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E-TOUR

"Electric Two-wheelers On Urban Roads"

ENERGIE

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Electric Two-wheelers On Urban Roads

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Motorised traffic is the main source of pollution in most European cities. Especially for passenger transport, a modal-shift towards two-(and three-) wheeled vehicles can be a crucial part of the solution to improve these aspects, because they require less space and use less energy. In this respect, bicycles are of course the best solution for personal transport (apart from walking), since they are absolutely clean and silent, but this means of personal transport is not widely used all over Europe. Motorised two-wheelers, motorcycles, scooters and mopeds, can provide solutions related to congestion and parking space but not necessarly to environmental problems. In some cases use of these vehicules may cause worse environmental problems than those caused by private cars.

This means that for two- and three-wheeled motorised vehicles, electric motorisation, which offers a clean and energy-efficient alternative to the internal combustion engine is a must. The advantages of electric two-wheelers are obvious: they operate fully emission free, are very silent and require much less road space than cars, a great advantage in city-centres. These vehicles are a key factor for sustainable mobility for the city of tomorrow.

The **E-TOUR** project has been set up to demonstrate, evaluate and promote the advantages of electric two-wheelers as a substantial contribution to sustainable mobility in urban areas. **E-TOUR** has been running from January 2000 till January 2003 and involved 7 European cities in the Netherlands, Spain, Belgium, Italy, Germany, Sweden and Switzerland, 2 Mediterranean islands in Greece and Italy, 3 universities in Belgium, Italy and Switzerland, the network organisations CITELEC and ISLENET and several private companies.

Cities from Italy, France, Monaco and Norway have been involved as followers, as were the European organisations of bicycle manufacturers and retailers (COLIBI, COLIPED and ETRA) for supporting dissemination activities. The project was co-ordinated by the Public Works Department of the city of Rotterdam, the Netherlands.

The execution of the project has been divided into three phases:

- **1st phase:** Preparation of the demonstration, with special focus on defining user needs and comparative assessment of products in the market.
- **2nd phase:** Demonstration of about 1.300 electric two-wheelers under completely different cultural circumstances and geographical conditions. During this phase, all applications and intermediate results have been constantly monitored, evaluated and disseminated.
- **3rd phase:** Evaluation of final results, with special attention:
  - Practical and technical experiences from users, in order to assess the impact of market introduction of electric two-wheelers and additional facilitating features.
  - Attainable reduction in energy use and polluting emissions.
  - Physiological and bio-mechanical aspects of the physical impact of using an electric bike.

A technological implementation plan (TIP) was provided in order to create a follow-up for future market penetration of electric two-wheelers and facilitating infrastructure, based on the results and knowledge gained from the project.

In total more then 1300 electric two-wheelers (almost 700 e-bikes and more then 600 e-scooters) have been introduced and tested in the 10 sites. The overall demonstration results have shown that e-bikes and e-scooters are a suitable means of transport for short ranges in urban traffic and on small islands. In this respect, the project succeeded in proving the viability of electric two-wheelers in these transport concepts, although in some sites it was quite difficult to get the desired application going "on wheels".

The intention to also provide knowledge for large scale market penetration cannot be considered as completely successful, but nevertheless a lot of learning points about necessary improvements on this point have been gained.

E-BIKE

The appreciation of the tested e-bikes is highly dependent on the site specific mobility culture. It may be concluded that the electric bicycle is certainly not a simple alternative for normal bikes, but a new mobility means, which has still to conquer its own market share. With this conclusion in mind, special attention should be paid to the VUB pilot study regarding the physiological aspects of using power assisted bicycles. The study showed that frequent cycling on an electric supported bike can also improve physical condition, a very positive outcome which needs to be heavily promoted.

Despite their rather heavy weight, e-bikes are easy to handle and very convenient for hilly trips. In addition, the necessary physical effort and the energy use are very low. Recharging is possible at home or in the office as the not so heavy batteries can mostly be taken out for that purpose.

Negative remarks about e-bikes concern the sometimes disappointing performance (speed and range) and high purchase costs. A lot of people find them too heavy, not attractive enough (low emotional value) and are frightened by uncertain battery lifetimes. Apart from the Dutch situation, it is clear that electric bicycles do need separate safe route networks like normal bikes.

E-SCOOTER

In contrary to the e-bike, the electric scooter is an almost perfect alternative for the ICE scooter or moped. For a lot of applications, recharging facilities are only needed at the home base for nightly (or weekend) recharging, if that matches with their use. In that respect, the general lack of public recharging stations does not seem to be the first major concern. However, in specific cases like electric scooter use in rental services (Capri and Rome), or in extended urban areas (Barcelona and again Rome), the necessity of public recharging facilities is highly valued.

The overall experience with e-scooters is basically very positive. Their strong points of being silent and not emitting any exhaut gas are greatly appreciated. Also very well appreciated are the low service costs, mainly due to relatively simple maintenance and considerable savings in fuel costs. Future use of renewable and/or sustainable energy sources will be leading to an even better energy/environmental balance for these transport means.

Negative remarks about e-scooters concern disappointing performances (speed and range) and high purchase costs. E-scooters are also considered too heavy and people are frightened by uncertain battery lifetimes. The market availability for e-scooters has proven to be problematic. There are only very few providers in the market, a very unfavourable situation compared to the broad range of availability of ICE scooters.

RECOMMENDATIONS

For future applications, the necessary product improvement of electric two-wheelers is crucial. This concerns not only the vehicles, but also most particulary their batteries.
The development of a more reliable and better performing battery could result in a breakthrough for a larger market share for this type of vehicle. However, the price of e-bikes and e-scooters will remain an obstacle, if a substantial reduction is not foreseen. This also concerns mainly the price of batteries, the determining factor for the whole vehicle price. Although better and more reliable batteries will tend to push prices up when produced in the same numbers, better products could lead to higher sales, which would in turn lower prices.

It is not yet certain that the future hydrogen / fuel cell technology might inhibit the extensive use of battery electric vehicles. Especially for urban rides, battery electric two-wheelers can still play an important role in future, providing that battery technology is further improved. Normally these vehicles are not intended for long distances and in that respect a small but efficient battery pack will be sufficient enough.

Better insight in user needs is crucial for new e-bike and e-scooter developments and daring but functional designs are needed for a large scale market introduction. Dealers can play an important role by improving their involvement, for example by introducing more rental promotions.

All public authorities, whether they are local, regional, national or European, will have to play an important role in these developments and should emphasise their desire for a future with clean vehicles, by introducing beneficial incentives for buying as well as using these clean and silent vehicles. Clean vehicle users are really wishing to enter areas, closed to ICE vehicles (ban on filth & noise), like city centres and other environmentally sensitive areas. In particular small islands are a perfect setting for the use of electric two- and three-wheelers, since these cannot be entered by vehicles from the outside, making it easier for local authorities to have the courage to allow only these transport modes on their roads.

1.1 PROMOTING SUSTAINABLE PRIVATE TRANSPORT

Most European cities are confronted with problems regarding air- and noise-pollution and congestion caused by motorised road traffic. In a lot of cities, the traffic & transport policy is therefore aimed at reducing the negative impact on both environment & public space.

Especially for passenger transport, a modal-shift towards two- and three-wheeled vehicles can be a crucial part of the solution to improve these aspects, because they acquire less space and use less energy. For a great part, bicycles would of course be the best solution for personal transport (apart from walking), since they are absolutely clean and silent, but unfortunately this means of personal transport is not widely used all over Europe, except in countries like the Netherlands and Denmark.

For a number of reasons however, most people seem to be more interested in motorised private transportation, than using means that require physical effort (except for sportive recreational use).

Most motorised two-wheelers, like motorcycles, scooters and mopeds, are only a good solution to solve problems regarding congestion and parking space, but not at all to solve environmental problems, since most of them make a lot of noise and their air polluting emissions are far worse than those from cars. This means that for two- and three-wheeled motorised vehicles, the introduction of electric motorisation is a very sensible step, since this offers a clean and energy-efficient alternative to the internal combustion engine. The advantages of electric two-wheelers are obvious; they operate fully emission free, are silent and require much less road space than cars; a great advantage in city-centres. Therefore, these vehicles are a key factor in sustainable mobility for the city of tomorrow.

At the moment battery electric drive trains are the most viable option, especially for bi- and tricycles. Although the battery weight in electric bicycles and scooters is relatively low in comparison with batteries of electric cars, this weight can still be considered too high in some cases. In this respect, further development of high performance light weight batteries and (in near future) small fuel cells is of the utmost importance.

The limited range of battery electric two-wheelers does not seem to be very problematic for this type of city use. Most electric bicycles may even be considered as a hybrid solution, since they can still be cycled when the battery is empty, although this requires higher effort, especially uphill.

1.2 E-TOUR - A EUROPEAN INITIATIVE

Partially based on previous experiences with electric vehicles, the **E-TOUR** (Electric Two-wheelers On Urban Roads) project has been set up in co-operation between a number of interested European partners in different countries and was approved for funding under the Energy Programme of the European Commission.

The overall objective of **E-TOUR** was to demonstrate, evaluate and promote the advantages of electric two-wheelers as a substantial contribution to sustainable mobility in urban areas. More concretely, the following targets have been reached:

- To demonstrate the suitability of these vehicles as a practical mobility means in urban and/or other restricted areas.
- To promote these vehicles as an environmental friendly alternative for (private) cars and scooters with internal combustion engine.
- To evaluate the practical and technical experiences from the users, in order to assess the impact of market introduction of electric two-wheelers and additional facilitating features.
- To set up a valid evaluation methodology for the comparative assessment at local level (cities/islands) on a European scale.
- To link alternatively generated (renewable) energy sources to mobility means.
- To analyse the attainable reduction in energy use and polluting emissions.
- To gain insight in the physiological and bio-mechanical aspects of the physical impact of using an electric power assisted bike.

As a result of the project a technological implementation plan (TIP) was provided in order to create a follow-up for future market penetration for electric two-wheelers and facilitating infrastructure, based on the results and knowledge gained from the project.

The project involved 7 European cities in the Netherlands, Spain, Belgium, Italy, Germany, Sweden and Switzerland, 2 Mediterranean islands in Greece and Italy, 3 universities in Belgium, Italy and Switzerland, 2 network organisations CITELEC and ISLENET and several private companies. Cities from Italy, France, Monaco and Norway have been involved as followers, as were the European organisations of bicycle manufacturers and retailers (COLIBI, COLIPED and ETRA) for supporting dissemination activities.
The project was co-ordinated by the Public Works Department of the city of Rotterdam, the Netherlands.

The practical organisation of the project was divided into 5 work packages.
Project-management, market-research including exploitation, real-life demonstration, comparative assessment and dissemination.

The execution of the project has been divided into three phases:

- **1st phase:** Preparation of the demonstration, special focus on defining user needs and comparative assessment of products in the market.

- **2nd phase:** Demonstration of 1.300 electric two-wheelers under completely different cultural circumstances and geographical conditions; electric power assisted bicycles to be tested in Rotterdam, Barcelona, Brussels, Basel& Mendrisio, Erlangen and Stockholm; electric scooters to be tested in Rotterdam, Barcelona, Capri&Mykonos, Mendrisio, Rome and Stockholm. During this phase, all applications and intermediate results have been constantly monitored, evaluated and disseminated.

- **3rd phase:** Evaluation of final results, special attention has been paid to:

  - Practical and technical experiences from users, in order to assess the impact of market introduction of electric two-wheelers and additional facilitating features.
  - Attainable reduction in energy use and polluting emissions.
  - Physiological and bio-mechanical aspects of the physical impact of using an electric bike.

Suggested links on the Internet

www.etourproject.org
www.citelec.org
www.thermie-transport.org
www.cordis.lu/eesd/home.html
www.europa.eu.int/comm/energy_transport/en/cut_en.html

2.1 User needs

The successful deployment of electric two-wheel vehicles, either bicycles or scooters, is dependent on matching the products and services offered with the needs of the user.

By analysing the relation between potential users and vehicles, the market opportunities can be identified. To this effect, the mobility pattern and potential interest for electric vehicles by the users has been probed through the distribution of questionnaires among **E-TOUR** project sites. Two types of questionnaires were drafted: one to be used at the first time the user is exposed to electric two-wheelers, another to be used after having acquired actual experience with the vehicle.

The first questionnaire gave some interesting insights in the perception of the electric two-wheelers. The various societal benefits of electric two-wheelers are well perceived by the respondents, with environmental benefits receiving the highest attention, followed by ease of use, mobility and (for the bicycles), the opportunity for exercise. The need for good infrastructures like cycle paths was strongly expressed. The perceived price of the electric two-wheeler is largely underestimated, even below than the actual cost. This is probably due to lack of actual market knowledge by the respondents, but it also underlines the need to provide the market with attractively priced products. This might be possible if mass production levels were achieved.

After a first short acquaintance with the electric two-wheeler, respondents appreciated the easy ride of the electric bicycle, its appeal to elderly and less sportive people and its use for commuting. For the scooters, comfort and silence were decisive criteria. Main drawbacks perceived were range limitations and charging times.

To have a real opinion about the electric two-wheeler, a more thorough experience is needed however. In the second phase of the of the **E-TOUR** project, electric two-wheelers have been put in actual use on different project sites, making them available to interested users during a period of at least a few weeks, and the experience of the users was gathered.

Electric bicycles managed to perform a modal shift from other transport modes, allowing a time gain compared with cars or public transport, and also incited the users to new displacement, thus increasing their mobility.

The actual user appreciation differed between the sites, depending whether or not a strong bicycle culture is present. Where this is not the case, like in Brussels with its hilly topography, the user-friendliness of the electric bicycle and its assistance on slopes were greatly appreciated, and it can be stated that the market availability of electric bicycles could lead to a significant increase of bicycling in such areas. The main drawbacks encountered with the electric bicycle were the weight on one hand and the range on the other hand. At about 30 kg average, the electric bicycles are in fact substantially heavier than ordinary ones, and can become a burden especially where users have to take them to their flat upstairs when no suitable storage space is available (in this framework, the higher risk of theft of these expensive machines was also quoted). Furthermore, the actual available range of the electric bicycle turned out to be lower than the announced range by the manufacturer (the latter being realised in "ideal" conditions on a flat road). The heavy weight of the bicycle becomes a real burden when one has to drive it by pedal force when the batteries are dead!

