Transport Research Arena 2014, Paris

# Promotion of E-bikes for delivery of goods in European urban areas: an Italian case study

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**Abstract**

The paper presents the first results of some tasks of Pro-E-Bike, an Intelligent Energy Europe (IEE) funded project, started on March 2013 ending in February 2016. Pro-E-Bike promotes clean and energy efficient vehicles, analyses the performance of electric bicycles and electric scooters (Light Electric Vehicle, LEV) for the delivering of goods in urban areas and tests the use of these vehicles in seven European countries with twenty five companies, both delivering ones and companies that deliver their own products. Pilots will enable the demonstration of measurable effects in terms of reduction of $CO_2$ emissions and energy savings in urban transport: related data about environmental, economic and social effects resulted by the introduction of e-bikes and e-scooters in the pilot cities will be collected. The paper will give an overlooks of the Italian pilot, that will take place in Genova, describing the subjects involved and the expected results.

*Keywords:* electric bikes, service management, urban logistics, pilot case

**Résumé**

Le document présente les premiers résultats de certaines tâches de Pro-E-Bike, un Intelligent Energy Europe (IEE) Projet financé, a commencé en Mars 2013 se terminant en Février 2016. Pro-E-Bike favorise les véhicules propres et économes en énergie, évalue la performance de vélos électriques et scooters électriques (Light Electric Vehicle, LEV) pour la livraison de marchandises dans les zones urbaines et les tests de l'utilisation de ces véhicules dans sept pays européens avec vingt-cinq entreprises, tant celles offrant et les entreprises qui offrent leurs propres produits. Les pilotes permettront la démonstration des effets mesurables en termes de réduction des émissions de CO2 et les économies d'énergie dans les transports urbains: les données relatives aux effets environnementaux, économiques et sociaux ont abouti à l'introduction de vélos électriques et scooters électriques dans les villes pilotes seront collectées . Le document donne une donne sur le pilote italien, qui aura lieu à Gênes, en décrivant les sujets concernés et les résultats attendus.

Mots-clés: vélos électriques, gestion des services, la logistique urbaine, Pilot Case

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## 1. Introduction

Urban logistics is one of the main issues of big cities: it moves vehicles in rush hours and in roads already congested by private traffic. The delivery peaks are, in fact, between 8 and 11 am and between 4 and 6 pm.
Logistic operations do have high impacts onto congestion and urban environmental quality. Concerning their impact the level of congestion, it represents between 8 and 18% of urban traffic flows (MDS & CTL, 2012) and it decreases by 30% the road capacity because of pick-up and deliveries operations (Patier, 2002). From the environmental point of view, it is responsible for about 20% of $CO_2$ emissions in urban areas (Schoemaker et al., 2006).
As a process, urban logistics still has large margins for optimization. More than 80% of road travels for final delivery are less than 80 km long (BESTUFS, 2004) and are performed by a variety of vehicles. Both Light Goods Vehicles (LGV < 3.5 t) and Heavy Goods Vehicles (HGV), that in Italy perform respectively around the 25% and the 12% of their total kilometres travelled (Schoemaker et al., 2006), travel on average at 70% of their load capacity, as displayed in Table 1. Furthermore most of deliveries usually occur on a daily basis (e.g. in Milan the 60% is daily delivery) allowing ample possibility for an optimization of logistics in urban areas.

Table 1: data collected within the Danish City Goods project, measuring freight vehicles entering and leaving Copenhagen urban area from 1st November 2002 to 31st January 2004.

| | Gross Vehicle Weight | Average use of capacity |
|---|---|---|
| LGV | 2500 - 2800 kg | 66% |
| LGV | 2801 - 3000 kg | 85% |
| LGV | 3001 - 3200 kg | 67% |
| LGV | 3201 - 3500 kg | 70% |
| HGV | 3501 - 6000 kg | 65% |
| HGV | 6001 - 12000 kg | 73% |
| HGV | 12001 – 18000 kg | 65% |

Moreover many opportunities for optimization of city logistics arises. A strong increase of online sales (+19% between 2011 and 2012, according to the Rapporto 2012 by Ossevatorio eCommerce B2C, 2012) has been registered in the last years; according to the international agency Nielsen (2012), in 2012 the best-selling products on the web, worldwide, were books, magazines, travel products, electronics (computers, smart phones, video games, etc.); foods and cosmetics are among the sectors with the fastest increase. All the aforementioned products are small in weight and volume, they do not need high capacity vehicles to be brought to final destination.

