daily routes and the collection of all activity-travel related information through a sequence of pull-down menus that reproduces the classical activity

⁵ The reader should note that the presented paper describes an internal research program as opposed to existing broader city-administered soft measures.

diaries. The main difference from traditional activity diaries is that activities are recorded in real time, instead of at the end of the day after returning home.

The application is accessible from the cell phone “home” screen, pressing a dedicated key on the bottom right. After a couple of authorization questions regarding personal data use and privacy issues, which the user necessarily needs to respond to, the *Activity Locator* connects to the server that then transmits a list of possible activities (Figure 1). The box on the left side of Figure 1 contains the first possible entry, which can either be a “new activity” (*i.e.* activity about to be performed) or a “forgotten” one (*i.e.* previous activity/trip, whose entry was forgotten). Further, the user ID can be changed (user), or the application updated (update). Once the user decides whether to enter a new activity or a forgotten one, the subsequent boxes elicit information on the “activity type” (*i.e.* in-home, out-of-home, trips) and further attributes of the activity. The application is also designed to send automatic pings every 5 seconds containing only positioning data (latitude, longitude). Lastly, to save battery life, the application includes another key that enables the user to turn on/off the GPS (basically the pings) when outdoors/indoors. The ability to turn on/off the GPS may be also presented to participants as a privacy benefit though still endorsing the importance of being able to track them throughout the day while ensuring complete anonymity.

The server software collects the information sent by each client. After decoding and decrypting, each user can visualize the information online, after account authentication (login and password) to the web version of the server⁶. Each user can be identified in real time on a map (powered by Google Maps) by a symbol containing all the user information (*i.e.* spatial, temporal, and activity information). The data are immediately available in database formats (*i.e.* xls, csv, xml) and downloadable onto any desktop or laptop computer. The data are transferred by each client to the server and vice versa via an internet connection. In addition, the server software is designed to send a variety of information to the clients such as traffic information and survey requirements.

In this project, the activity locator was installed on 35 Nokia N95 smart phones, and on 1 HTC Magic (Android), property of the University of Cagliari (Italy). Both Nokia and HTC have built-in GPS, long battery life (up to 7 hours), and wide screens for client software requirements. The cell phones were equipped with prepaid USIM cards for sending/receiving data, calls, and text messages.

3.2 The *Cap and save* pattern (guidelines)

The *Cap and save* program proposed in this work comprises four basic parts: (1) definition of a set of parameters (*i.e.* *cap*, *save*, participants in the program *etc.*), (2) a cognitive-motivational action, (3) analysis of activity-travel behavior *before* and *after* policy intervention, and (4) creation of personalized alternatives.

The parameters of the *Cap and save* program are as follows:

1. The environmental *cap measure*, which translates CO₂ permits into a quantity that participants can easily understand (*e.g.* vehicle kilometers to be traveled).
2. The corresponding *save measure*, which is the monetary value of the weekly *cap* in terms of personal costs (*i.e.* proportional and non-proportional costs of car use) and

⁶ <http://whereis.softfobia.com/login.jsp> (in Italian)

- externalities (*i.e.* societal and environmental costs). Both costs can be calculated for each kilometer traveled⁷.
3. The recipient of the *cap* - Should all car users receive a *cap*? Or should the *cap* be restricted to only car users or only car owners, or to only car drivers or only passengers? Frequently, car drivers use their cars for serving passenger that benefit passengers. In our scheme, both car drivers and passengers are provided with a personal *cap*.
 4. The number of permits (*cap*), which is determined based on a rate of vehicle kilometers traveled in regular conditions. A recent review of national and international soft measures reports frequent reductions in car use of the order of 5%-10% overall or 10%-20% in combination with hard measures (Cairns *et al.* 2008). Additionally, Brög *et al.* (2009) indicate a 5% to 15% reduction in car use by Individualized Travel Marketing techniques. Jones (2011) explains that people believe they can achieve a 10% reduction in car use and finally, a Japanese study found that the household share of car trips declined in the short term by 5% (see Weinberger and Lucas, 2011 for a comprehensive review).
 5. The permits trade scheme, or the trade scheme that participants are supposed to be part of, which may correspond to a tax reduction (*e.g.* on annual car tax) or incentives if the *cap* is maintained. On the other hand, an additional charge is applied for extra kilometers traveled.