Charging was not perceived as a major problem, and the quality and reliability of the bicycles gave no concern to most users. On sites like Rotterdam on the other hand, where bicycle use is already very popular, and the topography is flat, the users were much less impressed and saw fewer advantages of the electric bicycle, which was perceived more as a product aimed at elderly and less physically active users.

The southern European **E-TOUR** sites where electric scooters were deployed, have already a strong culture of electric two-wheelers; local users were quite satisfied with the performance of the electric scooters, although the lack of available charging infrastructures was felt as a potential problem. The introduction of the electric two-wheeler as an exclusive mode of individual transport in congested historical city centres was positively received.

The gathering of user opinions on the different project sites allowed assessing a number of aspects concerning user perception and appreciation on the different project sites, taking into account local particularities.

The overall conclusions from all the sites can be summarised as follows:

- The electric two-wheeler clearly has an appeal that extends to a large proportion of the population. The contribution the two-wheel vehicles can make to urban environment and mobility are clearly recognised.
- The reduction of physical effort through the power-assisted electric bicycle is perceived as a property allowing extending the use of two-wheel vehicles to a larger proportion of the population, particularly in cities where the topography now discourages bicycle use.

- The lack of infrastructures for two-wheelers is seen as a drawback for the wholesale introduction of electric two-wheelers. The most needed infrastructures are on one-hand cycle paths and traffic planning measures aimed to facilitate bicycle traffic, and, on the other hand supply and charging infrastructures specifically aimed at electric scooters. Local and national government action policies are thus needed to deploy infrastructures and promote electric two-wheel vehicles.

- The current market price for electric two-wheelers is perceived as too high by the users, whose expectations however, may be influenced by a lack of market knowledge for new products.

- The practical perception of the electric two-wheeler is generally positive; the weight (especially for the e-bikes), range limitations and charging procedures are considered the major drawbacks.

2.2 EXPLOITATION

The Exploitation Study identified suitable markets for electric two-wheelers, preparing a strategy for large-scale introduction of electric scooters and bicycles in different countries. After a relevant period of the demonstration phase, a research was conducted into user acceptance. This research addressed all aspects of using an electric scooter or bike: driving performance, facilitating infrastructure, and recharging infrastructure and all necessary additional equipment.

Information regarding the market for electric two-wheelers was provided both for the market of e-scooters (chapter 3 of the Exploitation Report) with the identification of consumer groups, the geographic target market and size, the figures, market chances for introduction of electric two-wheelers, legal and legislative context, identification of manufacturers and technologies in the field, emerging speed recharging stations, batteries technologies, the barriers for electric two-wheelers, marketing and distribution issues and for the market of the e-bikes (chapter 4 of the Exploitation Report) with the types in the market, the European legislation on EPAC's and the products tested in **E-TOUR**.

Exploitation activities in the sites were largely addressed with a general overview on electric scooters and electric bicycles. After that, a description of the activities carried out in the site was presented,showing some features for each site and some common aspects across the sites.

In Rotterdam, Basel, Erlangen and Stockholm a strong "bicycle" culture is already present. The introduction of electric bicycles was aimed at further increasing bicycle use. The cities of Barcelona, Basel, Mendrisio, Stockholm and Brussels have a hilly topography where power-assisted bicycles and scooters may offer a great incentive to promote the use of two-wheelers. In Barcelona and Rome thermal scooters and motorcycles are already heavily used. The project aimed at replacing polluting thermal scooters by clean electric ones. On the Islands of Capri and Mykonos the topography offered an ideal environment for (electric) two and three wheelers used in sharing systems. **E-TOUR** assessed also the impact of the introduction of facilitating infrastructure, like public recharging stations like in Rome and Barcelona. The report shortly described how this facilitating infrastructure can support the introduction of two-wheel e-vehicles. Even if this project has just only been the first attempt to introduce two-wheels e-vehicles and it is probably too early to express a definitive evaluation, the dissemination of the results of the projects including the huge variety of applications can anyway contributing to improve the confidence of future buyers as well as of the big two wheeler manufacturers.

In general, the EC funded **E-TOUR** project (2001–2003) has shown some promising approaches for applications of electric two wheelers. Nevertheless the final market breakthrough could not be reached. Most of the participating demonstration sites showed an interest in an ongoing common activity in this field. For several years electric bicycles have been produced worldwide by a huge number of manufacturers. With the exception of a few brands (e.g. Yamaha) the sales figures remain small. In European countries the number of electric two wheelers on the roads is still negligible.

Electric scooters have been available in the market for almost ten years, but in contrast to the electric bicycles there are only a few manufacturers, mainly concentrated in Taiwan and some European countries.

Local authorities appreciate the benefits of electric two wheelers as a sustainable means of transport. Electric two wheelers make no noise, they are not air polluting and they do not need much space for driving nor for parking. If they substitute cars or conventional motorcycles, substantial energy savings and greenhouse gasses reductions are noted.

The electric-two-wheelers need extensive promotion activities and a complete infra-structural network able to permit their normal use. Next to that, the thermal non-catalysed scooter has to be eliminated from the urban areas (at least in city centres) and the only mopeds allowed to enter these areas should be e-scooters. The application of this measure in the applicable sites will permit a real decrease in the pollution and the success of the e-scooter.

Studies made in Rome 2001 showed that non-catalysed thermal scooters (two strokes) emit a large quantity of PM10. The public administration is ardently seeking for strategies to reduce this kind of pollution, favouring the e-scooters.

Electric two wheelers can become an important means of transport for accessing the inner city centres of the large cities that tend to limit the access into these areas for conventional cars and scooters. The exploitation activity was executed during the whole project period and it was focused on the assessment regarding performance, reliability and acceptability of the chosen electric scooters and electric bicycles in a "real life environment". This activity was performed in a wide variety of project sites in terms of culture, environmental conditions, size, economic structure, social composition, demography and organisation of traffic and mobility. In the project life, most of the concerned partners have had their scooter fleets operating.

Within the **E-TOUR** project framework, more then 600 electric scooters and in the end phase 8 three-wheeled electric vehicles were running.

After an intensive market analysis carried out during the first year of the project, most partners have chosen two different kinds of electric scooters. The Peugeot Scootelecs are operating in Rotterdam, Mendrisio, Stockholm and Barcelona, whereas Capri and Rome selected the Oxygen Lepton scooters. In both cases, technical characteristics provided by the manufacturers are quite similar. Only in Mendrisio, two other brands have been functioning as well, the Elektra and the Celco Profil, both with lead-acid batteries.

The demonstration projects proved that electric scooters could be a very suitable alternative for individual trips. Electric scooters are popular and people were very interested in the demonstration activities in the sites. Benefits foreseen for the community are a better air quality and a substantial reduction of acoustic pollution. For the users themselves, fun and low energy costs are the main benefits.

The problems faced are the limited autonomy, the limited speed (< 40 km/h) and the difficulties related to recharging with excessive recharging times and the possibility of recharging during the night as the scooter has to be kept within closed areas with the current devices. Next to that, the high market price (although less important than electric cars), lack of information and no specific benefits for the e-scooter users are limiting problems.

The general experience gained from the demonstration of electric bicycles is that they improve biking considerably. Negative comments coming from some sites are relevant to the weak power assistance for some types of electric bicycles with disappointing performances, especially for the younger and sportive individuals.

An important result of the **E-TOUR** project is the right determination of users (target groups) and matching (technical) specifications for a "desirable" electric bicycle, as well as the determination of the list of materials matching these criteria.

Cycling is anyway easier and demands less human power, so one will not get "overheated", wet and/or tired and it is quite easy to cycle uphill or against strong winds. It is a very convenient and easy way to get around in a city. In some sites, the e-bikes attracted a lot of interest from other cyclists, car drivers and pedestrians, even from the youth. However, it is also clear that some of the e-bikes are developed for a group of people with reduced biking capacity. In those cases, youth and healthy middle-aged people are not strictly the target group, which most likely explains part of the negative comments given before.

All in all, the reduction of air pollutants, greenhouse gases and noise could be achieved with the contribution to sustainable urban transport given by e-scooters and e-bikes, moving some percentages of urban modal split towards such vehicles with a common strategy for their market introduction and penetration. We are still in the initial phase and the objective is to raise public awareness and to improve the distribution network.

The overall goal of improving air quality needs to be demonstrated continuously; making transparent the assumptions regarding the substitution of kilometres driven by conventional vehicles and other parameters. The dissemination of the results of the project, including the huge variety of applications can anyway contribute to improve the confidence of future buyers as well as of the big two-wheeler manufacturers.

Finally, the declaration of the environmental impact of the different electric two-wheeler based projects all over Europe will convince more and more cities to follow this approach. Integration among the cities within already established programmes like CIVITAS and new coming thematic networks need to be promoted in order to make the two-wheels electric vehicles very popular.

3.1 Rotterdam

* Introduction

Rotterdam has the largest port in the world and is the central main-port of Europe. The city is the second largest and the economic centre in The Netherlands and has about 600.000 inhabitants from which 300.000 inhabitants have to commute to work every day. The majority of the population in Rotterdam travels by bicycle or walks for trips shorter then 5 km, 24 % travels by car and only 5% uses public transport. For longer trips, the use of car and public transport increases to 65% and 23% respectively.

The high mobility needs in Rotterdam have resulted in the city policy to aim for reduction of the negative impact on environment and public space, especially reducing noise and air pollution caused by mobility. The environmental mobility problems can be divided into 3 categories, contribution to world-wide emissions (green house gases), local emissions cause air pollution and (car) mobility also affects the quality of life (noise, vibration and effecting public space).

The standard approach for solving these problems are mainly stimulating use of public transport, introducing environmental friendly vehicle technologies and guiding the mobility.
A modal shift towards energy efficient and environmental friendly means of transport is being promoted and the supply of traffic and transport infrastructure will be in line with the users and their demand for transport.

In Rotterdam the **E-TOUR** project introduced electric scooters as a perfect alternative to fuel scooters and mopeds. Electric bikes have been introduced for service trips and commuting transport (about 5-12 kilometres), not only to improve the environment, but also to introduce the normal cyclists' pleasure of commuting without getting delayed by traffic congestion.

* Approach

Main objective of the **E-TOUR** project in Rotterdam was to make electric two-wheelers an essential part in stimulating people to use two-wheelers instead of cars. The project would also serve as the starting point for large-scale introduction of electric two-wheelers.

The demonstration was focused on testing about 100 e-bikes and 5 e-scooters in different market segments, representative of the Dutch two-wheeler market. **E-TOUR** introduced e-bikes as an alternative commuter transport means for inhabitants of a new residential area in the region (Carnisselande). They were offered a partly subsidised e-bike to do their commuting in combination with public transport, from home to nearby public transport stations (Metro and Railway).

E-TOUR introduced a demonstration fleet was intended for companies within the Rotterdam region. Companies would have the opportunity to borrow and test a little fleet of 5 e-bikes and 1 e-scooter for a period of about 4-6 weeks. This test-set fleet had to circulate between different companies, in order to realise a very significant spin off. The test-set executed and monitored by the Assistant Contractor VCC Rijnmond, as part of their core business, stimulating mobility management in industrial estates.

E-TOUR also introduced e-bikes and e-scooters for in-company vehicle-sharing projects, to be used for business trips of employees in the city. These bikes and scooters had to be stationed at several municipal departments in Rotterdam.

* Results

1°) E-bikes

The first 20 bicycles (Giant and Sparta) were ordered and delivered in the autumn of 2000. An important selection criterion was the availability on the Dutch market, to be sure of service and maintenance. In the Rotterdam municipality, 15 e-bikes were introduced for service trips and commuting transport for some municipal departments and one private company, in order to convince employees about the benefits of this mobility alternative.

5 E-bikes (3 Giants and 2 Sparta's) were offered in the mentioned "test-set", to be used at different large companies for commuting transport or service rides. This part of the project had the objective to introduce the e-bikes to as many companies as possible and so stimulating mobility management in industrial estates.

Although in both applications the old-fashioned appearance of some bikes and the limited comfort for tall people were criticised, the e-bikes were in general still considered as being a good solution for physically less abled people.

In Carnisselande (a new developed area, with yet limited accessibility and poor public transport connections), 80 e-bikes were planned for introduction to the inhabitants of the area as an alternative for the lack of high quality public transport. This part of the project has been executed by the Dutch Automobile Club ANWB, but this very specific application did not succeed, instead of the planned 80 e-bikes, only a poor 3 could be introduced.

It may be concluded that this concept mainly failed due to the lack of interest of the inhabitants of that area, but in combination with a not so very interesting model and similar financial arrangement.

In order to reach the goal of the planned number of e-bikes to be demonstrated for this specific target group in the Rotterdam project, another approach had been worked out, which had to lead to an easier procurement of e-bikes for the interested (car-)commuters.

In this new approach, products with a higher "emotional" value have been introduced. This part started late in the project and only lead to the introduction of an extra 10 e-bikes.

All in all, the concept of e-bikes has not been judged very positively. Performances were considered disappointing, especially with regard to range and speed. Also the heavy weight, uncertain battery life time and capacity and the appearance of most tested e-bikes have been considered as insufficient.

Other factors which might have played a role in Rotterdam are the high costs, lack of after-sales and a negative image. This latter point may for the greatest part be accounted for the Dutch bicycle tradition, nevertheless an important number of e-bikes have been stolen.

2°) E-SCOOTERS

The local transport company RET (Rotterdam Electric Tram), introduced 3 e-scooters as 'trouble-scooters', which were used to inform tram passengers about delays. This approach proved to be very successful, so the RET decided to procure 2 extra e-scooters for this purpose.

For the in-company transport at municipal departments, 2 e-scooters have been used regularly. In the afore mentioned "test-set", stationed at different companies in order to be used by company employees for commuting or service rides, 1 e-scooter has been used.