The European Commission indicated some of the priorities for ameliorating urban logistics and to lower environmental impacts on cities: 1) to foster the development and the take-up of low emission vehicles for "last mile" deliveries, 2) to encourage the development of facilities in urban areas for the transfer of freight between sustainable modes of transport (for medium and long distance flows) to road transport (for "last mile" deliveries) and 3) to develop and disseminate good practices in Urban Freight Transport throughout Europe (MDS & CTL, 2012).

In this framework, the Pro-E-bike project, funded within the Intelligent Energy Europe programme, promotes clean and energy efficient vehicles, electric bicycles and electric scooters (E-bikes), for delivery of goods among private and public bodies such as delivery companies, public administration and citizens in European urban areas as an alternative to "conventionally fossil fuelled" vehicles. Besides this, the project specific objectives are:

- to encourage a modal shift towards less polluting modes in urban logistics;
- to share a practice that demonstrated to be successful, in some European country such as the Netherlands, that is last-mile delivery with electrically assisted cycles;
- to engage logistic players, public organizations and administrations, e-cycle distributors and manufactures and commercial activities in a common platform, to foster cooperation and knowledge exchange among actors.

The project, that started on March 2013 and will end in February 2016, will focus on the problem of the impacts of good delivery in urban area, studying, testing and monitoring the effectiveness of electric bikes as an integrated part of the complex delivery chain. The consortium includes 10 partners, coming from 7 European countries: EIHR - Energy Institute Hrvoje Požar (HR, coordinator), ITENE (ES), Poliedra – Politecnico di Milano (IT), Mobycon (NL), East Sweden Energy Agency - ESEA (S), Sinergija Development Agency (SLO), OCCAM (PT) the European Cyclist Federation (ECF) and Lombardo Cicli SpA (IT). The data used for the elaboration of this paper have been collected by all the partners and elaborated by Poliedra – Politecnico di Milano.

This paper will particularly focus on the service management analysis, carried on during the first 6 months of the project, in order to understand how traditional service models work, which are the operational variables and the organization aspects. Chapter 2 first lists some of the main feature of LEVs, on particular those that will be tested in the pilots; chapter 3 illustrates an overview of the service models adopted by different categories of delivery company; chapter 4 describes the main characteristics of the pilots and of the parameters to be monitored; chapter 5 draws conclusions and future developments.

## 2. Light Electric Vehicles

Nearly all the major delivery companies have been experimenting the introduction or have already introduced e-scooters, e-bikes and e-cargobikes into the traditional fleet. Pro-e-bike analyses and tests the use of these different kind of Light Electric Vehicles (LEV). On one side the "Pedelec", namely a proper bicycle with an electric motor that assists the rider in pedalling, with both traditional frame and cargo bike frame. On the other, the e-scooter, equipped with electric engine and rechargeable batteries. In this paper we will refer to both categories with the unique name of LEV, underlining, where necessary, the existing differences.

Last-mile delivery activities in operation with a major logistic player often need electrically assisted vehicles in response to the increase of volumes transported; the choice generally goes to tricycles or e-cargobikes. In other cases, small bike couriers can include one or more e-vehicle in their fleet to carry heavy loads, whilst big delivery companies generally adopt e-vehicles for other reasons like, for instance, to communicate a green image of the company. As regards the big companies, the challenging aspects concern the integration of these kinds of vehicles into the traditional supply chain management, bound to variables like autonomy range, battery recharge cycles and the optimization of loads. Most of small delivery company or home delivery services generally adopt scooters or bikes, not necessarily electrically assisted, although e-cycles become often part of the fleet to assure flexibility.