A cognitive-motivational action plays a crucial role in persuading individuals to change their travel behavior. A number of principles of persuasion can be adopted⁸: (1) *Reciprocation*: an incentive, given unconditionally, leaves the participants with the perception of having been asked genuine favor (in this research, an all-inclusive weekly phone plan and a final dinner out were offered to participants), (2) *Commitment and consistency*: if the participants take on an initial commitment, it will guide their subsequent actions (participants were first involved in testing a new device for supporting pro-environmental policies, then between the first and second week a set of personalized alternatives was suggested (with no obligation for participants) for adopting sustainable behaviors (*i.e.* reduce car km), (3) *Social proof*: choosing peer groups for the program increases the willingness to participate (a social network of students was selected in the current research), (4) *Liking*: people are increasingly inclined to follow a request brought forward by someone they like and materials should be designed and presented in an attractive fashion (the students were provided with a personalized book), (5) *Authority*: when making a decision, it is common to seek expert advice from an acknowledged source (the Department Director during a formal seminar explained climate change-related issues), and (6) *Scarcity*: the principle of scarcity reflects the fact that as opportunities become more scarce, they are perceived as more valuable (the “costs” aspect was emphasized).

The analysis of activity-travel behaviors *before* and *after* policy intervention involves the collection of accurate activity-travel patterns for two weeks plus a number of questionnaires

⁷ To give an example, the personal cost per kilometer traveled can be obtained as the sum of proportional and non-proportional costs. 0.38€/km is the average value for small petrol and diesel saloon cars (15.000 – 20.000 km traveled annually) as calculated in <http://servizi.aci.it/ServizioCK/SelezioneModello>. Regarding the societal costs, following Lombard *et al.* 2005, for the situation in Italy, a value of 0.37€/km (private urban trips) is calculated. In particular, the contribution to climate change is taken as 1% (0.006 €/km).

⁸ See Seethaler and Rose (2005) for a general review of Cialdini’s (2001) six principles and for an application to VTBC programs.

regarding: (1) personal, household, and vehicle data, (2) climate change attitudes, and (3) feedback and suggestions. Both the activity-travel pattern collection efforts and the questionnaires rely on the support of a team of operators who (1) check for data consistency (mistakes and forgotten activities) during real time data collection, (2) re-call participants in order to correct the databases, and (3) create the final databases.

The creation of personalized alternatives follows the analysis of weekly activity-travel patterns from the first survey week and is based on the objective of finding sustainable alternatives for each regular trip reported. The alternatives are created for any trip mode that is considered part of an unsustainable trip (*i.e.* trips that can be comfortably substituted by bus trips or walking trips, short distance trips traveled by motorized trips, multiple vehicles driven by household members at the same time and towards the same destinations *etc.*) and for any trip purpose as well (*i.e.* discretionary trips, work/study trips *etc.*). The number of alternatives created for each participant depends on the personal cap, which is a certain rate of his or her kilometers traveled during the first week. Further, students' cultural and social values (drawn from meetings and questionnaires completed by the students) were taken into account when considering behavior change, combining proposed personal alternatives with sustainable development and energy saving objectives. In particular, the driving culture itself, especially in terms of a generalized overuse of private cars in Italy, was indicated as one of the major causes of carbon emissions from the transportation sector. Small changes in car use behavior were then presented as a highly effective contribution to sustainable development.

3.3 The Cap and Save Pilot Survey

During the first week of July 2009, a group of 18–28 year old students from the University of Cagliari, part of a common social network, were invited to an informal meeting to describe a study being carried out by CIREM (University of Cagliari). At the end of the meeting, 26 students agreed to participate in a survey to collect individual activity-travel patterns using an innovative device that needed to be tested. Each of the students received an activity locator along with a personal data questionnaire (*i.e.* address, household and personal information *etc.*) and instructions on using the device. The participants were then invited to use the *Activity Locator* to collect in-home, out-of-home and travel during the whole incoming week. Each smart phone was equipped with a 3€ week unlimited daily data plan and 3€ week for 60 min/day voice calls and 100 texts/day, which the students were invited to use.

During the survey week, a team of operators assisted the participants by (1) checking data consistency, (2) reminding the participants to turn on the device and (3) testing system performance (GPS data collection accuracy and server load/response time). To ensure that the data were as accurate as possible, the users were contacted both in real time and at the end of the day to fill in missing locations and activity attributes, usually after a text message asking for their availability. At the end of the week, the devices were retrieved and each user's activity-travel pattern was analyzed in detail. First of all, the personal weekly "cap" was computed for each participant as 20% off the actual kilometers traveled by car. As Abrahamse *et al.* (2005) report, there are many ways to set a goal (decided by participant, predetermined, combined with feedback or other interventions). In this study, 20% goal was assigned to participants since observing first week activity-travel patterns, showed on average 20% surplus car kms. Further, for each trip reported during the week, a sustainable alternative (if one exists) was created, including options for car pooling with family members or friends, public transit, parking further

away than the destination, walking and even omitting unnecessary trips (*i.e.* repeated friends' pick up/drop off at some distance from participants' current position).