All 8 e-scooters, Peugeot Scootelec, have proven to be a good alternative to fuel scooters and mopeds with low service costs. The advantages consist of the absence of noise for the environment and people seem to realise that in this way sustainable energy sources can be used. The e-scooters also contribute to traffic calming and demand very little parking space.

The performances were sometimes disappointing, mainly described to low range, high purchase costs, heavy weight and uncertain battery lifetimes.

* Recommendations for future applications

The Rotterdam **E-TOUR** project has proven that e-scooters are a good alternative to fuel scooter and mopeds with low service costs. The e-bikes have shown to be a reasonable alternative in short distance to private cars, but were especially considered as being a good solution for physically less abled people.

With these experiences, Rotterdam will continue its work and will certainly try to introduce more electric two-wheelers. At the municipal departments the procured electric two-wheelers will continue to be at employees' disposal for service and commuting trips. Since the municipality of Rotterdam nowadays has an energy supply containing 100% "green" current, the use of these electric vehicles may be considered completely environmental friendly.

In order to convince regional commuters about the mobility benefits of these vehicles, the **E-TOUR** approach will be continued within the TELLUS project.

Based on the overall results, we may conclude that electric two-wheelers could provide an important contribution to urban sustainable mobility. However, at this moment, there are still a lot of reasons for improving these products before a large scale introduction on a reasonable term can be expected. That is because some important negative points (price, performance, image etc.) are interfering with the wholesale diffusion of electric two wheelers. These points really have to be improved, before e-scooters and e-bikes will be circulating widely on our urban roads.

Two "actors" can play a major role in this overcoming process:

On one hand the Public Sector (national and local government) incentives are critical to supporting an early market for electric two-wheelers. These should include economic support, urban privileges such as free parking, and stewardship in creating partnerships and network of actors. Moreover, public authorities must actively support the implementation of new charging infrastructures with the co-operation of energy companies.

The latest news in the Netherlands is that from January 2003, just after the end of **E-TOUR**, electric (power assisted) bicycles are also placed within the fiscally favourable arrangement from the Ministry of Finance. So procurement of these bicycles will become easier for consumers. Unfortunatly, this has come a little too late for the project. It is nevertheless finally a positive answer to all requests from users and test-drivers in the Rotterdam project.

On the other hand electric two-wheeler manufacturers (in co-operation with their electric part suppliers) and local dealers can give a considerable contribution in the overcoming process.

They can do that by introducing far better and more appealing (high emotional value is needed) products in combination with rental promotions to stimulate the sales.

Renting of e-bikes and e-scooters can attract the sceptical user to give them a real test. It has been demonstrated at the Swiss **E-TOUR** sites that e-bike rental is a key element of promotion aimed at stimulating sales.

3.2 BARCELONA

* INTRODUCTION

With 7% of the city's daily mobility running on thermal motorcycles and scooters (225,000 registered vehicles), the original site focus aimed to encourage the uptake of electric scooters (e-scooters). The initial surveys found that citizens perceived the benefits for the city (noise reductions, energy saving, etc.), but not for themselves as individual users. The results identified the need for a package of incentives to overcome two principal obstacles: the higher price of e-scooters, and the need for convenient and fast re-charging (most of Barcelona's citizens live in apartments, and scooters are usually parked on the street). Electric bikes (e-bikes) were to be used by local politicians / public servants as an example of good practice - with no initial aim to promote uptake by citizens. (At the start of the project cycling accounted for only 0.8% of the daily mobility, in spite of the efforts made to establish a strategic network of approximately 100kms of safe routes).

* APPROACH

With the collaboration of the Education Section of the Environmental Department, Barcelona Municipality introduced fiscal incentives in terms of annual vehicle tax exemption for owners of electric scooters. Attention then focussed upon how to implement a public recharge point using solar energy. Different municipal departments were involved in trying to agree on a demonstration configuration, but it became clear that the Municipal policy of generating a proportion of its renewable energy requirements via large solar panel installations on municipal buildings (not necessarily distributed to facilitate e-scooter recharging) was a key factor in reducing city interest in the demonstration. Another determining factor was that the e-scooter seat must be kept open for re-charging; whilst this may be acceptable in one's own garage, this is unacceptable to citizens in Barcelona who are used to storing items in the space under the seat and/or not prepared to risk tampering. These reservations prompted us to seek an e-scooter demonstration elsewhere in the Province of Barcelona.

* RESULTS

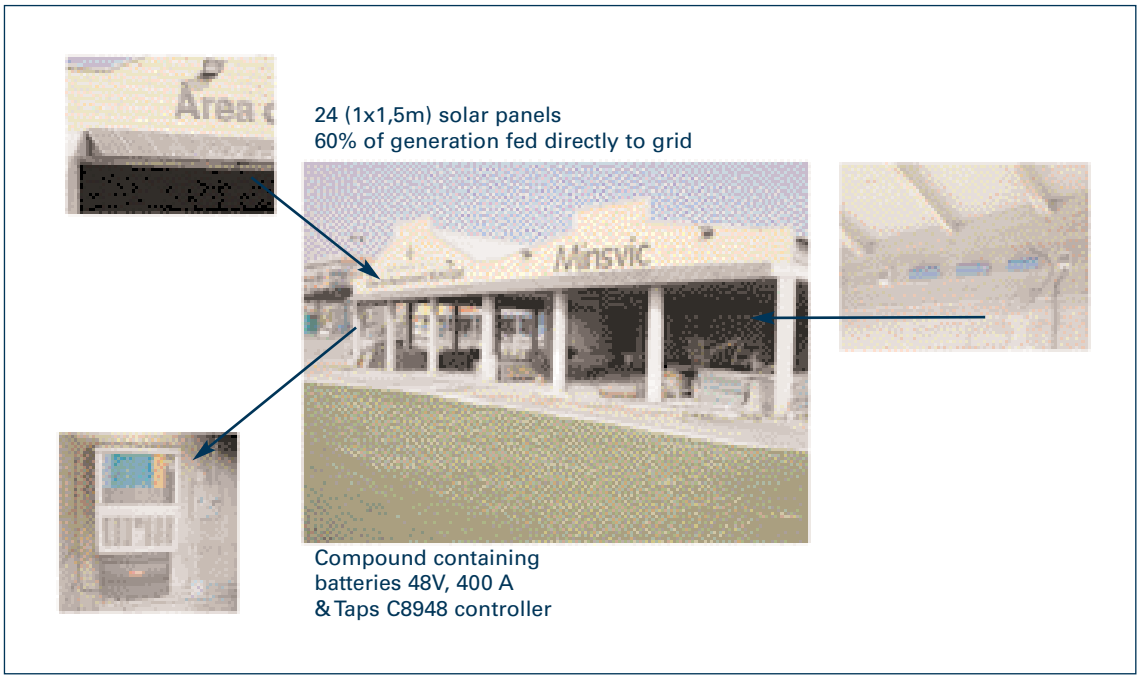
(Peugeot) Scootelec e-scooters of the Vic municipal police had been used in an early stage of the project to obtain reliable measurements of energy requirements, i.e. the dimension of the size of the solar panels for recharging an installation of e-scooters. Vic Municipality also had plans for implementing solar panels configured for re-sale to the grid.

The authority was sensitive to the issue of clean recharging ever since the press conference that presented the e-scooters of the police vehicle fleet. It accepted revisions to the solar panel installation such that:

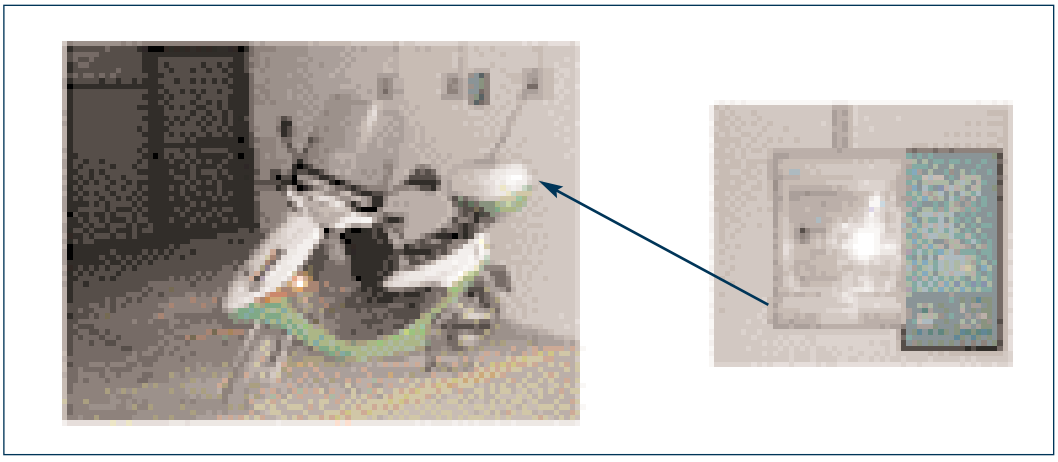
- the Municipality demonstrates an e-scooter fleet recharged from solar energy
- the performance of a stand-alone configuration of batteries and panels could be tested.

The solar-recharging infrastructure has been installed at a new maintenance depot operated by a subsidiary company of Vic Municipality called Minsvic. The 3 Scootelecs operated by the municipal traffic police are relocated to the Minsvic site and a fourth Scootelec has been acquired – for use by maintenance staff. The exterior view shows the 24 solar panels fixed above the portal entrance of the depot.

The controller is housed in a compound constructed to the side of the main building in which the bank of batteries is located. When the batteries are fully-charged, generated energy is re-sold to the grid. The interior view shows the control display and counter units at the sockets. Having a back-up grid supply has proved to be invaluable in maintaining optimal battery levels and the acceptance of users of these fleet vehicles; any failure that might cause non-availability of the vehicles would have brought about a premature end to the demonstration.

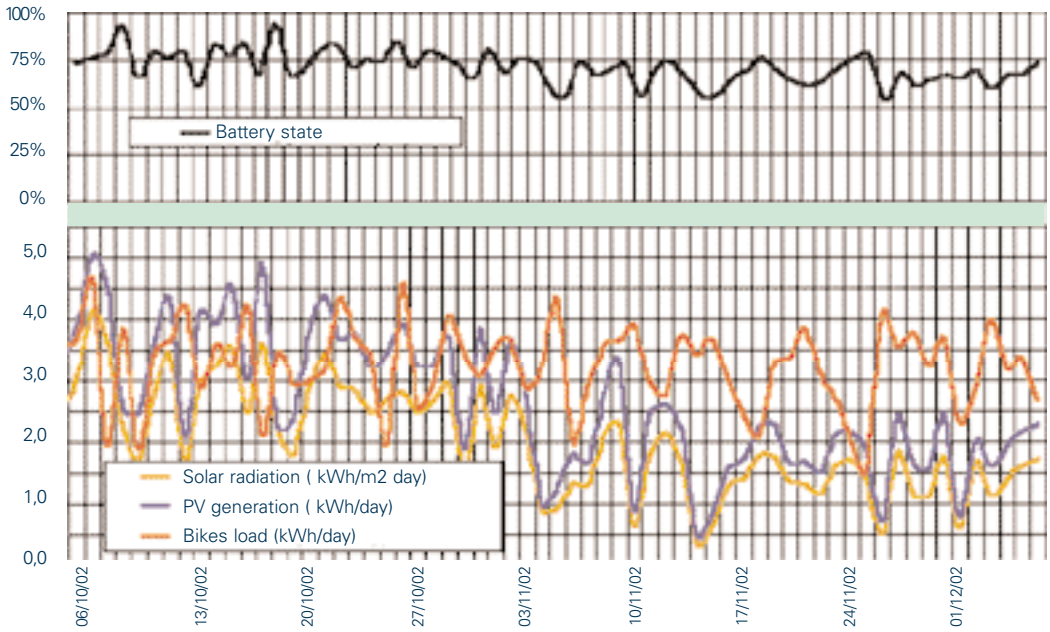


Exterior view of solar re-charging of fleet e-scooter at MinsVic, Barcelona



Interior view of solar re-charging of fleet e-scooters at MinsVic, Barcelona

The following figure shows that a photovoltaic (PV) system of 2 kWp of installed peak power (15.6 m2 of panels) enables the electricity recharging of the three electric bikes used daily by the municipal police. It shows the daily evolution of the state of the battery charge against the electricity required for bikes recharging. It also shows the generated electricity according to the solar radiation. The system has been arranged so as to avoid critical low charge situations. It is important to note that the monitored days correspond to the period of the year with less solar radiation, i.e.: for the rest of the year the system will operate even better.
The installation is ideally located to form a staging post for the planned Solar Rally of 2003 from Toulouse to Barcelona.



Evolution of the bikes load and PV generation, and the resulting battery state.

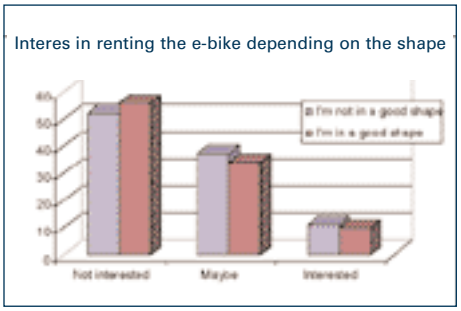
* E-BIKE DEMONSTRATION

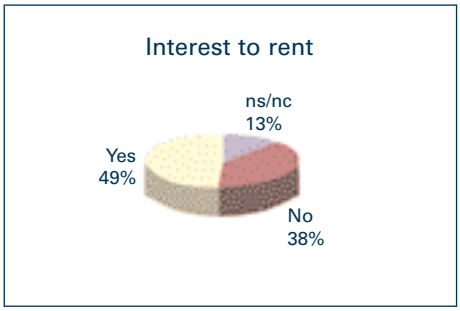
Shortly after the Environmental Department of Barcelona Municipality was brought into the project, the original objective of e-bike demonstration was achieved - with politicians and key public figures riding Yamaha PAS e-bikes during Barcelona Bike Week (May 2002) and during the first Solar Rally held in Catalunya in June 2002.