The main characteristics of light electric vehicles for urban logistics, in comparison to LGV and HGV vehicles traditionally used for urban logistics, are manifold, well explained in Transport for London (2009), and can be summed up as follows. Costs for both purchasing and maintenance for LEVs are lower than vans even if the main costs in the delivering activities are attributable to the running and staff costs. Also taxes, insurances, storage and depreciation are lower for e-bikes than for vans. Generally the cost savings are perceived by the management as a benefit in the switching from traditional vans to e-bike and not as the driving reason for doing that.

LEVs are, generally, not subject to restrictions for the access to urban areas and Pedelec can be parked anywhere without incurring penalty charge notices. Furthermore, even if their load capacity is consistently lower than the vans' ones, the speed in urban areas is generally higher or similar and not effected by high level of congestion, ensuring a better delivery punctuality. The problems related to the limited range and the fatigue for the drivers (in the case of bike) are considerably decreased by the support given to the rider by the electric engine.

It can generally be stated that the adoption of e-bikes, e-scooter, e-van and e-cargobike does not affect the efficiency of the system.

The constraints introduced by the adoption of e-vehicles can be summarized as follows:

- a full recharge cycle of an e-bike is between 4 and 8 hours, implying that it usually performed in the nighttime;
- the range is variable, from approximately 30 to 90 km. The range can be extended by substituting the discharged battery with an extra-battery stored at the depot;
- load capacity and payload decreases in cases of substitution of a van or diesel light duty vehicle with a e-cargobike or a e-tricycle.

In Table 2 the main characteristics of different vehicles are summarized. Even if the transport performance in terms of load capacity, average speed, etc. are similar between traditional human powered vehicles and those with an electric engine supporting human effort, these latter have the advantage of allowing the user to ride longer, in more difficult condition (for example with not flat path) and to carry the same load with less fatigue. The advantages of an electric scooter respect a traditional one, instead, are related to the level of pollutant emission, locally equal to zero, and to the lower level of greenhouses gas emissions.

Table 2: main specifics of urban vehicles for goods transport: cycles and ICE van: a comparison .

| | Traditional Bikes | | Pro-e-bike LEV | | | LEV not used in Pro-e-Bike | Traditional VAN |
|---|---|---|---|---|---|---|---|
| | City Bike | Cargobike | E-bikes | E-cargobike | E-scooters | E-tricycle | Diesel Van |
| Payload (volume) | 40 - 60 l | 160 - 300 l | 40 - 60 l | 160 - 300 l | 100 – 200 l | 500 - 1500 l | 6500 - 7900 l |
| Payload (weight*) | 100-120kg | 170-210 kg | 100-120kg | 170-210 kg | 180 – 250 kg | 170-300 kg | 710 -1.490 kg |
| Recharge time (full) | 0 | 0 | 3-5h | 4-8h | 3-5h | 4-8h | 0 |
| Average speed in traffic | 20 km/h | 20 km/h | 20 km/h | 20 km/h | 35 km/h | 15 km/h | 8÷15 km/h |
| Maximum range (battery autonomy) | - | - | 50-70 km | 50-70 km | 50 - 120 km | 50-90 km | - |
| Driving | Easy | Challenging | Easy | Demanding | Easy | Easy | Easy |
| Guide in adverse conditions | Easy | Demanding | Easy | Demanding | Easy | Easy | Easy |
| Emissions | Zero | Zero | Zero | Low | Low | Low | High |
| Costs | Low | Low | Average | High | Average | High | Very high |

*including the rider

The importance of the choice of the right e-vehicle is illustrated in Fig. 1 that summarizes the main performances of e-bikes, e-cargo bikes and e-scooters. In general it is possible to say that scooters have the best performances concerning capacity (180-250 kg), speed (maximum speed is over 100 km/h, in urban context it can travel, congestion permitting, at 35-40 km/h) and autonomy (160-180 km) while their cost is almost two-three times e-bikes one and double of e-cargo bikes cost. E-cargo bikes have similar performance in terms of capacity of a e-scooter (160 l), they can travel at the same speed of a e-bike (25 km/h) with the same autonomy (around 70 km). E-bikes have the best performance in terms of costs but are disadvantaged for the capacity, considerably less of e-cargo bikes and scooters.