During the first week of October 2009, the same students were recalled and invited to participate in a formal seminar called "Cap and Save project". During the seminar the issues related to carbon emissions from the transportation sector were explained to the students by the Department Director. Specifically, personal and societal costs per kilometer traveled by private car were presented together with the savings corresponding to a reduction of 20% in annual average kilometers traveled. Finally, the students were clearly informed that the objective of the second survey week was to try reducing private car use. In order to do so, each participant received a personal book containing (1) a brief welcome message from the project coordinator, (2) a questionnaire to test their knowledge and obtain their attitudes about climate change issues (3) a reminder of personal and societal costs due to car usage, (4) general suggestions for reducing the kilometers traveled together with the personal weekly "cap" of kilometers to be traveled by car and the corresponding monetary and carbon "save" estimates, (5) a table summarizing the personalized set of sustainable alternatives, (6) information on bus services (schedules and map) for each bus trip suggested (7) a table containing the summary of all participants' (identified by anonymous ID) targets and potential savings. The last point needs to be evaluated within the context of the specific sample involved in the pilot study. Participants actually all formed part of a common social network, therefore activity-travel behavior was well-known to all of them before the proposed program. The decision to show everyone's target was dictated primarily by the desire to stimulate competition among friends in order to achieve 20% cut of personal kilometers, regardless of how many they covered during the first week. Extending the survey to larger samples will require omitting the above table in order to prevent the "boomerang effect", an undesirable effect related to performance comparison among peers that implies a lapse in sustainable behavior among individuals who realize they are already more sustainable than others (Schultz *et al.*, 2007).

At the end of the meeting, 14 students agreed to participate in the Cap and Save pilot survey (86% car drivers and 14% car passengers). They were equipped with the activity locators and asked to start recollecting their activity-travel patterns starting from the next morning. The team of operators assisted them for the whole week, though less support was needed this second time around mainly due to system familiarity and the user's increased confidence with the device. At the end of the survey, the users were asked to return the cell phones and to complete a questionnaire with their feedback regarding (1) the cognitive-motivational approach followed to present the Cap and Save project (book and seminar), (2) the Cap and Save pilot survey, and (3) the activity locator device.

Finally, the users and operators were invited out for dinner by the Department Director to express appreciation for their contribution.

4. DATA DESCRIPTION

The first and second week databases are merged and a brief description of data is provided in this section. The analysis includes only the 14 students who participated and completed both survey weeks. Note that the analysis in this part is intended primarily to explore the potential of the activity locator in terms of quality and quantity of collected data. However, notwithstanding the small sample size, the data do provide some limited insights into activity-travel behavior.

Six different databases were created for each survey week: (1) Individual file (2) Positioning file, (3) Segment file, (4) Episode file, (5) Tour file and (6) Time use file. The

individual file contains all the individual, household and vehicle information associated with each participant. The positioning file includes all the automatic pings (latitude, longitude) and the manually inserted activity information. The segment file aggregates the positioning cases in trip segments (trip legs due to transfers, pick up/drop off *etc.*). The episode file is created by the further aggregation of segments to obtain the final origin-destination trip (primary mode and purpose have been derived⁹). The tour file contains the different types of tours and related characteristics. Finally, the time use file contains the weekly individual time allocated to each activity type. In the remaining part of this section, a brief description of each database is provided.

Individual file. The sample comprises students from the University of Cagliari, with 57% males and 43% females; half of the students are aged 20 – 22 years, and the remaining half of the students are between 24 – 28 years of age. All the students live with their families, 79% in the capital Cagliari, and 21% in the hinterland and metropolitan area. Regarding vehicle usage, 93% possess a driving license (50% owns a car and 43% has access to the household vehicle). The average annual kilometers traveled are between 12,000 and 15,000 (detailed car info is included in the database in order to compute CO2 emissions). None of the students in the sample own or use a bike, but 7% own a motorcycle. Only 14% of the sample has a monthly bus pass.

Positioning/Segment/Episode files. During the two survey weeks, a total of 61,287 positioning points (*pp*) were recorded, corresponding to 1229 activities in-home, 999 out-of-home, and 1515 trip segments (legs). Almost 78.5% of the positioning points were collected during weekdays and the remainder on weekends. Each user, on average, recorded 3404 *pp* (265 *pp*/day) corresponding to about 28 tours (2 person tours/day), 30 activity stops (2.15 person activity stops/day), 73 trip episodes (5.65 person trips/day, 50 *pp*/trip), and 391 km (28 person km/day). In particular, 96.3% of the total distance was traveled by car (56% as a driver and 40.3% as a passenger), while the remaining distance was split between the non-car modes as follows: walking (0.7%), bus (1%) and motorcycle (2%). Further, 47% of the total distance was attributable to urban and metro-area trips, and 53% to interurban and inter-province trips.