Very few e-bikes had been sold in the city prior to the ETOUR project, and only the Yamaha PAS model was initially available; 7 were acquired (5 for the Municipality, 2 for a university). Market research was carried out to determine the level of availability of other models, with a view to realising additional promotional activity with models covering the full range. This resulted in 3 models being promoted at the Mercè fiesta held in September (the Flyer was demonstrated for the first time, following completion of importation and distribution agreements the previous month). In total, 285 responses have been obtained and analysed from citizens participating in the test-rides.

Models	Motor (Watt)	Battery Type	Range (Km)	Speed (Km/h)	Recharge Time (h)	Chassis	Weight (Kg)	Price (E)
Yamaha PAS	235	24V 7,4 Ah NiMh	25	24	3,5	high tec	27,7	1000
Giant La Free	250	24V 6,5 Ah NiMh	30	20	3,8	aluminium	22	1500
Flyer F2	250	36V 5 Ah NiCd	35	30	3	aluminium	29	2500

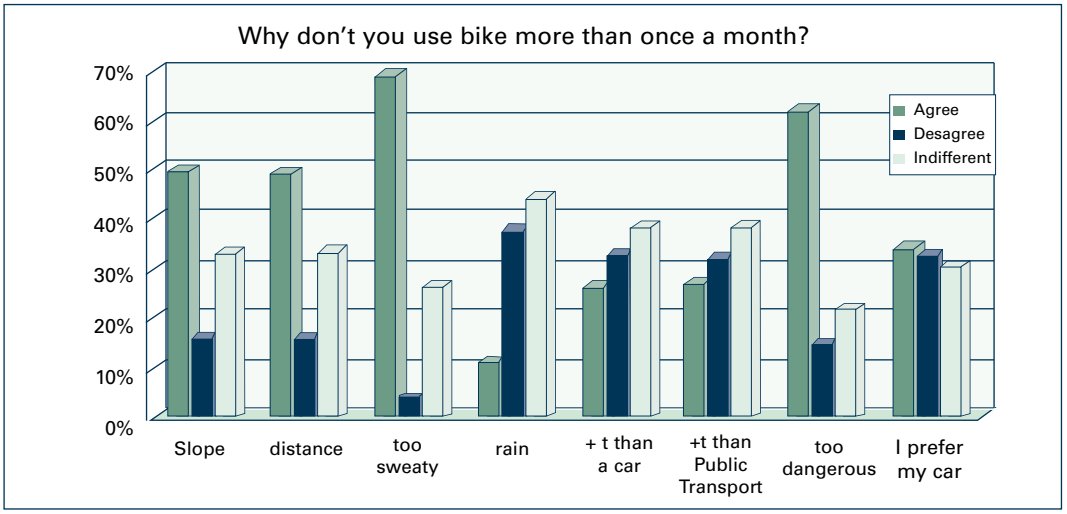
E-bike test-rides in the city of Barcelona; models & key results





The results indicate that the e-bike could achieve a market share between conventional bikes and thermal scooters:

- It is a more attractive option than the normal bike for those older, heavier (even business!) people who consider themselves not to be fit enough to use a normal bike (or who wish to avoid heavy sweating).
- It is a cheaper option than a scooter – both in terms of purchase and insurance, and is simpler to put on the road (no tax).



Respondents' reasons for not using a conventional bike in the city of Barcelona

Several key obstacles could be resolved by e-bikes (getting sweaty was the main reason, cited by 70% of respondents, and also distance and hilliness). Nevertheless, the lack of safe infrastructure is perceived to be an obstacle by over 60% of those responding to why they don't use a conventional bike. The commitment of Barcelona Municipality to develop a network of safe cycle routes was stated at the outset of this site report. It is interesting to compare the ETOUR response (suggesting that more is required) with the expansion of this network (the increase from 100 to 115kms has included important connections, and the plan is to reach 250kms by 2005). Evidence suggests that people are starting to realise the possibilities of finding routes; the contribution of cycling to the daily mobility during the lifetime of ETOUR has doubled (to 1.5%).

* Recommendations

The e-bike results are promising – and certainly better than had been originally envisaged. Different models of e-bike are now available for local purchase, but sales are still very modest, and no dealer is yet prepared to offer a rental service (due to insurance complications and limited resources). E-bike renting is something that respondents would like, and it has been demonstrated at other ETOUR sites that e-bike rental is a key element of promotions aimed at stimulating sales (ref. Swiss New-Ride Program). The growing popularity of two-wheelers is provoking municipal actions to control on-street scooter parking, to provide selected on-street cycle parking, and to promote secure off-street parking as the preferred option. Offering e-bike rental via the network of municipal off-street car parks could form part of a program that registers new e-bike purchases. It is recommended that the Municipality develop a pro-active policy regarding the new EC norm for power-assisted cycles since this new group (e-bike users) can be used to develop policy actions for the other two-wheeler groups. Further promotion should also aim to establish if and when e-bikes can be a substitute for thermal mopeds and scooters.

3.3 BRUSSELS

* INTRODUCTION

The Brussels Capital Region has a hilly topography and suffers from a sub-optimal use of the bicycle as a mode of transport. Many efforts are focused on establishing biking routes, to organize bicycle-parking places at public transport stations and to allow the access of bicycles to the public transport system (underground and buses). Furthermore, a map with all biking routes is now being published. A central bicycle parking, distribution and renting shop will be set up at the high speed train station "Brussel Zuid/Bruxelles Midi" with a view to improving the intermodal correspondence with this railway station. An increase of bicycle use is now being observed in the region. The power-assisted bicycle as a tool to enhancing the attractiveness of this mode has been demonstrated and subsequently evaluated in an extensive way in the context of the **E-TOUR** project. The bicycles procured for the purpose of the demonstration have been evaluated from a technical viewpoint in order to compare their performances with the subjective evaluation from test persons.

* APPROACH & RESULTS

1°) EXTERNAL FUNDING

The procurement of the electric bicycles was almost entirely sponsored by the Belgian national electric energy supplier Electrabel, who also offered their journal as a forum for the dissemination of the project intentions. The Vrije Universiteit Brussel offered financial support to develop the test facilities for the bicycles, process the enquiry results and host the project.

2°) ACTIVITIES

In Brussels 48 electric bikes have been introduced and have been demonstrated in four distinctive ways. The following bicycle types were procured:

Number of procurements	Type of bicycle	Sponsor
10	Merida pre-scoot, equipped with lead acid batteries	Electrabel
3	Yamaha PAS frame size 39, equipped with NiCd batteries	Electrabel
2	Yamaha PAS frame size 50, equipped with NiCd batteries	Electrabel
5	Yamaha PAS frame size 50, equipped with NiMh batteries	Electrabel
3	Yamaha Easy frame size 48, equipped with NiMh batteries	Electrabel
8	Yamaha Easy frame size 55, equipped with NiMh batteries	Electrabel
10	Sachs Elo-bike, equipped with NiCd batteries	Electrabel
5	BK-Tech Swiss-Flyer, equipped with NiCd batteries	Electrabel
1	Merida step-scoot, equipped with NiMh batteries	L'avenir (supplier)
1	Piaggio, equipped with lead-acid batteries	made available by private person

The bicycles have been made available on multiple public happenings with large audiences. (see following table). At these occasions, a large number of persons were given the opportunity to make a short test ride (typically 15 minutes).

Date	Events	Location	Number test rides
6 May 2000	official launch **E-TOUR** Brussels at VUB	Brussels	69
7 May 2000	"Dring-dring" car-free Tervurenlaan	Brussels	226
4 June 2000	"Leefmilieufeest" Koning Boudewijn Park Jette	Brussels	117
22 September 2000	European Day without my car	Brussels	196
24-27 October 2000	IFEST fair in Ghent	Ghent	244
3 November 2000	Excursion in Limburg	St-Truiden	29
6 May 2001	"Dring-dring" car-free Tervurenlaan	Brussels	159
6 May 2001	Spring festival Evere	Brussels	42
3 June 2001	"Leefmilieufeest" Woluwe parc	Brussels	59
18-24 March 2002	Printemps de la Science ISIB	Brussels	56
5 May 2002	car-free Tervurenlaan	Brussels	7
12 May 2002	"Dring-dring" Tervurenlaan	Brussels	88
2 June 2002	"Leefmilieufeest" Woluwe parc	Brussels	99
21-23 June 2002	Open doors at Evere	Brussels	41
22 September 2002	European Day without my car	Brussels	37
19-20 October 2002	"Wetenschapsfeest" Flanders Expo	Ghent	454 (629 km)

Number of persons who offered to serve for testing a bicycle for an extended period of 6 to 8 weeks and who were selected for this purpose	366
Number of persons returning a completed questionnaire after the test period	232
Age range of the test persons	22 to 80 years
Total mileage covered during the tests	58.000 km
Largest mileage covered by one bicycle	7.850 km
Men-women distribution of test persons	58-42%

At special events, the bicycles have been exhibited and/or made available to selected groups of persons: local authorities, police, officials, civil servants. An overview of these special events is show below:

Date	Type of event	Location	Users
6 May 2000	Official launch **E-TOUR** Brussels at VUB	Brussels	Officials from the State Secretary Delathouwer; officials from the university
22 June 2000	Parcours du citoyen	Brussels	visitors
9-19 July 2000	Transeuropean 2000	Monaco to Hannover	3 cyclists
22, 26 September 2000	Presentation to Commissioner Busquin	Brussels	Commissioner Busquin, officials from the university
22 September 2000	European Day without my car	Brussels	Eu officials and civil servants
23, 24 September 2000	Visiting the regional cycling routes	Brussels	7 registered participants
30 September 2000	Demonstration of electric bicycles in Anderlecht	Anderlecht (Brussels)	Local authorities, city council
19-29 October 2000	Exhibition week on Energy St-Gorikshallen	Brussels	Local authorities, visitors (exhibition only)
10 June 2001	Visiting the regional cycling routes	Brussels	25 registered participants
14-16 September 2001	Exhibition at "Conseil informel des ministres de Transports et de l'Environnement de l'Union Européenne	Louvain la Neuve	European ministers of Transport (Exhibition only)
22 September 2001	European Day without my car	Brussels	Local authorities police and civil servants in 8 minicipalities
19-28 October 2001	Energy week	Brussels	Exhibition only
11 November 2001	Exhibition at Centre culturel du Brabant Wallon	Brussels	Exhibition only
20 March 2002	Colloquium "Le véhicule électrique et hybride"	Liège	Lecture and exhibition
28 September 2002	Prophelios III	Louvain la neuve	Exhibition

The bicycles have been made available to a selected group of twenty test persons, to evaluate effects on general health condition. This topic is further developed in paragraph 4.4.

Each person using one of the bicycles for an extended period has been asked to complete a questionnaire. Intermediate results have been presented in the paper "Electrically assisted bicycles demonstration in Brussels" at the 18th International Electric, hybrid and fuel cell vehicle symposium EVS-18 Berlin, 20-24 October 2001. The results are further presented in chapter 4.

For analysis and research purposes a bicycle test facility has been developed and the characteristics of a number of bicycles have analysed. The results have been presented in the paper "Characterisation of Electric Bicycles Performances" at the International Electric vehicle exhibition and symposium EVS-19 Busan, Corea, 19-23 October 2002.

* Dissemination

The project results have been presented at the most important yearly world Electric Vehicle Symposium as indicated in the previous paragraph at EVS-18 in Berlin, 20-24 October 2001 and at EVS-19 in Busan, Corea, 19-23 October 2002.

The project activities have been reported in multiple national and international newspaper and television programs.

* Conclusions and recommendation for the future

The **E-TOUR** project in Brussels has demonstrated the usefulness of electrically assisted bicycles for the mobility and the health of persons with reduced mobility and its fundamental usefulness for short distance mobility between home and work. In this field it can be an element of development of company mobility plans in the region and in cities in general.

A future RTD action is necessary to develop all aspects demonstrating in the **E-TOUR** action and to reach a perfect man - bicycle relationship with a significant market potential.

* Recommendations

The product "electrically assisted bicycle" must evolve towards higher quality with appropriate reliability and single charge mileage range at a better accepted procurement cost.

Actions are required to inform and educate the potential users of the product.

The target group of potential users should be further identified and marketing towards this group should be organized.

The retail and repair network must be organized.

The network of charging opportunities in public places must be organized.

With respect to standards, actions are required for the clarification of definitions and for removing limiting specifications, which act as barriers to the introduction of the bicycles.

3.4 CAPRI/MYKONOS

3.4.1 Capri

*** INTRODUCTION**

The Island of Capri, part of the Campanian Archipelago, is 30 km distant from Naples main Harbour (Molo Beverello) and has a population of about 15.000 people. Capri has a healthy Mediterranean climate, with average temperatures of 10°C in February and 28°C in August, making the isle attractive to tourism throughout the year.

Within the isle, Capri Municipality has a total area of 3,97 square kilometres and 7.235 inhabitants (1997 data), with a population density of 1.782 inhabitants per square km; this situation completely changes during summertime, when, due to tourists, there is an Increase in population of up to 7.000 people.

Main road network in the municipality is defined by narrow cross-sections. This circumstance, combined with that of considerable slopes at some points, drastically limits vehicle capacity; moreover, roads in the municipality centre are for pedestrians only: within this area, transport of goods and baggage has for many years been performed by electric trolleys, which ensure protection from chemical and noise pollution.

The fleet of motorised vehicles in the Municipality of Capri consists of 82 buses, 63 taxis, 488 private cars and 477 motorcycles. Especially in the periods of large tourist flows (from the beginning of spring to the end of autumn as well as Easter and Christmas), the public transport system, due to the peaks in transport demand caused by the arrivals and departures of ferries and hydrofoils, is over-saturated and used almost exclusively by arriving and departing tourists.

These first data clearly show that Capri is characterised by two opposite factors: on the one hand, a great attraction of people; on the other, the necessity to preserve, at most, the environment and to protect the needs of the resident population.