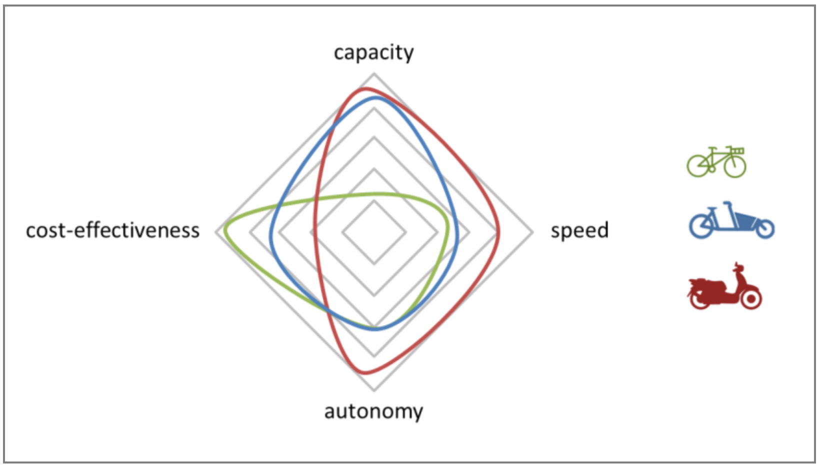


Fig. 1 Comparison of the main performances of e-vehicles

## 3. Service analysis overview

### *3.1. Delivering by bike*

Delivering by bike is not a properly new activity, although it is considered as a novelty in the city logistic sector (Goldman et al., 2006). Immediately after the development of the pedal-driven *velocipede*, in the second half of nineteenth century, people began to use the bicycle for delivery purposes. In contrast to the current situation, the focus was on speed whilst sustainability was less an issue at that time (Cyclelogistics, 2011).

Bike delivering services share particular characteristics: they get goods from the origin (a depot, a production centre, a shop, etc.) and deliver them to the final destination, completely by bike. They mostly operate in densely populated urban areas where they can quickly move and cover middle-range distances. Since they have a limited maximum speed, they are not as suitable as vans or light duty vehicles for delivering outside the city, but they take advantage from congestion on city roads, city policies limiting traffic (e.g. congestion charge schemes, environmental zones, time limiting access, etc.). These conditions make some delivery time slots more profitable than others: busy morning and evening time. Bike delivery takes advantage also from weather conditions and seasonality: the do not affect bike delivery more than traditional deliveries with vans.
Volumes and weight are limiting factors, making bike delivery not properly suitable for any kind of goods: moving big parcels is actually possible but knocks down many of the advantages of speed and punctuality that characterized deliveries made with bikes.

As argued in Fietsdiensten.nl (2009), there is a clear segmentation in the various last mile markets depending on the items delivered. Mass market (a) concerns the movement of letters, documents and small packages, delivered by companies in nearly monopoly conditions, such as postal services. Volumes are large, recurrent, with low priority and with a low willingness to pay. More specific markets (b) are featured by higher priority and larger variety of goods volumes; reliability and traceability are more required with consequences of increasing the price level. The high-end market (c) is featured by high standard in timing, increased expectations in terms of reliability and safety, very high willingness to pay by side of customers. Bike couriers and small delivery company can play a role, though, as long as new logistic model are adopted and put into practices through public policies: bike couriers can become part of a new urban logistic system.