Tour file. The tour behavior has been analyzed separately for six different tour types: (1) Non Work/Study tours (NNW), (2) Before Work/Study (BW), (3) Home to Work/study commute (HW), (4) Work/study-Based (WB), (5) Work/Study to Home commute (WH), and (6) After Work/study (AW). The average time spent in daily tours is about 4 hours; 68% of this time was spent in stops and the remaining 32% on travel. NNW tours, which identify mainly tours during non-study days or student's tours with no work/study activity on the survey day, are more frequent during weekends (1.2 NNW person tours/day on Saturday and 0.89 NNW person tours/day on Sunday). On average, students participated in almost two commute trips on weekdays (one HW and one WH). AW tours are more frequent than BW tours, with the highest percentage of AW tours being reported on Thursdays and Fridays (50% of the students participate in after school activities). By contrast, BW participation is higher on Mondays and Tuesdays (8%).

⁹ In this work the travel mode used in the *last trip leg* has been associated with the tour mode in non work, before work, home to work and after work tours and the mode used in the *first trip leg* for work to home (see Bhat (1997) for a similar classification). In both cases, when 2 or more legs were traveled by different modes, the motorized mode received priority. In case of simultaneous presence of two or more motorized modes the primary mode is assigned firstly to modes that involve some degree of dependence (related to the transportation system or relying on others, such as bus and car as a passenger), and lastly to travel modes that ensure a greater degree of independence (i.e. car as driver and motorcycle). Walking tours are supposedly traveled entirely on foot.

Time use file. The time use behavior is characterized by in-home (IH) and out-of-home (OH) activity time allocation to (1) maintenance activities (*i.e.* personal care, household care, meals), (2) mandatory activities (*i.e.* work/study), (3) discretionary activities (*i.e.* recreational, social, sport, leisure (TV, books, internet), voluntary service, religion, coffee break), (4) shopping, (5) errands (car, house, etc.), (7) waiting for a ride (bus, car), and (8) sleep and relax. The results indicate a general tendency to spend more time at home in maintenance and pure leisure activities (about 36 hours a week) compared to the time spent out of home for the same activities (12 hours/week). In terms of sleeping and relaxing time, students, as expected, spend more time in-home rather than out-of-home: 58 hours/week IH (slightly more than 8h/day) vs. 5 hours/week OH. On the other hand, the time spent at home working or studying is 40% less than the time spent out of home (11 hours/week IH vs. 17hours/week OH); the time for discretionary activities is mostly spent out of home (1h/week IH vs. 14h/week OH). Shopping and errands take up about one hour a week each.

5. RESULTS

In this part, the results of the Cap and save pilot survey are described, classified into three parts: (1) attitude revealed by students toward climate change, (2) feedback on the Cap and Save project and the activity locator device, and (3) finally comparison of students' activity-travel behavior before and after the Cap and Save presentation.

5.1 Attitudes toward climate change

The students' attitudes toward climate change were investigated before the beginning of the second survey week. Based on the responses, all the students believe human behavior is responsible for climate change. 86% of the sample believes that changing individual behavior could help reduce emissions, but the majority usually does *nothing* (31.6%) or *little* (24.7%) to reduce own emissions. Among those who do something to reduce emissions, the main ways included (1) diminishing regular car usage (64%), (2) using non-motorized transport (walking, bike etc.) and taking the bus (71%), (3) buying local products (57%), (4) buying green items (86%), and (5) using eco-technologies (71%). However, the majority of the students (93%) recycles and consciously tries to make efficient use of heating/air conditioning and domestic appliances (64%).

In general, the students consider cutting personal emissions too difficult due to the following reasons: too much time and effort is required (71%), sustainable alternatives are little known (71%), and advanced planning is usually required (57%). Further, the main reason why they would reduce their carbon emissions is because the environment is a common property (86%). The desire to save money and the possibility of increasing physical activity levels each account for about 79% of the student responses. General concerns about climate change are important for 64% of the students; however, the fact that other people try to cut carbon emissions only affects 7% of the participants, indicating low levels of peer influence (see Nolan *et al.* (2008) for similar results).

5.2 Feedback on the Cap and Save project

The students were first asked during the survey whether they were aware of the objective of the project: all of them indicated that the objective of the survey was to "reduce carbon emissions due to kilometers traveled by car". Further, they were invited to list two sustainable options, which they were already aware of before the beginning of the survey. Most respondents

indicated one of taking the bus, walking, or using a motorcycle as sustainable alternatives to car use. The responses relating to the personal book provided at the beginning of the second survey indicated that the book was in general well explained (93%), useful and interesting (86%), but respondents did not find any original information about the alternatives provided (57%).