For the above mentioned reasons, the Local Administration of Capri has drawn up a General Urban Traffic Plan (PGTU), which outlines long and medium-term scenarios for mobility and also proposes short-term solutions. The plan also indicates working themes in the design phase to be developed through specific intervention programmes.

In terms of energy savings and environmental quality the following are of particular importance: the Bollino Blu campaign (vehicle emissions control and certification) and the E-Scooter-Sharing project, also in accordance with the Government decision to provide financial support to citizen in order to eliminate traditional scooters not respecting European rules on pollutant emissions and, in particular, to substitute traditional scooters with electric ones.

*** APPROACH**

Starting from the guidelines defined in the PGTU report, and together with the exchange of experience with other cities, a special focus on Capri was set, in order to test electric scooters in island environments and measure the impact they have on island communities.

The objective was to test user acceptance under different circumstances (tourists, administrators, inhabitants or luggage carriers) and in particular geographical specificities.

These targets have a great importance, especially for tourist islands, where it is difficult or impossible to take in or to use cars, since in these areas traditional scooters are an efficient transportation system and, hence, scooters are commonly used, despite the negative effects in terms of energy consumption and the environment.

Within the **E-TOUR** Project, the Municipality of Capri has introduced 35 scooters Oxygen Lepton, managed by three different private rental companies (local partners of the Municipality of Capri, in charge of co-financing the project).

The scope of the Capri project was initially the design and implementation of a Scooter –Sharing System allowing shared use of electrical scooters by a "users' club" through a "do it yourself" rental service. A call has been launched by the Municipality for private investors and market offers, according to public procurement rules. As a result of the first bid, three private rental companies were chosen to run the service providing co-financing for the project. The outcome of the second call was that, due to an attractive offer made by Oxygen Lepton, instead of the originally planned 20 scooters, 35 scooters were bought in Capri, in the **E-TOUR** framework. Unfortunately, after this really positive beginning, some difficulties were encountered, due to the fact that two of the three private rental companies, renting the e-scooters together with their conventional ones, complained about the lack of interest from public. It appeared that in the second half of 2001, neither residents nor tourists were renting e-scooters, stating disappointing performances, which were most probably due to incorrect usage of the e-scooters.

In confirmation of this last possibility, a second test on the road was carried out in May 2002, and performed by the Municipality of Capri, in collaboration with University of Naples, C.N.R. (National Research Council) – Istituto Motori and Oxygen, with the presence of the three private partners. This test confirmed the stated performances of Lepton e-scooters, underlining that, probably, e-scooters on the isle of Capri do not perform as they could due to incorrect usage (two persons riding, frequent acceleration/deceleration). As a last issue, due to all these difficulties, the Scooter Sharing System has not been finally implemented, although it had been designed and simulated. The Municipality, has expressed its willingness to complete the project and has included some changes in the local project implementation, in the direction of empowering system infrastructure network on the isle.

* Results

Within the **E-TOUR** project framework, the Municipality of Capri has clearly made its decision in order to shift, on the territory, from conventional scooters to electric ones, paying more attention to technical requirements and manual instructions to achieve best performances.

Purchase price is still perceived as pretty high and hence rental companies are reluctant to keep up e-scooters without support. Probably, to overcome this problem, incentives (traffic, financial) should be given as a local policy sign for the promotion of the environmentally friendly scooters. in addition, scooter performances seem to have not satisfied user-needs for several reasons.

The maximum speed of 40km/h is considered too slow, since driving behaviour on Capri congested network often leads to fast reactions with high acceleration needs.

The maximum range of 35 to 40 km is still too low to encourage the use of the electric vehicle in place of a traditional thermal scooter in Capri, which is one of the most hilly islands in Europe, with long distances between different parts of the island.

Moreover, market introduction of new models and technologies is so far restricted in islands, still facing more problems with vehicles import, new infrastructures for recharging stations, service and maintenance by skilled staff. Dealers should be better informed in order to implement a good satisfactory service and provide their commitment for maintenance or recharging stations.

Finally, it is important to stress that, within the **E-TOUR** project life, a judgement came from Tribunale Administrativo Regionale (Region Administrative Law-court), stating that two wheeler renting services on the isle of Capri, starting from next year, should be carried out only by using electric scooters. Following this decision, the Municipality of Capri is now waiting for the final sentence, to start the replacement process of traditional scooters with electric ones, over the entire municipality territory.

At the same time, the necessity to empower infrastructure system in Capri is evident, by creating additional recharging points, with the aim to create a network supporting e-scooters rental services and to guarantee recharging possibility on every classical tourist route on the isle. In the same direction, it is necessary to provide renters and users with correct information about e-scooters, since they do need greater care and have to be correctly used, in order to provide best performances.

* RECOMMENDATIONS

The use of sustainable energy and its impact on energy supply and the environment merits specific interest when considering the case of insular communities as Capri, since both energy supply and energy use present specific characteristics in the island environment.

As a matter of fact, Capri economy is completely linked to tourism, which is typically a seasonal activity. During busy periods, the population present on the island is, as previously seen, several times more than during the off-season, with a corresponding influence on the demand for energy.

Leisure activities create a big demand for energy together with increased demand for transport: both scheduled transport services (buses) and unscheduled services (car sharing, car rental, scooter rental) have a great potential in a tourist island setting. The resulting traffic congestion puts an extra burden on Capri environment, which can create problems due to the fact that island's ecosystems tend to be rather fragile given the limited area and the limited natural resources available. The island's natural beauty, which is often a main reason for tourists to visit the island, becomes threatened by the increased tourism, and the sustainability of the island's economy becomes jeopardized.

This trend can be effectively reversed by generalising the use of environmentally friendly vehicles for these newly generated displacements. Potential applications include among others electric scooters for rental.

The use of electric scooters is particularly interesting on Capri, where the geographical setting makes the range limitations of such vehicles less of an issue, even if an adequate energy supply must be present for recharging these vehicles. The sustainable character of the system will be highlighted even more when renewable energy sources are chosen.

This is also the reason why the Municipality is now seeking co-financing, in order to implement the telematic infrastructure, already designed within the **E-TOUR** framework, and hence realize the scooter-sharing system, as initially foreseen.

It is finally worth to underline that the **E-TOUR** project in Capri, highlighted for the first time this energy problem, and was the starting point for several similar initiatives in the Neapolitan Area (isle of Ischia, isle of Procida, Municipality of Napoli).

3.4.2 Mykonos

*** INTRODUCTION**

The island of Mykonos belongs to the Cyclades archipelago and lies southeast of Piraeus, at a distance of 94 miles from Piraeus and 71 from Rafina. It has a total area of 85 square kilometres and a coastline of 81 km. It is highly touristic with seasonal tourism mainly during summer. The preservation of the natural environment in the island of Mykonos is a priority for the Municipal Authority of Mykonos as well as the Prefectural Authority of Cyclades because of their willingness to contribute to the implementation of EU and National Policy for the Protection of the Environment as described in several Programmes, such as the Fifth Environmental Action Programme, the CSD 1997, Natura 2000, the Hellenic Action Plan for the Abatement of CO2 and other Greenhouse Gas Emissions etc.

Touristic activities seriously affect the natural environment of the island, and important criterion for the selection of a holiday destination, the "unspoilt environment" criterion.

The town of Hora, capital of Mykonos, by the Presidential Decree 594/78, has been proclaimed as traditional settlement. The city is characterised by very few open spaces and many narrow streets, paved in grey stoned slabs and surrounded by the facades of the houses with their external, wooden – balustraded staircases, their balconies, and their white – washed stone benches, and the picturesque arches. Inside the city, the dimension of the streets varies from 1.2 to 3.5 m, while the dimension of the streets outside the city varies from 4 to 8 m. The grade of almost half of the streets is between 5 and 10% and the maximum grade reaches the 35%. Private cars are allowed to circulate only from 1st of November until the end of February, in the area from Mando square until Alefkandra (in the city centre it is not possible for the cars to circulate due to the dimensions of the streets)

*** APPROACH**

Before the **E-TOUR** project the transport of persons and goods from the harbour to the city centre was being done through animals (donkeys) or noisy old-technology three-wheeler petrol vehicles that affected seriously the environment. There were 25 such vehicles, 10 of which were used by public authorities (municipal, prefectural etc.) while the remaining 15 were private –owned. The circulation of those three-wheeler vehicles is permitted until 15:00 every day. The average distance per day covered is between 10 and 40 km and the maximum distance per portage is 2.5 km. The use of the private vehicle refers to 5 portages per day during the low period, 10-15 during the average season and 20 portages per day during the peak touristic period. The average required vehicular weight ranges from 80 to 140 kg and the required dimension of the carrier is 1.20m (w) _ 1.20m (l) _ 0.70m (h). The replacement of the old technology vehicles form ecological, zero-emission ones was a priority and the **E-TOUR** project provided the opportunity to start under the best circumstances since it provided opportunities for communication cooperation with Institutions and Companies of great experience in the subject.

In view of this perspective and following certain coordinated actions and constant notifications the Energy Centre of Cyclades, acting within the Regional Development Agency of Cyclades S.A, stressed to the Greek relevant agents (Hellenic Ministry for the Environment Physical Planning and Public Work, Prefecture of Cyclades, Municipality of Mykonos), the importance and advisability of the project was recognized.

All the above and especially the Municipality of Mykonos and the Prefecture of Cyclades reacted in a very positive way regarding the implementation of the **E-TOUR** project and committed themselves to cover from their own sources the own participation corresponding to the project. The Energy Centre of Cyclades, undertook serious efforts in order to create the optimal conditions ensuring the successful implementation and completion of the project. Within this context, the users and the agents that would finance the project identified the users needs that the **E-TOUR** project would cover taking into account the subject of the work and its acceptance. According to the results of this research, what the Municipality really needed were small electric three wheeler vehicles used for transporting people and goods.

Taking into consideration this finding, the Energy Centre asked from the project co-ordinator to consider the possibility of modifying the technical specifications of the vehicles to be supplied in accordance with the new requirements.

The result was that in the context of the **E-TOUR** project, Mykonos replaced 8 conventional vehicles used for the transportation of persons and goods from the harbour to the historical centre of Hora with 8 electric three-wheelers and their incorporation in the traditional urban landscape.

* Results

According to the specifications of the needs and the transportation requirements and after an extensive market research, it was decided that the only suitable model is the three-wheeler electric vehicle model APE-50 of PIAGGIO. After a successful test drive of this model, under real conditions, the Energy Centre of Cyclades, in close co-operation with the Municipality of Mykonos, concluded to purchase, 8 such vehicles, with the following characteristics:

ENGINE:	DC series excitation
VOLTAGE:	24 V
NOMINAL POWER:	2 kW
COOLING:	Air
OPERATING BATTERIES:	4 6 V – accumulators – 180 Ah
AUXILIARY BATTERY:	12V – 32Ah
RECHARGER:	on board
ELECTRIC SOCKET:	16 A-200/230V – 50 Hz.
RECHARCHING TIME:	6 h
MAXIMUM SPEED:	30 kilometres per hours
RANGE:	45 kilometres between recharging
TRANSMISSION:	direct to the rear wheels with reverse drive
SUSPENSION:	independent with helicoidal spring and hydraulic shock absorber on each wheel
TYRES:	10/90 – 10”
BRAKES:	front wheels: mechanically operated by handle-bar mounted ever rear wheels: pedal operated hydraulic rear-wheels hand break
STEERING:	handle bar commanded
STEERING CIRCLE:	4.8 m
SEATS:	1

The installation of the recharging station is under the responsibility of PIAGGIO, near the water reservoirs of the Municipality and the possibility of charging the vehicles through the use of photo-voltaics is strongly considered. The Municipal Authority of Cyclades and the Local Authority of Mykonos presented the vehicles to the public in a special event that was organized. The vehicles have taken the name “My Hermes” and the private users can use them by renting them (recharging costs are included in the price).

The Energy Centre of Cyclades monitor and register the use and behaviour of “My Hermes”: the users complete every day a questionnaire. The conclusion is that “My Hermes” cover very well the needs for which they were purchased. Consequently, their acceptance by the users is also very positive.

The introduction in Mykonos of electric three wheeler vehicles in the framework of the **E-TOUR** project, as a contribution to the preservation of the natural environment, was greatly publicised by the Greek press. Mykonos was characterised by the press as a “green” island and the authorities received very flattering comments for their ecological sensitivity.

This means that the **E-TOUR** project for Mykonos created very positive impressions and the appropriate circumstances for the introduction of electric two or three wheeler vehicles in other islands. After the first months of positive experience with these vehicles the supplier PIAGGIO offered a 9th vehicle for a very special price, which was purchased in the last project month, December 2002. After the very problematic starting phase, the **E-TOUR** project in Mykonos finally ended with 9 electric three-wheelers in service.

* RECOMMENDATIONS

The implementation of the **E-TOUR** project for Mykonos showed that the opportunities for introducing electric two or three wheeler vehicles in Greece and especially in islands are great. The **E-TOUR** project created very positive conditions for that. On the other hand the market research task showed that there is currently a lack of electric two or three wheeler vehicles in the Greek market. Even for products that are currently available in the market, there is a significant lack of information. If ever, electric vehicles require having a market share, a promotion and marketing campaign should be organised, in order to advertise this kind of vehicles, present their technical characteristics and of course underline the benefits from their use. Manufacturers and dealers should examine this issue.

Another problem / barrier for the wide use of electric two or three wheeler vehicles, is the difficulties in their procurement and maintenance due to the lack of dealers and manufacturers especially in remote island regions. For the time being and as it concerns the maintenance of the 9 electric three-wheelers in Mykonos, the dealer of PIAGGIO in Athens will provide specialised training to local technicians. Since islands are ideal for the use of such vehicles the suppliers should strongly consider the possibility of establishing a more efficient network of dealers and manufacturers.

3.5 ERLANGEN

* INTRODUCTION

The aim of the project was to demonstrate, evaluate and promote single-seated light electric vehicles for use in the Erlangen area and in conjunction with solar-charging stations.