In terms of goods , the market of delivering by bike is quite various. From law firms, advertising agencies and administrations, that need to send documents, under time pressure, to door-to-door delivery service that includes products that can be purchased at the shop or home-delivered, like food/meals, flowers, photocopies.
As underlined in the introduction, a common feature of goods delivered by bike is limited volume and weight: this factor, together with the increasing need for both e-shops and traditional shops to deliver sold items, makes bike-delivery a very suitable option. Traditional scooters still have the major part but e-vehicles, bikes and cargobikes are rapidly becoming profitable alternatives. Several examples already exist of cycles (i.e. freight bikes or ordinary bikes) being used to deliver items or to perform services, as, for example:

- Printed matters: papers, promotional materials, newspapers, mail and small parcels, confidential documents, etc.;
- Small parcels: office supplies, audio/video on hire, clothes, shoes, etc;
- Food: sandwiches, lunches, pizzas, shopping items, flowers, supplies for pharmacies, etc.;
- Services: catering, butchers, photographers, chimney sweeps, electricians, advertising, locksmiths, maintenance (es. Municipal illumination), bicycle repair, painters and decorators, street vendors, etc.

### *3.2. Service management analysis*

The fundamental idea that underlies most initiatives collected under the topic *urban logistics* is to stop considering each shipment, firm and vehicle individually: they should be considered as components of an integrated logistics system. This kind of integrated system is not actually really pervasive: bike delivery experiences still are not completely integrated into the city logistics and it is rather common that they represent, as part of a more complex logistic chain, starting experiences and pilot initiatives (as they already play a role as independent delivering services) waiting for a common framework.
Because of the complexity of urban logistics chain, *service management* is one of the most important aspects to take care of.

Starting from the former considerations regarding bike delivering services, a preliminary distinction of delivery services can be drawn into three major classes:

- **home delivery service**. This group embodies the activities performed by commercial activities, including web shops, making use of bikes to deliver goods purchased by customers.
- **courier service**. This pool includes young companies, often grown during the last ten years, that have been occupying a significant market niche, most of whom use traditional bikes. They have generally followed a similar development path, starting from a very small (even one-man) company, to enlarge year by year, symptom of a sustainable business model and of a good market penetration.
- **last-mile service**. This group includes the service generally provided by big companies themselves or through third parties that integrates last-mile bike delivery into the whole logistic chain.

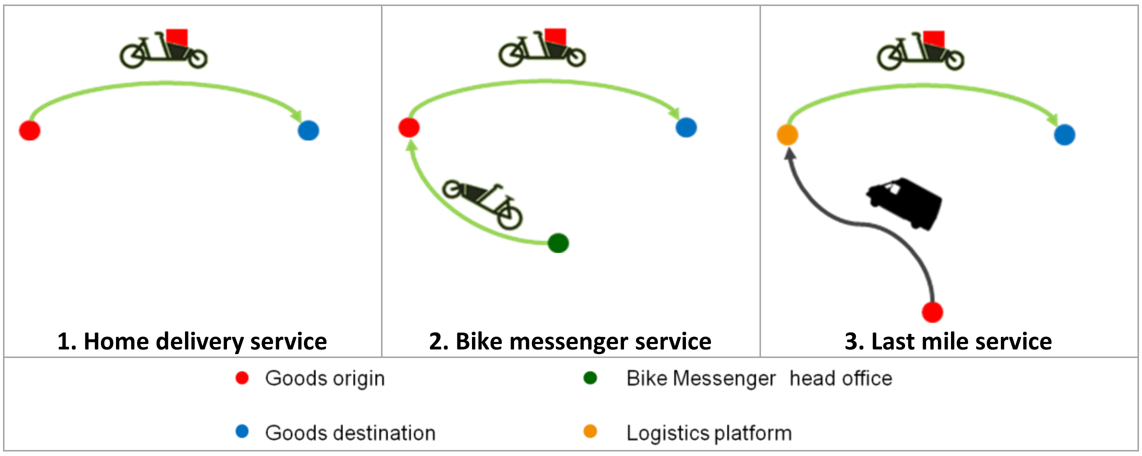


Fig. 2: schematization of the delivery models adopted by delivery companies

A further distinction depends on the type of goods delivered, as described in the next paragraphs.