Regarding how many kilometers they traveled during the second survey week, about 46% could not respond and none could indicate the carbon emitted during that week. The only costs easily remembered, and only by those who indicated the weekly kilometers, were related to the proportional costs of personal car usage. Finally, responses to the questions regarding whether and how individuals had changed their behavior indicated that 28.6% did not change behavior, 57.1% changed behavior by using a non-car alternative for one or more trips originally pursued by car, and 14.3% changed behavior by reducing the distance traveled by car, either through suppressing trips or chaining trips or going to closer activity locations. Note that these behavioral change estimates are based on overall self-reported respondent perceptions of their own behaviors. Among the students who indicated a change in behavior by using a non-car alternative, 77% indicated that they used some of the modal alternatives found in the book and 90% said that the change had not been stressful at all. Among those who reported no travel behavioral change of any kind, 40% reported that they did not have the time to try the proposed alternatives, 20% indicated that they stayed at home all the time, another 20% reported that they tried but it was too hard, and the final 20% of respondents indicated that the given target was not appropriate to the second survey week.

5.3 Feedback about Activity Locator device

The questionnaire concerning the *Activity Locator* proved helpful for identifying gaps in the device and problems with usage. The results suggested that 35% of respondents forgot to enter pick up/drop off stops as soon as such stops were completed, 21% missed some in-home activities immediately after completion, 14% forgot one or more walking trips just after completion, 14% missed impulse (or instantaneous trips that were unplanned), and 6% each missed one or more meal activity episodes and very short/not regular activity episodes immediately after pursuing such episodes. However, the respondents also indicated that these missed activities were easy to enter as “forgotten” entries and no particular difficulties were indicated with using the device.

More than 64% of respondents remembered to turn off the GPS during indoor activities in order to save cell phone battery life, and all respondents appeared to be careful to check the GPS signal. 42% of the students sometimes experienced connection problems sending their information and 64% complained about battery life. About 50% of the students would have preferred the activity locator installed in their cell phones and about 80% were sure they would not have participated in the survey had they had to fill/correct the activity diary manually at the end of the day. Furthermore none of them were bothered by the operators’ phone calls to check data inconsistencies or missing data. All of them described the activity locator as an easy and friendly device requiring really little effort and time. Interestingly, only 21% felt someone was spying on them.

5.4 VTBC analysis

In this section, the activity-travel patterns collected during the first and second weeks are compared in order to detect activity-travel patterns rearrangement resulting from travel behavior changes (i.e. reduction of kilometers traveled).

Table 1 shows the average distances traveled during each survey week and the percentage variation by car as a driver, car as a passenger and by walking for different trip purposes, separately for individuals who share a vehicle with other family members (car users) and individuals who have their own cars (car owners)¹⁰. We focused our attention only on the relatively stable (across seasons) urban, metropolitan and interurban trips and on weekdays alone, which ensure a more accurate inter-week comparability. The table shows that the distance traveled by car users (when driving a vehicle) diminished for meals and shopping. The distance traveled by car owners when driving a vehicle diminished for work/study and shopping. For both classes of drivers the kilometers traveled increased for recreational, sport and leisure purposes. The second column of Table 1 shows that the distance traveled by car users and car owners as passengers increased for work/study, and decreased for recreational/sport/leisure purposes (car users) and for meals and shopping (car owners).

Finally, walking distances increased for car users for work/study purposes and decreased for shopping and recreational, sport and leisure. Car owners walked shorter distances for meals. These results are not immediately intuitive, and suggest the need for a larger sample collection. However, to a certain extent it is possible to recognize a trade off for both car users and owners between trips performed as drivers and passengers. The group of students has in fact identified car-pooling as a means of reducing personal kilometers traveled, instead of each driver using his/her own car to reach a common destination. In this new scenario, some types of trips have decreased as to number of kilometers traveled as a driver and others have decreased as to number of kilometers traveled as passengers. This is probably the reason why car users experienced a negative variation by car as a driver and a positive variation as passengers for meals and shopping (vice versa for return trips and recreational), or why car owners decreased work/study trips as drivers and increased the same trips as passengers (vice versa for meals).

Table 2 presents the average weekly duration in minutes (for the first and second survey weeks) and the percentage variation for in-home and out-of-home activities, on weekdays. In- and out-of-home trends are consistent among car users and car owners except for out-of-home meals and shopping that increase among users and decrease for owners (this can be related to the fact that car users – as opposed to car owners - increased distances traveled by car as passengers for those types of activities so duration may have been dictated by car drivers' schedules). In-home activities appear in general to decrease both for car users and car owners, except for recreational/sport/leisure purposes. The extra time spent studying at home during the first survey week may have encouraged participants to take care of personal needs as opposed to the additional recreational time spent at home if the time required for home studying is less (second week). With regard to out-of-home activities, car users experienced a general increase in the time dedicated to each activity possibly indicating a trade off between in- and out-of-home activities. Car owners additionally seem to have rearranged their out-of-home schedules – mostly shopping and errands - for the benefit of recreational activities. The time use analysis in conjunction with analysis of trip distance (Table 1) suggests that participants, while identifying a way to reduce kilometers traveled that did not require giving up their cars entirely (i.e. car-pooling), were also able to spend additional time out of the home regardless of activity type (car users) and specifically on recreational activities (car owners). Additionally, Table 2 indicates that the time spent in out-of-home work/study increases only by a small percentage for both car users

¹⁰Note that the only student without a driving license was excluded from the analysis reported in this table and from the following one.