The city of Erlangen has approximately 100.000 inhabitants. The largest employer is SIEMENS with more than 20.000 employees, followed by the University of Erlangen.

In Erlangen, a strong "bicycle" culture is already present. The city of Erlangen is well known for its bicycle friendly policy, resulting in a high percentage of bicycles. Between 1974 and 1985, inner city motor traffic was reduced from 41 % to 38 % but passenger cars increased from 34.000 to 49.000. The number of cyclists in inner city traffic increased during the same period from 14 % to 26 %. A survey in 1993 showed that 28 % of the population preferred the bicycle as their primary means of transport, 19 % preferred to go on foot and 13 % preferred to use public transport. The remaining 40 % involved individual motor traffic. Terminating and originating traffic is clearly dominated by individual motor traffic with a figure of 88 % of trips. Public transport features 8 %, bicycle and pedestrian traffic together amounted only to 4 %.

Erlangen is the home of the "Solarmobil Verein Erlangen e.V.", a small but active group of volunteers working on "solar mobility" with light and ultra-light electric vehicles. It is the oldest and largest of such groups in Germany, they publish the "Solarmobil Mitteilungen", the only German publication specialized in light electric and solar vehicles. Within the Solarmobil Verein Erlangen, there is a rather active "bicycle group" experimenting with all sorts of pedelecs, i.e. power assisted bicycles equipped with electric motors. The Solarmobil Verein Erlangen owns three solar powered charging stations for electric vehicles in Erlangen.

* APPROACH

Special electric power assisted three-wheeler bicycles ("trikes") named CABI had been developed by the company "KARAD". Manufacturing of 22 prototypes for this project was planned. These vehicles were foreseen for testing and evaluation in the city of Erlangen, by a rather large number of different users. The results and driving experiences and the vehicles were to be evaluated by experts from the Solarmobil Verein Erlangen. The results should have been the basis for improvements and modifications in the later volume production.

The vehicle "CABI" can best be described as a "Velo-mobile". The Cabi is a single seated light weight vehicle with three wheels; two rear wheels and one front wheel.

The main technical data are:

- single seat for one adult plus one or two children
- pedal and electric drive system with electronic control
- lead acid battery system 24 Volt, 30 Ah
- L x W x H: 2,60 m x 0,95 m x 1,47 m
- weight 65 kg (without driver), max. weight: 200 kg
- luggage room approx. 200 dm3
- motor(s) 2 x 270 Watt or one single motor of 600 Watt.

The main office for handling the vehicles was the office of the Solarmobil Verein Erlangen at Schillerstrasse 54 in Erlangen. The office is equipped with computer and Internet access and has an additional showroom for vehicles and a small workshop. The electric energy for all the office, workshop and for the charging of the electric vehicles is delivered from the solar power plant on the roof of the building. The power output was 3,3 kW up to mid-2001. An extension of 5,1 kW was installed, the peak power output is now 8,4 kW. The energy is fed into the grid and the 6 charging stations for electric vehicles are connected to the grid.

The performance of the vehicles had to be tested by many different drivers.

Monitoring of the performance was foreseen by the following systems:

1. Questionnaires in written form
2. Measuring the km travelled by each vehicle (on board km measurement)
3. Measuring the electric energy used for battery charging (on board kWh meters and Ah meters)

4. Technical evaluation of the vehicles in the workshop of the Solarmobil Verein Erlangen
5. Assessment and publishing of the results.

When it was clear that the CABI prototypes would not be delivered in time for evaluation in the **E-TOUR** project in Erlangen, a number of alternative measures were taken:

An Anthrotech three wheeler bike was modified with Heinzmann motor plus electronic control and NiCd batteries by the Solarmobil Verein Erlangen. The vehicle was given to the City of Erlangen for testing.

Anthrotech: The manufacturer of the Anthrotech three wheeler was approached with the plan to develop and manufacture vehicles similar to the CABI and suitable for the **E-TOUR** project in Erlangen.

Carbike, HALF: Similar activities and manufacturers of light electric vehicles were evaluated.

Flyke: A three wheeler bike was equipped with front wheel electric motor and tested in Erlangen.

EVT scooter: 25 EVT-Scooters were brought to Erlangen for display and assessment by the public.

"Microbility" and "Solarmove" Berlin: Monitoring their activities in the field of renting and selling electric two-wheelers in Berlin and in planning and installing electric charging station in large numbers (160 in the beginning) in Berlin. The "Solar Power Station for charging of electric vehicles" was extended to 8,4 kWp and 6 outlets.

* Results

The Erlangen project results are described in detail in the Final Report November 2002, Erlangen Project of the **E-TOUR,** obtainable from the applicable product management (see under 8 contact).

Due to the absence of the 22 CABIs, some alternative two- and three-wheelers were provided by the Solarmobil Verein Erlangen for testing and evaluation. The results of these promoting activities with light electric vehicles in the urban areas of Erlangen in short:

1°) Evaluation of the CABI

The prototype was far from perfect. The drive system consisting of motor and the pedal drive would have to be perfected for production. The weight of the vehicle was too high.

The lead acid batteries were too heavy for the light vehicle. The expected life span of the batteries was considered to be too low. It was however agreed, that the test of the prototypes would have to prove the concept. Alterations would quickly be possible by experimenting with available NiCd battery systems.
The manufacturer was not in a position to manufacture the CABI in required numbers and in time, not even the 22 prototypes for the Erlangen project.

2°) Anthrotech three wheeler electric bike tested in Erlangen

An Anthrotech three wheeler bike was modified with Heinzmann motor plus electronic control and NiCd batteries by the Solarmobil Verein Erlangen. The vehicle was given to Mr. Stammberger of the City of Erlangen for testing. The test person war for some time unable to ride his normal bike due to a broken leg. The acceptance of the electric assisted three wheeler was very high, all normal mobility in and around Erlangen was possible. Extending the range with a second set of batteries was reported to be very practical.

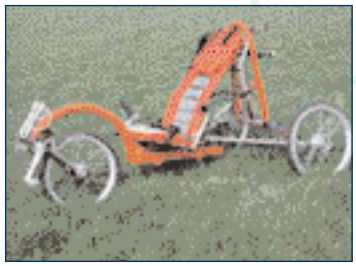
3°) New vehicle to be designed and produced by Anthrotech

At a number of meetings at the workshop of the Anthrotech company, an alternative vehicle was discussed. The technical ability of Anthrotech was recognized, however the time required for Anthrotech to develop such a new vehicle was regarded as prohibitive for the project. Anthrotech is very much interested in such a project and it is believed that they continue with the idea of constructing and building a similar vehicle in the future.

4°) Carbike, HALF

Both concepts, the well known Carbike and the HALF, are very interesting light electric vehicles for urban transport. The CARBIKE is still at a very early prototype stadium, but mass production is still anticipated. Negotiations are continuing…

The HALF was developed as a design-study at the Hochschule für Design und Kunst, Burg Giebichenstein, Halle under Prof. Dr. E. Scharnowski. It is pedal-driven with the assistance of two hub-wheel motors in the rear wheels. The four wheel vehicle has one drivers seat plus one additional seat. The mass incl. battery is 95 kg, the total weight is up to 175 kg including 36V 35Ah lead-acid batteries. The top speed is 21 km/h, the range is about 80 km when pedal-assisted. The vehicle has a light roof with 3 solar modules of 26 W each, but no further weather protection. Only about a dozen or so of the HALF vehicles were manufactured. With small scale workshop production ("by order") it is far too expensive. Manufacturing has stopped. Prices were in the range of 6.000 to 7.000 Euro each. There are prototypes as well for three- and four-seated versions.



Further information may be found in the Internet at www.burg-halle.de/~ntg/half.html

5°) Flyke

The Flyke, a three wheeler for ground transport of para-flyers, was fitted in Erlangen with front wheel motor and is currently tested. The weather protection covers are still under construction (November 2002). Further information about the Flyke may be found in the Internet at www.flieg.com/fresh.breeze

6°) EVT scooter

In June 2001, a member of the Solarmobil Verein Erlangen organized a special exhibition of 25 EVT-scooters at five different OBI hardware stores in the Nürnberg-Erlangen area. The scooters were displayed for about 4 weeks. In spite of not selling scooters at the exhibition (but later), the display and testing was seen as a great success in the field of publicity. Internet: Technical information about the scooter is found at www.evt-mobil.de and information about the local Erlangen service is found at www.elektromobil.net.

7°) "Microbility" and "Solarmove" Berlin

Microbility Berlin is offering different electric scooters both for sale and for rent. More details about the scooters and rental programs are found at www.microbility.com. The same people run the "solarmove" activities. They are planning to install up to 120 public charging stations in the city of Berlin, primarily for electric scooters, an in cooperation with the electricity supplier (BEWAG). The outlets are added to the mast of normal street lights. For details see in the internet at www.solarmove.de

8°) Solar Power for Electric Vehicles in Erlangen

The Solarmobil Verein Erlangen extended the solar power station at the Schillerstrasse 54 from 3,3 kW by 5,1 kW to a total of 8,4 kW peak power output. There are six outlets of 230V 16A each for charging the required number of electric vehicles at the workshop of the Solarmobil Verein Erlangen.

9°) Recommendations for further activities

In general, there could be great environmental impact, provided the light electric vehicles would substitute petrol or diesel driven vehicles, and provided the electric energy would be emission-free. In addition, such vehicles are usually very quite (no noise!) and they require less space both when driving and parking.

There are some very personal experiences learned in this project, and it is believed that there is a considerable market for such vehicles, if the following problems can be solved:

- The vehicle must be produced in quantity
- The vehicle should be of high quality and should function without major problems (which was, in part, the objective to determine by this project)
- The battery problems with respect to life-time and range must be solved
- The vehicle must have an outstanding design as some sort of “life-style” product
- The vehicle must be practical and easy to use
- The vehicle must have a price not more than 3.000 to 4.000 Euro
- The vehicle must be backed by strong marketing activities
- The vehicle must be backed by a competent manufacturer and by competent service partners

We learned due to project delays not to rely on the promises of potential manufacturers.

The problems of bringing a prototype into production were grossly under-estimated, both with respect to sub-suppliers and to starting volume production. This seems to be a typical problem with prototype vehicles. The lesson learned is that the time risk in getting the vehicles for a specific project is almost non-existent when vehicles are used which are already produced in volume.

The activities around electric assisted two- and three-wheelers for urban roads will continue in Erlangen. Results will be published in the magazine “Solarmobil Mitteilungen” and in the Internet at www.solarmobil.net.

3.6 Basel/Mendrisio

* City description, project design

The large-scale fleet test of lightweight electric vehicles (LEV) in Mendrisio started in 1995 and ended in mid 2001.

Mendrisio is a small town of 7.000 residents in the Italian speaking part of Switzerland (Ticino). It was selected by the Swiss Federal Office of Energy as a pilot city for the large scale fleet test in 1994 among 34 applying communes.

Six of the not selected communes followed a call for a partnership with smaller projects also supported by the Federal Office of Energy.

The three main objectives of the projects were as follows:

- Demonstration of the practical use of LEVs in everyday life (including four and three wheelers as well as two wheelers),
- Testing and evaluating of measures aimed at promoting LEVs,
- Integration of LEVs in environment-friendly mobility concepts.

The promotion of LEVs covered a wide range of more than 30 single measures including financial incentives (50 – 60 % of the purchase price), infrastructure, communication, education and technical support.

The second project, "Die bessere Mobilität " (better mobility), was launched in spring 2000 in Basel and included only two Swiss e-bikes. Its aim was 1) to make e-bikes visible on the roads of Basel offering a 50 % subsidy on the first 400 vehicles, 2) to promote the sale of energy saving vehicles, 3) to promote renewable energy (solar energy). In autumn 2000 all 400 vehicles were sold. In contrast to Mendrisio the vehicle offer was restricted to two Swiss products.

* Approach, objectives and aims

The political background of these programmes consists in energy saving and reduction of environmental impacts on urban traffic. It goes without saying that electric two wheelers can only contribute to these objectives if they substitute relevant numbers of cars respectively kilometers driven by cars.

Beside the exchange of experience with other projects a special focus of the Swiss participation in **E-TOUR** was put on the investigation of the mobility pattern of the drivers of electric two wheelers in order to get deeper insight into these effects.

The objective was to get a sample of 300 drivers who reported all their trips in a mobility diary during 4 days, once before the delivery of the vehicle, and then one year later. In addition they have registered the yearly kilometres driven by all motor vehicles in the household before and after the delivery. Additional telephone interviews to each state of survey gave more detailed information for the interpretation of the socio-economic variables influencing mobility patterns (changing of a job, persons with new drive licence in the household, etc.).

This investigation provides policy makers with important information on the benefits of a large scale introduction of electric two wheelers on urban roads (e. g. air quality, green house gases, noise, congestion, reduced demand on parking space, etc.). It will hopefully motivate them to furthermore support the market introduction of LEVs.

* Results

1°) General results

The most important lessons learnt form the pilot and demonstrations projects are:

- Information office "InfoVEL" Mendrisio:This official co-ordination, contact and information office gave a clear image of the project to the outside world.
- Suppliers: A successful market launch requires the full involvement of the various actors all along the chain of suppliers (manufacturers, importers, dealers).

- Dealers: A prerequisite for the successful promotion of innovative vehicles is full involvement of the dealers in the promotional strategy. Dealers must be able to make a profit from selling vehicles based on new technologies, in view of the risk factor that they must accept.

- Impact of promotional measures: Despite the high level of acceptance of LEVs throughout Switzerland promotional measures have not yet managed to significantly increase demand for these vehicles due to the supply deficiencies and the fact that prices remain high.

- Test drives: The possibility of testing an LEV over a period of several days allows potential buyers not only to learn about the vehicle's characteristics but also to acquire first experience of the travel range and battery handling.

- Awareness: These demonstration projects have succeeded in making the public and the political authorities more aware of LEVs and innovative vehicles in general as an everyday phenomenon. As a result of this the cantonal parliament of Ticino voted a credit of 4 million Euro for the VEL2 follow-up programme.