*3.2.1. Home delivery service*

In this model the product is brought from the origin of production, namely a commercial activity, to the destination, directly by the employees of shop: it's the typical model adopted by restaurants, pizza places, supermarkets or internet food shops.

The delivery model is quite simple. The request of delivery is collected by a switchboard and the product is prepared and load on the bike or, if already prepared, just packed and loaded. The delivery can be both B2B and B2C. If the request is not to be satisfied in real time, the producer/provider can try to arrange more deliveries in order to optimize the route. If the request is a real time one, typically the lunch orders, it's possible to make one or two deliveries for each trip. Naming *A* the origin of the shipment and *B* the destination, the home delivery service is based on a *Take Away Model* constituted by many *AB* shipments, each of them performed with great time pressure and generally wholly implemented for a customer. This usually involves only limited volumes per trip, such as a package or pizzas. The market expects round trips rates to be cheap or even free: willingness primarily depends upon quickness of delivery.

*3.2.2. Courier service*

Such a model takes the name from the recent experiences of bike messengers. Bicycle messengers companies, picking up and delivering items by bicycle, are generally present in central business districts of metropolitan areas. Very likely, they work on a small scale, collecting packages and distribute them quickly throughout the city, because bikes do suffer less from road congestion problems: it can be stated that the more urban areas face congestion, the more these have an advantage. Delivery times are short, high reliability is offered since bike couriers, compared to the conventional transport, do not suffer weather conditions, traffic jams, peak or off-peak times, strikes in public transport.

As concerns organization activities, requests use to be collected both in advance (generally the day before) and in real-time, organizing tasks in short time, often directly on the bike. Most of the contacts with customers go by telephone, while seeking new clients happens on bike, by distributing flyers. The amount of deliveries varies widely, depending on the company mission and size: small companies (up to five bikers) deliver an average of twenty parcels per day. Delivery occurs all along the working week, at any daytime till closure time (depending

on country), while food delivery is generally available also on Saturday. The service model is mainly influenced by the disposal of a storage facility. The presence of it enables optimization of shipments and routes, together with the need for dedicated personnel: in this case, shipments are organized into parcels in the evening to be delivered in the morning.
As regards the trip optimization, the *round trip model* is generally adopted by the vast majority of bike couriers. It consists in a number of pick-up and deliveries in a series: the courier exits the depot and proceeds towards the first pick-up point to load and continues to the first delivery point; then he checks his schedule and goes on to the next pick-up point, till the last delivery of the day. In presence of a depot enabling the storage option, goods are loaded at the depot and then delivered one by one along the scheduled path.

*3.2.3. Last-mile service*
The name reflects the main feature of this model that is the integration of bike delivering with the traditional logistic chain managed by big delivery companies. The traditional model makes use of a truck to bring parcels to a suburban warehouses where goods are stored, sorted, labeled and loaded on trucks or vans to be delivered to the final destinations. Parcels are delivered to a central depot during the day, then injected in the network to the destination depots during the evening/night and delivered to final destinations within the following 1-3 days, depending on the delivery zone the destination depot belongs to. Vehicles generally perform round trips, serving several delivery points before returning to the base. The introduction of bike delivery into this widely adopted model implies a further step along the chain, generally named *Urban Consolidation Centre* (Leonardi et al, 2012) or *Urban Satellite Platform* (Crainic et al., 2009). These facilities enable the transfer of goods from vans to bikes or cargobikes for the final delivery, as illustrated in Fig. 3.