(+5.26%) and owners (+4.90%), indicating fairly similar mandatory schedules of the students during the two survey weeks.

Finally, Table 3 shows a summary of individual Cap and Save results in terms of (1) total kilometers traveled during the first week, (2) the proposed target, (3) kilometers traveled during the second week, (4) difference between kilometers traveled during first and second week, (5) percentage variation (6) annual projection of personal costs saved and (7) annual projection of CO₂ saved. The table shows that 50% of the survey participants reduced the kilometers traveled, but only 30% achieved the proposed target. The average participant (last row of the table) traveled 138 km the first week, but instead of traveling 27 km less by car to cut emissions by 20%, he/she only reduced the distance traveled by 8 km corresponding to about 6% less. Maintaining this behavior, in one year, the student would save about 244€, reducing CO₂ emissions by 0.06 tons. The pilot results do not enable us to evaluate the program effectiveness in terms of ability to produce a reduction in kilometers traveled, because of the small number of participants. However – considering that all students involved had similar schedules – those who happened to travel greater distances during the first week (supposedly overusing their cars) were definitely more able to reduce personal weekly kilometers. As Table 3 shows, students who increased kilometers traveled during the second week had traveled below average kilometers in the first compared to their peers; however, only in two cases did second week kilometers exceed the first week average.

6. CONCLUSIONS

It is widely recognized that GHG emissions from the transportation sector are the result of *what* individuals drive (*i.e.* vehicle efficiency and fuel type) and *how much* they drive. The majority of current programs for carbon emissions reduction are aimed at influencing *what* individuals drive (mainly through technological advances), with little or no emphasis on *how much* they drive and the related “externalities” (*i.e.* congestion, urban sprawl, safety of drivers and non drivers *etc.*) related to private vehicle mileage. Nevertheless, the continuous increase of carbon emissions as a direct result of human activities in the residential and transportation sectors needs to be addressed by relying on both technological advances (the *what* dimension) and individual behavioral changes (the *how much* dimension).

Currently, the implementation of behavioral strategies aimed at reducing *how much* individuals drive represents one of the most topical challenges in transportation research. The objective of this work is to implement a *Voluntary Travel Behavioral Changes* program that relies on opportune changes in individual activity-travel patterns. In particular, in the research undertaken in this paper, a program called “*Cap and Save*” that is based on the analysis of individual weekly activity-travel patterns has been designed and implemented during a pilot program that involved a small group of students from the University of Cagliari. To support the creation of a set of sustainable alternatives for each participant, CIREM at the University of Cagliari (Italy) has implemented an innovative portable system called “*Activity Locator*”, a smart phone with built-in GPS that allows to track individual trips and record real-time activity-travel patterns. Using the *Activity Locator*, the students involved reported two-weeks activity-travel data, *before* and *after* definition of a set of personalized alternatives based on individual schedules and needs.

Although drawn from very limited data, the analysis of Cap-and-save feedback and activity-travel patterns data brought to light some important aspects regarding survey methods and innovation of data collection, especially in terms of integration between activity-travel

studies and cognitive-motivational campaigns. First of all, the Cap and Save pilot survey has highlighted the importance of accurate activity-travel patterns data for creating real alternatives for car users. Also, a rigorous cognitive-motivational approach is necessary to persuade individuals to change their travel behavior. The pilot results do not allow us to draw general conclusions regarding the program effectiveness because of the small number of participants; VTBC evaluation is in fact a critical aspect, still under debate in the international literature. In particular, it is widely recognized that a large data set and subsequently large sample sizes would be required to detect any changes with confidence (Stopher *et al.* 2009, and Philp and Taylor (2010) for a discussion regarding current VTBC state of art). On the other hand, some initial results described in this work support the preliminary hypothesis related to the important contribution provided by detailed activity-travel analysis to VTBC programs. Specifically, in the context of soft measures implementation, time use analyses and GPS tracking methods have a twofold role: (1) providing car drivers with opportune suggestions for small changes to habitual schedules (after observing the entire set of weekly activities and trips), (2) analyzing individual response to VTBC programs in terms of rearranged activity-travel patterns resulting from a reduction in kilometers traveled. The latter point is especially relevant if we are to ensure a high quality of life for our citizens (mostly safeguarding the time spent out of home vs. in home, and in others' company vs. alone etc.), while trying to reduce personal car use.