2°) Results of the mobility pattern study

90 % of the vehicles have been bought as additional vehicles in the household, only few replaced an existing one. Nevertheless it is possible that some existing vehicles in a household have been kept just to prove the reliability of the electric vehicle and will be replaced once the will need to be.

The reason for the purchase of electric two wheeler was often the need for an additional vehicle because the socio-economic variables changed due to e.g. new route to work, additional person in the household with driving licence, a new job, the move of house, etc.

Considering these facts, the study showed the following results:

- The analysis of the total mileage in a household shows that the introduction of an electric two wheeler leads to a reduction of the mileage of the other motor vehicles in the corresponding household. Due to the small sample at the moment theses figures are statistically not significant. Hopefully there will be more consistent results at the end of this investigation in spring 2003.

- The substitution of the mileage of conventional vehicles is higher in Mendrisio than in the German speaking parts of Switzerland. A possible reason is the total mileage of all vehicles (cars and motorbikes) in the households, which is much higher in Mendrisio (22.000 km) than in the latter (13.000 km). People in the German speaking part of Switzerland seem to make more use of other means of transport (e.g. public transport, bicycle), whereas the Italian speaking persons are more related to cars/motorbikes and can therefore be more influenced by innovative vehicles such as LEVs. Furthermore, scooters are more popular in Ticino, bikes more in the other parts of Switzerland.

- In the canton of Tessin (Ticino) the motorisation, i.e. the availability of a car in one household, is higher than in the other parts of Switzerland. Thus, the LEV is more often used instead of a conventional vehicle; whereas in the German speaking parts of Switzerland the LEV is more often used instead of other means of transport, e.g. public transport and conventional bicycles.

- According to this investigation the substitution of the mileage of conventional vehicles by e-scooters is much higher that by e-bikes. One possible reason for this fact is that e-bikes substitute also conventional bikes which are not included in the mileage of conventional vehicles.

- These observations are based on today's state of the art regarding vehicle technology and user application. For future potential assessment changes in these terms can contribute to relevant changes in the results.

* Recommendations and prospects for the future

In 2001, when the two projects in Mendrisio (incl. the partner communes) and Basel were terminated, new programmes followed in both areas:

	1995 - 2001	2001 - 2005	2005 - ...
Ticino (Mendrisio)	Large-scale fleet test of Lightweight electric vehicles	VEL2	VEL3
Other Switzerland	"Die bessere Mobilität" Basel; Mendrisio partnership	NewRide	

* VEL2 in canton Ticino

The VEL2 (VEL = veicolo efficiente leggero = lightweight efficient vehicle) project of canton Ticino is a direct follow-up to the large-scale fleet test. Its aims include improving public awareness of energy-efficient vehicles, reducing energy consumption and CO2 emissions. The fleet test follow-up project will itself give way to VEL3, which would go even further. VEL3 would require the introduction of a bonus-malus system as of 2005, although the legal basis for this has yet to be created.

All road vehicles in EU-classes M1 and N1as well as electric two wheelers, which are responsible for CO2 emissions of less than 120 g/km, can take advantage of vehicle subsidies in the context of VEL2. This corresponds to petrol consumption of 5,2 l/100 km, or diesel consumption of 4,6 l/100 km. All vehicles must also fulfil the Euro4 emission standards, which become mandatory as of 2005.

There is expected to be an annual total of 1.000 vehicle subsidies. The procedures will not be the same as those of the large-scale fleet test. Subsidies will be paid out as fixed amounts, with the size depending on the vehicle category, e.g. SFr 2.500 for electric scooters and SFr 1.000 for an e-bike.

This programme allows Mendrisio and the entire canton of Ticino to further develop an international reputation as centres of excellence for electric and other efficient vehicles.

* NewRide

Encouraged by the positive experiences with electric 2-wheelers in the partnership projects of Mendrisio the canton of Berne launched in the spring of 2001 the NewRide programme, supported by the Swiss Federal Office of Energy and other federal agencies.

At the beginning six communes participated the programme. In 2002 three big cities (Basel, Bern, Zurich) followed. The programme aims at accelerating the market introduction of electric two wheelers by creating networks consisting suppliers (manufacturers, importers, dealers), public authorities and users (companies, private individuals).

It focuses on two areas of measures:

- Communication: Organisation of exhibitions with ride and drive, media campaigns, information on website (www.newride.ch);
- Improving distribution network: Commitments with manufacturers/importers in order to define their contributions in this programme, education of dealers (electro-technical, marketing), introduction of a label "NewRide dealer".

Subsidies are not provided in the NewRide programme, except of some communes which have a legal base in the form of an energy saving fund.

3.7 Rome

* Introduction: city policy for clean transport

In the city of Rome about 600.000 thermal scooters and motorbikes are circulating. The use of two-wheelers is increasing continuously due to the traffic congestion as well as to the necessity of a lot of people to enter the Limited Traffic Zone, still opened to all two-wheeled vehicles without any restriction. Furthermore, the public transport is not sufficient to satisfy the demand as well as the climatic condition permit to use the two-wheeler almost the hole year through.

A high air-pollution of PM10 and NOX is the consequence mostly due to the two-stroke non-catalysed vehicles. The Italian Ministry of Environmental, in the decree of the March 1998, called "Sustainable Mobility in the Urban Areas", assigned to the Local Governments the competence to take out measures against the pollution. On local level, STA, the City of Rome's Mobility Agency, has been entrusted to enforce the decree to every activity concerning the sustainable mobility in the urban areas. Within the project for sustainable mobility STA activates different activities to encourage the use of two-wheeled electric vehicles, promoting the pass over from traditional thermal scooters to electric ones.

The administration of Rome has been committed in the last 8 years to manage transport reducing the emissions' impacts on air quality. Therefore the Municipality of Rome decided to participate on the **E-TOUR** project with the main aim to reduce significantly air-pollution and to improve the environmental impact of individual transport modes.

Since 1997 a strong support to testing and diffusion of electric vehicles has been given with the purchase of 40 buses. In the beginning of the **E-TOUR** project, the positive experience with electric busses for public transport had conducted the Rome administration to experiment also other electric vehicles.

Thanks to State funds, the Municipality assigned to an Italian manufacturer a contract to deliver, by the end of 1999, 400 electric scooters that could be rented by users (Roman citizens and visitors) in two parking places in the city centre. The customers leave the car in the parking place and continue his trip by electric scooter. During the year 2000 of these electric scooters 100 have been entrusted to the Agency that used these vehicles for their volunteer staff in the City Centre during the Jubilee.

In two parking places nearby the city centre (Villa Borghese and Ostiense - Piazzale dei Partigiani), two recharging stations have been set up, with two types of recharging points: one for slow recharging and the other for fast (partial) recharging.

A monitoring system has been defined to collect data in the years 2000 and 2001 about the use of the electric scooters, including: number of customers, number of kilometres travelled, level of customers' satisfaction, customers profile (age, profession, gender, etc.), reasons for choosing the electric scooter, consumption of electric power, advantages and disadvantages, suggestions for improvements.

The introduction of electric scooters is part of the policy line adopted by the Municipality of Rome to promote alternative vehicles and mobility patterns to the private car and reduces negative externalities of transport in the city centre.

The Municipality of Rome negotiated with manufacturers a set of incentives to promote and disseminate the use of electric scooters amongst users. 40 billion of ITL (approx. 20 million Euro) have been made available to contribute to the large-scale introduction of electric vehicles in Rome.

In addition, to support such a rapid increase of electric vehicles, a network of recharging points, located in public and private areas has been planed and partly realised.

* Approach and E-TOUR impact

In Rome, due to mostly individual traffic, a high air-pollution and traffic congestion is registered. In the city centre, the most evident means of transport is the scooter or the motorbike. The weather conditions, the traffic congestion as well as their velocity within the narrow streets of the inner city are the most important arguments for the use of the thermal two-wheeler. On the one hand, the two wheeler helps to reduce the traffic congestion, on the other the emission of NOX and PM10 of a non-catalysed scooter are almost as high as those of a diesel powered car.

For these reasons the Municipality of Rome decided to promote the use of electric two-wheelers in the city. According to the act of the Italian Parliament n.65 of 23rd December 1996, called "Jubilee 2000", the Municipality of Rome received funds to create a renting service of electric scooters closed to the centre of the town. The service has been operating from December 1999 in the exchange parking of Villa Borghese and, from the start of January 2000, in the exchange parking of Piazzale dei Partigiani - Ostiense.

The plan was set up very rapidly and it consisted of:

- purchase of 400 electric scooters and 400 crash helmets and 70 windshields;
- identify the suitable areas in two exchange car parks of the Municipality;
- planning and realisation of charging stations in the above parking for all the 400 e-scooters fleet;
- purchase of in/out gates connected to guarded cash desks;
- stipulation of insurance policies;

Pending the supply on market of the socket and the four-pin plug standardised in Italy, the scooters and the charging points have been equipped with sockets and plugs modified to avoid danger also for the users when the scooter is charging.

On the whole, the two charging stations next to park&ride lots have 400 charging points (340 for traditional charge and 60 for a quick charge).

The Municipality of Rome, in co-operation with "Italia Nostra" and "WWF Italy", set up an information point in the Villa Borghese parking, delivering information about how to obtain funds from the Municipality for purchasing electric two-wheelers.

To guarantee evaluation data each user fills up a questionnaire and has to answer to 15 questions regarding the sustainable mobility and the electric vehicles use. All the data collected during the years 2000 and 2001 gave a detailed overview of how Rome citizens react to this new mean of transport.

Besides, the City of Rome intents to realise a network of on-street charging stations for electric vehicles on public The engagement is to guarantee a regulate recharging service to the user of electric two and four-wheelers. The public recharging network will serve the Limited Traffic Zone, the park & ride lots as well as some zones of the inner city with elevated traffic density.

The localisation-plan of 12 recharging stations has been realised. All of them are situated in zones of elevated traffic density. For every recharging station have been carried out inspections to verify the condition and the availability of all areas. According to the programmed parameters, for each station a detailed project contains the number and the position of recharging columns and furthermore the amount of reserved parking spaces for electric vehicles. An electricity meter and an user-interface will provide every recharging station with a smart card device for payments. Each station has been dimensioned to be used not only by electric scooters but also by electric cars as long as they don't exceed the consumption of 3 kW. The safety measures will be conform to the legal standards.

To accelerate the time of executive realisation, the 16 project sites have been divided into three groups ("lotto"). The first group of projects has been approved during the authorisation conference in September 2001.

On September 22nd, 2002 the first four recharging stations have been realised and opened to the public during the "Car Free Day" with the presence of the Mayor and of the Councillors for the Environment and Mobility of the City of Rome. The 7 locations of the 2nd group are in authorisation-phase, having completed the design phase.

Economic incentives for purchasing of electric vehicles were settled. The Incentives for purchasing the e-vehicles were assembled in order to permit the reduction of the purchase costs by approximately 50% for new electric scooters.

The successful demonstration of electric scooters should support the validity of the product and therefore boost sales possibilities for electric scooter producers in Rome and elsewhere. Based upon the results of the users needs analysis and the progress of the exploitation study dissemination activities of **E-TOUR** in Rome were planned. Promotion campaigns for electric scooters as a new, clean and convenient alternative to traditional scooters were foreseen. The advertising campaign targeting individuals is crucial since the use of electric scooters should be further expanded as promoted by the Municipality with support of the Ministry of Environment.

The results of **E-TOUR** in Rome are giving a complete overview about how to introduce electric two-wheelers in a large urban context as well as information about the technical demands on the vehicles that ought to be diffused to producers, users and retailers of electric vehicles. Through the **E-TOUR** project and the participating networks (e.g. CITELEC) the results achieved in Rome by the introduction of the largest fleet of electric scooters in Europe will be disseminated to other cities facing similar pollution and congestion problems.

* Results

The Incentives for purchasing the e-vehicles discussed before permitted the obtaining of the main goal is to encourage the use of alternatives to polluting methods of transport for systematic and leisure travel. Until now about 1000 between e-bikes and e-scooters have been sold.

The private recharging network has been realised due to the subsidies by the Rome Municipality available to citizens, multiple dwelling communities, companies, institutions, schools and ministries, etc. interested in realising a recharging point. It has been activated an information telephone number for al of them that have questions about the technical characteristics and the financial aspects for the implementation of recharging points.

On the other hand, since the beginning of the year 2002 the Municipality had to face different problems regarding the scooter fleet. The financial subsidies of the Jubilee partly destined to the promotion of new ecological means of transport have been finished. The scooter performances do not satisfy the user-needs. The maximum speed of 40 km/h is too slow, concerning that the driving behaviour in Rome conducts to fast reactions with high acceleration needs of the vehicles. The maximum range of 35 to 40 km is much too less for the use of the electric vehicle in place of a traditional thermal scooter. Rome is one of the largest cities in Europe, with inevitable long distances between different zones of the city. Some parts of the city are also hilly, reducing the driving performance considerably.

Besides, demand of renting operations in the two park & ride lots close to the city-centre, excluding the "car-free Sundays" where the scooters could be taken free of charge, during 2000-2001 the mean value of the regular fares was anyway low, even it was satisfying the request of mostly professional users. These data invited all the responsible people to a serious analysis of the renting service and to the associated costs, necessary for a so large fleet. The minimum cost for maintaining a renting service in the two parking areas was about 125.000 Euro per year, absolutely not covered by renting revenues. At the beginning of the year 2002 the situation was unchanged and the Rome Municipality and STA decided to stop the renting service and to set up alternative schemes.