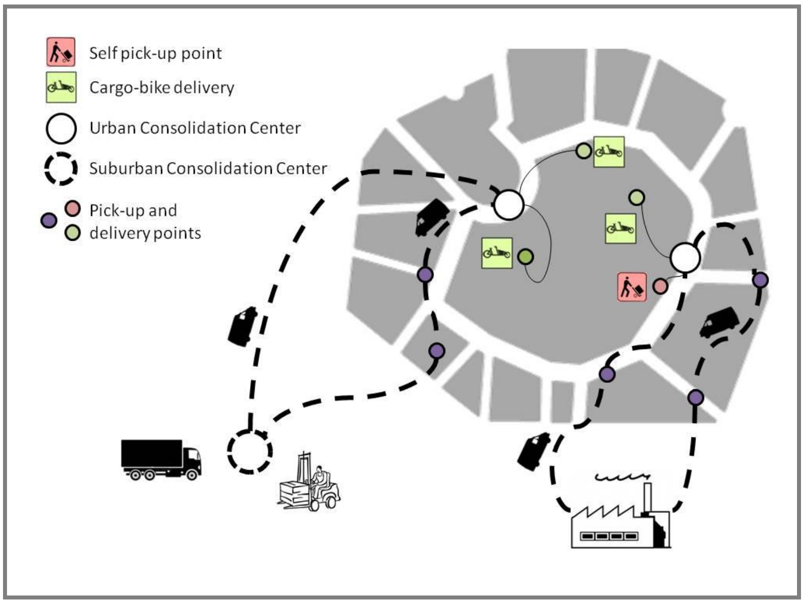


Fig. 3: the introduction of a Urban Consolidation Center and bike delivery into the traditional delivery model

## 4. Pro-e-bike pilot city trials

Pilot cases in Pro-E-Bike project is designed as living laboratory where test the analyzed models, under various issues. In fact pilot cases will make possible to collect data in order to verify the conditions for economic, management and environmental sustainability of using LEVs in urban delivery. Pilot cities are been chosen in order to test as many different situations as possible, from the point of view of cyclist culture of the country, weather conditions, city orography, etc. (Fig. 4).

| Country | Pilot city |
|---|---|
| Croatia | Zadar |
| Italy | Genova |
| Portugal | Torres Vedras |
| Slovenia | Moravske Toplice |
| Spain | Alzira |
| Sweden | Motala |
| The Netherlands | Nijmegen |

Fig. 4: pilot cities in Pro-e-Bike project

The Italian case study will take place in the city of Genova. The city has been chosen because of its particular hilly conformation, that will make more effective the test of e-bikes and e-scooters and of their advantages in delivering goods and for the particular attention the City is giving to electro-mobility, further confirmed by the participation into the IEE ELE.C.TRA project (Ele.C.Tra, 2012). The pilot will take place between January and December 2014, giving the possibility to test all the weather and operating conditions.

All the three kind of vehicles (e-bike, e-cargo bike and e-scooter) will be tested, such as the three models for delivering services (Home delivery, Bike Messenger and Last Mile) and the two trip model (Round trip and Take away). The subjects involved in the trial, as summarized in Table 3, are:

- TNT Italia: international express and mail delivery services company. TNT will test the use of 2 e-scooters for last mile delivering.
- Eco Bike Courier: the first ecological delivery company in Genova. It’s a small company. They already use electric pedal assisted cycles and will have at disposal an e-cargo bike that will make possible for them to enlarge their load capacity in delivering big parcels.
- GraficaKC: the first ecological typography in Liguria, using environmental friendly material for its printing. They will test the use of a e-cargo bike for delivering their products.
- Cibielibri: a vegetarian restaurant, with a home delivering service (currently done with traditional scooters). They will have a e-bike at disposal.

Table 3: Description of companies involved in the Genova Pilot

| Logo | Name | Categories | Vehicles | Service | Trip Model |
|---|---|---|---|---|---|
| TNT | TNT Italia | Big delivering company | 2 e-scooters | last-mile service | round trip |
| | Eco Bike Courier | Bike messenger | 1 e-cargo bike | courier service | round trip |
| KC | GraficaKC | Typography | 1 e-cargo bike | home delivery service | take away trip |
| cibielibri la gastronomia vegetariana | Cibielibri | Restaurant | 1 e-bike | home delivery service | take away trip |

It will be possible to collect data, monitoring the service performance through key performance indicators and evaluate the effectiveness of the different services in delivering goods with electric bicycles. The key indicators identified regards:

- the technical characteristics of the vehicles: load capacity, time of recharging, average speed, etc.
- the performances of the delivery service and trips description: number of orders delivered with e-bikes, average distance per order, total kilometres travelled, average distance and time per journey, etc.