The initial results drawn from the VTBC analysis indicate, as a possible consequence of the Cap-and-save measure, a trade off between trips performed as drivers and passengers. In particular, a reduction in the distance traveled by car as a driver for the benefit of car use as passengers is identified for meals and shopping (car users) and work/study (car owners) trips. Further, the time use analysis shows that participants were also able to spend additional time out of the home regardless of activity type (car users) and specifically on recreational activities (car owners). These results are not immediately intuitive, and suggest the need for a larger sample collection. However, looking also at participants' performance in terms of a reduction in kilometers traveled and considering that all the students involved had similar schedules, those who happened to travel greater distances during the first week (supposedly overusing their cars) were definitely more able to reduce personal weekly kilometers (by 4 to 30%). Therefore, the impression is that, in line with earlier findings (see point 4, section 3.2), 5 to 15% of car use reduction would not require any substantial effort especially if a set of personalized alternatives is offered to drivers who clearly overuse their cars. This result confirms the pivotal role of activity-based analysis in supporting soft measures implementation in that only by observing daily (weekly) activity-travel patterns can specific behaviors be detected and addressed.

Concluding, the *Activity Locator* itself has shown several distinctive features: it is a small device, is a new interesting content for cell phones, and is easy to install in any smart phone and in particular in Android platforms. It is inexpensive because of the GPRS/UMTS connection and can be personalized by the user. Potential sectors of application of the device include vehicle tracking, ITS and safety, and mobility management. More specifically in the research field, it can be employed in time use analysis and route choice analysis, or can be used to provide data input to other research fields (*i.e.* exposure analysis, physical health *etc.*).

The next step planned for future research is to extend the survey to a sample of representative households analyzing their activity-travel patterns in order to identify new sets of sustainable alternatives while evaluating program effectiveness itself, to improve GPS accuracy, increase web server application interactivity and integration with microsimulation models.

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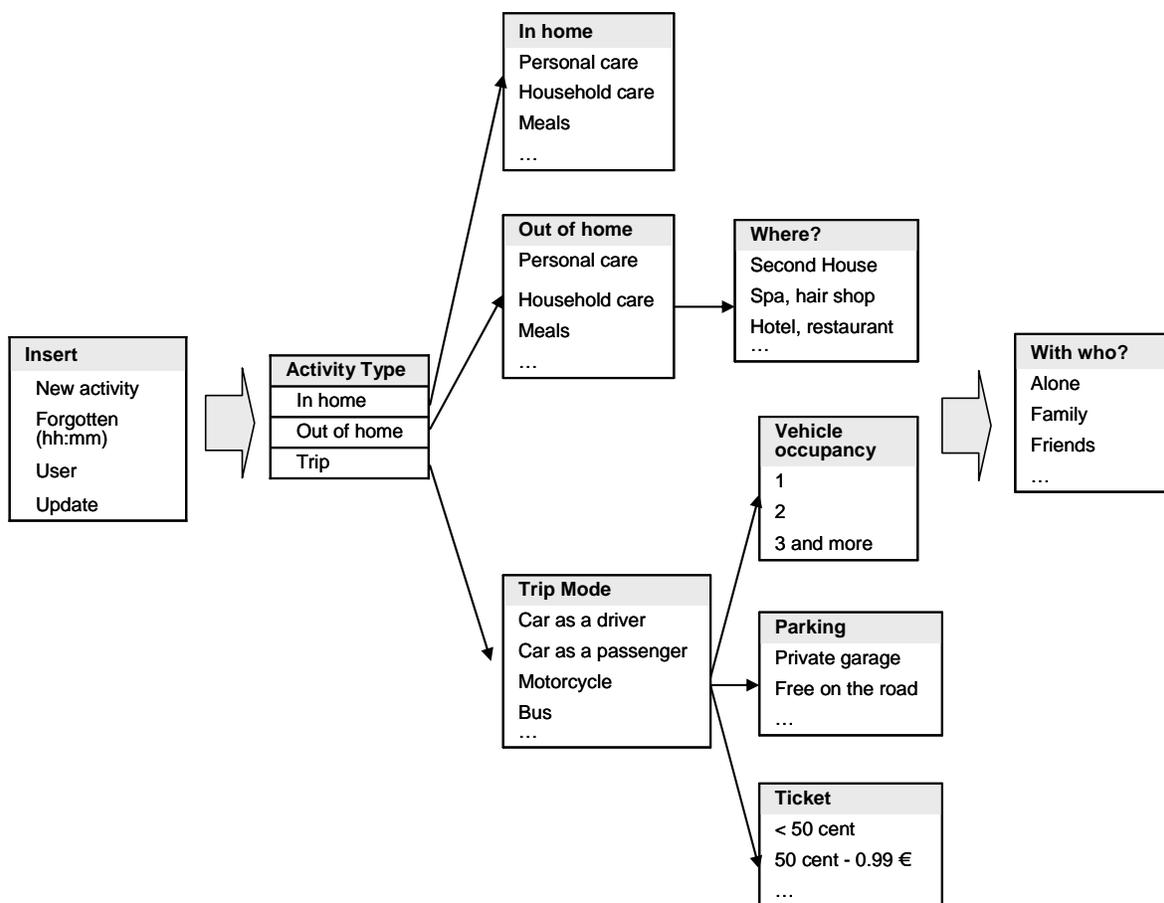