Particular attention will be given to the financial sustainability of services based on the delivery with e-bikes and a number of economic indicators will be measured such as rental fee for each LEV, maintenance and insurance costs, cost for a full recharge. Costs will be compared to the profits obtainable and the economical performances of LEV will be compared with the relative performance of traditional vehicles in delivering goods.

## 5. Conclusions

LEVs represent more than an opportunity for urban logistics. The use of cycles, in many cities, has already been successfully tested: the Pro-e-bike project aims to depict a general framework, to collect data for populating assessment indicators and to design an evaluation system able to estimate the main performance index of delivering services using e-bikes, e-cargobikes and e-scooters. The general advantages of delivering goods with LEVs respect traditional vehicles are quite known. They are directly related to delivering company business (i.e. less energy consumption, less costs, both fixed and variable, positive impact among clients and society in terms of company's image, same level of productivity) and for the society (i.e. less pollution, less traffic congestion). It is less known, though, what are the operational parameters to be considered as decision variables to assess the profitability of substituting traditional vehicles with LEVs, in the field of last-mile vehicles: this is the question Pro-e-bike aspires to answer, relying on the data and information collected within the pilots and on the service management analysis carried on during the first 6 months of the project.

As particularly regards the Italian pilot, the companies involved represent a good sample of the various existing typologies of goods delivery. The pilot will start at the beginning of 2014, lasting one year, enabling the further evaluation of performances, the definition of decision variables and the focus of major operational parameters, to describe and include in the next scientific publications.

**References**

BESTUFS (2004). Consolidated Best Practice Handbook. Available at: http://www.transport-research.info. Accessed on 23rd September, 2013.

Crainic, T. G., Ricciardi, N., & Storchi, G. (2009). Models for evaluating and planning city logistics systems. *Transportation science*, 43(4), 432-454.

Cyclelogistics (2011). Short History of Cargo Cycling – lessons to be learnt from present and future . Deliverable D2.1 from IEE Cyclelogistics project. Available at http://www.cyclelogistics.eu/. Accessed on 23rd September, 2013.

ELE.C.TRA IEE project (2013). Details available at: http://www.eaci-projects.eu/. Accessed on 27th September, 2013.

European Commission (1998). COST 321: Urban Goods Transport. Final Report of the Action. Brussels, Luxembourg: European Commission.

Fietsdiensten.nl (2009). Environmental assessment of the use of bike messengers rather than by delivery vans. Available at: http://www.fietsdiensten.nl. Accessed on 23rd September 2013.

Goldman, T., & Gorham, R. (2006). Sustainable urban transport: Four innovative directions. *Technology in society*, 28(1), 261-273.

Leonardi, J., Browne, M., & Allen, J. (2012). Before-After Assessment of a Logistics Trial with Clean Urban Freight Vehicles: A Case Study in London. *Procedia-Social and Behavioral Sciences*, 39, 146-157.

MDS Transmodal and CTL (2012). Study on Urban Freight Transport. Final Report for DGMOVE of the European Commission. Available at: http://ec.europa.eu/transport/themes/urban/. Accessed on 23rd September, 2013.

Nielsen, 2012. How digital influences how we shop around the world. Available at: http://www.nielsenkorea.com/. Accessed on 17th September, 2013.

Osservatorio eCommerce B2C (2012). Rapporto e-Commerce 2012 – Executive Summary. School of Management Politecnico di Milano. Available at: http://www.osservatori.net/ecommerce_b2c/rapporti/. Accessed on 23rd September, 2013.

Patier, D. (2002). *La logistique dans la ville*. CELSE Editeur, Paris.

Schoemaker, J., Allen, J., Huschebek, M., & Monigl, J. (2006). Quantification of urban freight transport effects I. BESTUFS Consortium.

Transport for London (2009). Cycle freight in London – a scoping study. Available at: http://www.tfl.gov.uk/. Accessed on 23rd September 2013.