FIGURE 1 Activity Locator (Client Server structure)

TABLE 1 Distance traveled by different modes and users on weekdays (km)

	Car Users			Car Owners		
	I week	II week	% Variation	I week	II week	% Variation
<i>Car as a driver</i>						
Return	36.76	45.96	25.03%	21.75	25.98	19.45%
Meals	19.88	14.26	-28.27%	3.00	6.41	113.67%
Work/Study	9.60	11.83	23.23%	18.03	9.72	-46.09%
Shopping/errands	10.74	8.41	-21.69%	13.30	9.50	-28.57%
Recreational, Sport, Leisure	13.87	21.18	52.70%	10.28	19.72	91.83%
<i>Car as a passenger</i>						
Return	21.51	17.42	-19.01%	8.70	9.31	7.01%
Meals	7.06	8.49	20.25%	6.78	4.60	-32.15%
Work/Study	12.75	15.43	21.02%	2.77	6.73	142.96%
Shopping/errands	4.40	9.93	125.68%	3.12	2.89	-7.37%
Recreational, Sport, Leisure	17.66	13.79	-21.91%	6.41	6.82	6.40%
<i>Walking</i>						
Return	1.90	2.04	7.37%	0.38	--	-
Meals	0.18	--	-	0.60	0.20	-66.67%
Work/Study	0.55	1.35	145.45%	0.60	--	-
Shopping/errands	0.82	0.78	-4.88%	--	0.35	+
Recreational, Sport, Leisure	2.40	1.28	-46.67%	--	--	--

(--) Indicates a zero value

(+/-) Indicates a percentage variation compared to a zero value during the second week

TABLE 2 Weekdays Time use (average weekly minutes)

	Car users			Car owners		
	I week	II week	% Variation	I week	II week	%Variation
<i>In home</i>						
Personal/household care	438.33	319.52	-27.11%	281.76	169.89	-39.70%
Meals	471.74	432.89	-8.24%	544.07	354.46	-34.85%
Work/Study	886.00	646.57	-27.02%	559.43	445.50	-20.37%
Recreational, Sport, Leisure	687.36	782.11	13.78%	537.17	748.48	39.34%
Sleep, Relax	2583.49	2407.93	-6.80%	2860.24	2077.68	-27.36%
<i>Out of home</i>						
Meals	353.58	435.31	23.11%	307.03	293.19	-4.51%
Work/Study	773.07	813.74	5.26%	815.14	855.06	4.90%
Shopping/errands	51.33	73.22	42.65%	129.33	79.83	-38.27%
Recreational, Sport, Leisure	469.89	638.30	35.84%	678.39	896.66	32.17%

TABLE 3 Cap and Save results

Mode	Km I Week	Target (-20%)	Km II Week	Difference in kms between I and II weeks	% Variation in kms	Money saved (€year)	CO2 saved (tons/year)
Car as a driver	32	25	4	-28	-88%	552	0.20
Car as a driver	210	168	147	-62	-30%	1234	0.45
Car as a driver	82	66	58	-24	-30%	480	0.18
Car as a driver	242	193	176	-66	-27%	1300	0.48
Car as a driver	113	90	100	-13	-11%	250	0.09
Car as a driver	236	188	226	-10	-4%	188	0.07
Car as a passenger	211	169	203	-8	-4%	-	0.06
Car as a driver	276	221	277	1	0%	-21	-0.01
Car as a driver	73	58	75	2	3%	-44	-0.02
Car as a driver	69	58	72	3	4%	-53	-0.02
Car as a driver	64	51	70	6	9%	-120	-0.04
Car as a driver	135	108	156	21	15%	-411	-0.15
Car as a driver	130	104	151	22	17%	-430	-0.16
Car as a passenger	67	54	111	44	65%	-	-0.32
<i>Mean</i>	<i>138</i>	<i>111</i>	<i>130</i>	<i>-8.04</i>	<i>-5.69%</i>	<i>243.76</i>	<i>0.06</i>