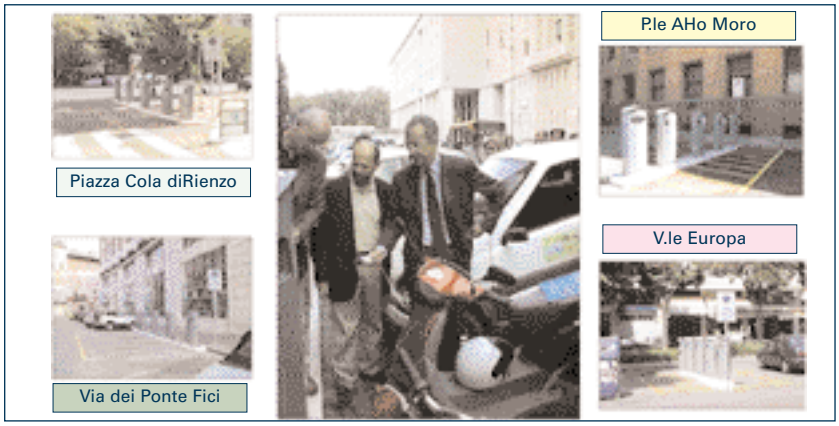
There upon the City of Rome prepared a Municipality Decree to be authorised by the City Council, introducing a new exploitation program. Different actions are diversified by the program to promote the use of electric scooters favouring sustainable mobility and reducing environmental pollution as well as to disseminate the existence of the electric scooter as a real alternative for individual mobility in urban context. By this measure, the Rome Municipality entrust the STA to carry out all activities linked to the management of the fleet of 398 electric scooters in property of the City of Rome to different interested third parts to promote a kind of "educational use". The scooters are currently offered by this municipality decree to institutions and companies willing to promote the use of electric zero-polluting vehicles. The typologies of possible contracts are different and covers all the possible needs, including some private renting activities (about 60 scooters to private renting services by call for tender in 2003).

As a consequence, the program will permit the entrustment of about 100 e-scooter to Municipality institutions (district departments, municipality offices, municipality police etc.) , to ensure their continuous use and the dissemination towards the users; the entrustment to institutions of public utility as Universities, Caritas, public health department, voluntary works; to private renting services by call for tender, installation of recharging stations for electric vehicles next to the parking-places of the institutions and a dissemination campaign in form of idea contests for students of university and secondary school, promoting the use of electric vehicles, giving as first prices electric two-wheelers.

* Recommendations and future plans

Rome confirmed at the beginning of 2002 the interest towards the use of e-scooters. On the other hand, the restrictions of the car access in the city centre, electronically enforced through the Access Control System for the Limited Traffic Zone (LTZ) in Rome, opened in October last year, obtained a reduction in car flows but an increase in 2-wheels use. As already recognised by the institutions, the thermal scooter are emitting pollutants like a car, especially in PM10 that are really an emergency in Rome.

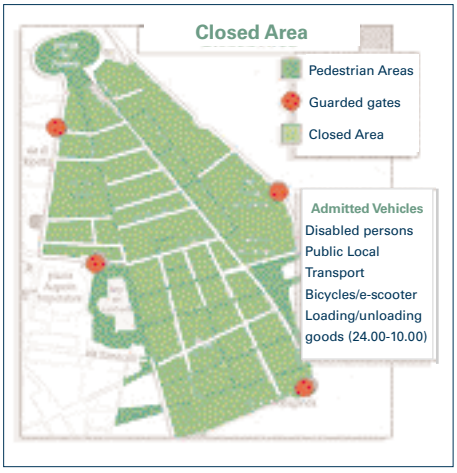
The aim of discouraging the use of 2-wheels thermal scooter is a principal objective of the City Administration: at the same time, the need of social acceptance of the Access Control System has to be maintained. For these reasons, the need of promoting e-scooter is becoming more and more important for the city. The future began thus very early in 2002 in Rome with the realisation of the first 4 recharging stations, permitting the contemporary use of 48 recharging points across the city. As previously said, their opening ceremony (see photo) was carried during the "car free day", last September 22nd by the major and the councillors for mobility and environment with a large press coverage.



The stations are completed with a "master station" where a specific smart card can be inserted, enabling the recharging period, settled in two hours maximum. For promotional reasons, the recharging period is free of charge for the users and the smart card is available in STA free of charge for e-scooters users.

A new incentive plan for the purchase was discussed by the City Council and it was made effective few days ago, ensuring financing funds to promote always more the e-scooter as alternative vehicle to access the city centre.

According to the preliminary results of the project, the Rome Municipality is pushing the program to promote the use of electric scooters favouring sustainable mobility and reducing environmental pollution diversifies different actions. The main goal of the program is the use of the electric scooter in the city centre to promote the attention on electric vehicles as a real alternative for traditional thermal scooters. As part of this strategy, the completion of the public recharging stations as well as the continuation of the incentives programs will be carried out.



The fundamental step to force the introduction of e-scooters could be the closure of specific areas in the city centre for the non-catalysed thermal scooters. Simulations were already carried out in the yearly air quality report for the city of Rome. The results in terms of reduced pollutants are impressive, but the need for obtaining social acceptance imposes to go towards incentives in order to promote e-scooter more than to limit the access to the others. Anyway, in the next years the Administration expects to put some multi-step limitations, according to a specific plan to be designed in the near future.

During the period of December 8th, 2002 – January 7th, 2003, a portion of the LTZ was closed to thermal vehicles and it remained opened to the e-scooters. The experiment was successful and this enforcement is presently running.

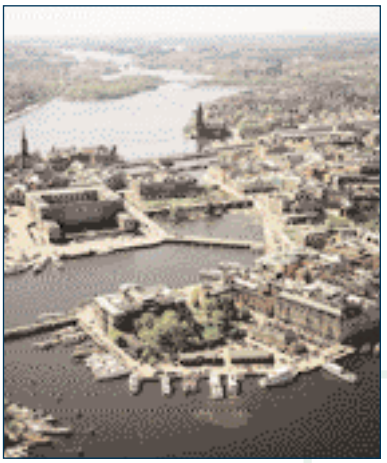
The general prevailing conditions are thus changing. The institution of privileged conditions for the users of electric scooters like admittance to Limited Traffic Zone, reserved routes and reserved parking is began to be realised. Therefore there's now a real advantage to use an electric two-wheeler in comparison with the traditional thermal scooter, permitting their diffusion in the users attracted towards restricted zones.

3.8 STOCKHOLM

* INTRODUCTION

Electric scooters and bicycles have proven usable and popular in the three-year test within **E-TOUR** in Stockholm. The interest from the public is high. Obstacles are, however, the high price and the sometimes cold and snowy Swedish winters, limiting the use to about eight months a year. Stockholm will continue to promote electric two-wheelers to increase the number.

The city of Stockholm with a total of 1.8 million inhabitants, 760 000 in the immediate surroundings, is the economic heart of Sweden. The inner city of Stockholm covers an area of approximately 5km x 7km, where 280,000 people live and 323,000 people work. The constantly growing number of vehicles, in the city centre of Stockholm, causes major problems with regard to noise and air pollution.



The city of Stockholm has an extensive traffic policy to improve the environmental and living quality of the area. The introduction of zero and low emission vehicles (electric, biogas and ethanol) is an important part of this traffic policy. Today about 600 clean vehicles operate in the city fleet and 250 ethanol buses are in use in the public transport system. Based on the previous successful promotion activities of clean vehicles the City of Stockholm is introducing electric scooters and bicycles.

A scooter is not a very common vehicle in the Stockholm traffic. Bicycles are fairly popular during the warmer seasons. The city of Stockholm welcomes electric scooters and bicycles with zero emissions and low noise. In most cars in the Stockholm traffic you see only one person, usually travelling with limited or no luggage. An electric two-wheeler would here be very suitable, maybe with exception for cold winder days. A two-wheeler takes less space, is easy to park and pass by any congestion. Through the **E-TOUR** project Stockholm has got the opportunity to demonstrate a few electric two-wheelers. The city has also received information from, and got inspired by, other European cities where scooters are more common.

* APPROACH : 37 ELECTRIC TWO-WHEELERS TESTED

As part of the **E-TOUR** project the city of Stockholm decided to introduce 20 electric Scooters and five electric bicycles in the city fleet. The two-wheelers where to be used by city employees on duty and should replace regular petrol cars.

The first scooters, Peugeot Scootelec, started to operate in early spring 2000 and all were installed by the end of August. When informing the city administrations about the possibility to use an electric two-wheeler the interest was lager than expected. 12 additional scooters was therefore purchased. In total 32 electric scooters are in operation in Stockholm.

During 2000 and 2001 one scooter was available within a test fleet for the business sector. Thus private companies could test the scooter for a shorter period of time (1-2 weeks). The hope was that the companies in this way would be inspired to buy and operate a scooter.

The 5 electric bicycles were all ordered in the beginning of June 2000 after a market research of electric bicycles in Sweden. The first bicycle, Merida Powercycle 550 with NiMH batteries, was delivered immediately after ordering and the remaining four were promised by August but did unfortunately not arrive until November. In the meantime the manufacturer lent a Merida with lead acid batteries, which was in operation from August to October (shorter driving range, heavier and more environmentally harmful battery than NiMH battery).

The Stockholm scooter fleet consists of 20 electric scooter, Peugeot Scootelec. At the time of the start of the **E-TOUR** project this was the only available electric scooter on the Swedish market. The 20 scooters were purchased within the **E-TOUR** project with EU funding.

These 20 scooters were included in the proposal and contract. Because of a large interest, an additional 12 scooters were bought. Stockholm has evaluated all 32 scooters and included the results from all 32 in the **E-TOUR** project.

The five electric bicycles are Merida Powercycle 550. At the time of the start of the **E-TOUR** *project there were three different electric bicycles available on the Swedish market (Piaggio Albatros, Cobra e-Citybike and Merida Powercycle 550). It was important to buy bicycles, sold in Sweden to be sure of service and maintenance. All three types were tested during a few days in May 2000. Based on that short test, the Stockholm* **E-TOUR** *team decided to purchase the Merida Powercycle 550 with NiMH batteries.*

* Results : Electric two-wheelers are easy and fun to ride

The general experience from the scooter drivers is that the scooter is easy and fun to drive. It is very easy to find a place to park (compared with a car) and you easy drive past any traffic congestion. Many drivers also appreciate that you do not need to drive to a petrol station to fuel the scooter. The charging is done over night while parking and requires no extra effort from the driver. The only negative aspect is that pedestrians and bicyclists do not hear the scooter and sometimes get very surprised by its appearance.

Some technical problems have occurred with the electric scooters. It is hard to lock the scooter and there have been some difficulties with the start key. In some cases, parts have been loosening during the ride and brakes have been squeaking. There have been problems white the black-box which controls the electric engine. A few scooters have been stolen or subjected for attempted theft, without success. The damages were repaired, and paid by insurance.

As the MFO repair shop closed at the end of 2001, the service of the Peugeot Scootelec, from January 2002, is managed by the Swedish retailer, a company called Combi Motor. Despite a lot of effort to smoothen the change of service supplier, problems did occur. Training of personal and ordering of special tools necessary for repairs was delayed. It took over 3 months before Combi Motor could function well as a service provider for the scooters.

In total the 32 scooters run 113 262 km altogether to the end of year 2002. This is an average of 3 540 km/scooter.

The general experience from the scooter drivers is that the scooter is easy and fun to drive. It is easy to park and pass by any congestion.

The bicycles have operated well. One bicycle drove 600 km during 2000, when only one bike was in operation. In 2001 and 2002 the five bikes drove 300 km in average/year. In total the five bicycles have driven 3 600 km. The only problem during year 2000 was a strange noise appearing while pedalling. This was immediately dealt with under warranty.

Because of snowy and cold winters all the bicycles have been stored during that season.

The general experience gained from the 5 bicycles in operation, is that the electric bicycles improves biking very much. Cycling is easier and demands less human power, so one does not get "overheated", wet and/or tired. It's quite easy to cycle uphill or against strong winds.

It is a very convenient and easy way to get around in a city. The bicycles attract a lot of interest from other cyclists, car drivers and pedestrians, even from the youth.

* Recommendations and future plans

Stockholm continues the work with electric two-wheelers

Stockholm plans to continue to offer economic contributions for electric two-wheelers in the city fleet, in order to increase the number of these kinds of vehicles. The city hope that the positive experiences from **E-TOUR** will encourage others to try the two-wheelers.

Stockholm is currently starting a big information campaign, to inform private companies in Stockholm about the good possibilities to operate zero and low emission vehicles. In this work the **E-TOUR** experience will be transferred to the business sector with the hope to inspire them to buy and operate these vehicles.

According to the results the two-wheelers have all functioned well and are much appreciated by the drivers. They have been in operation during 8 months each year and stored for the winters. There have been less noise and emissions although 37 two-wheelers are not enough to make an impact on the traffic situation in Stockholm.

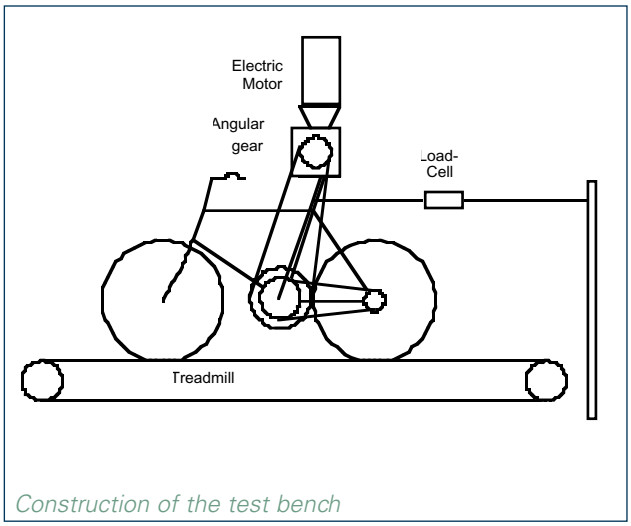
With the positive experiences of **E-TOUR**, Stockholm will continue its work and try to introduce more electric two-wheelers. The only real obstacles are that the two-wheelers are not that attractive to use during a Swedish winter and that the purchase price is considered too high. At the start of the **E-TOUR** project, an electric scooter had almost a doubled price compared with a petrol scooter. Today the purchase price is about 10 percent higher, which is a great improvement.

4.1 TECHNOLOGIES USED

* ELECTRIC BICYCLES

Several types of electric bicycles have been deployed in the framework of the **E-TOUR** project; this offer was typical of the products now on the European market.

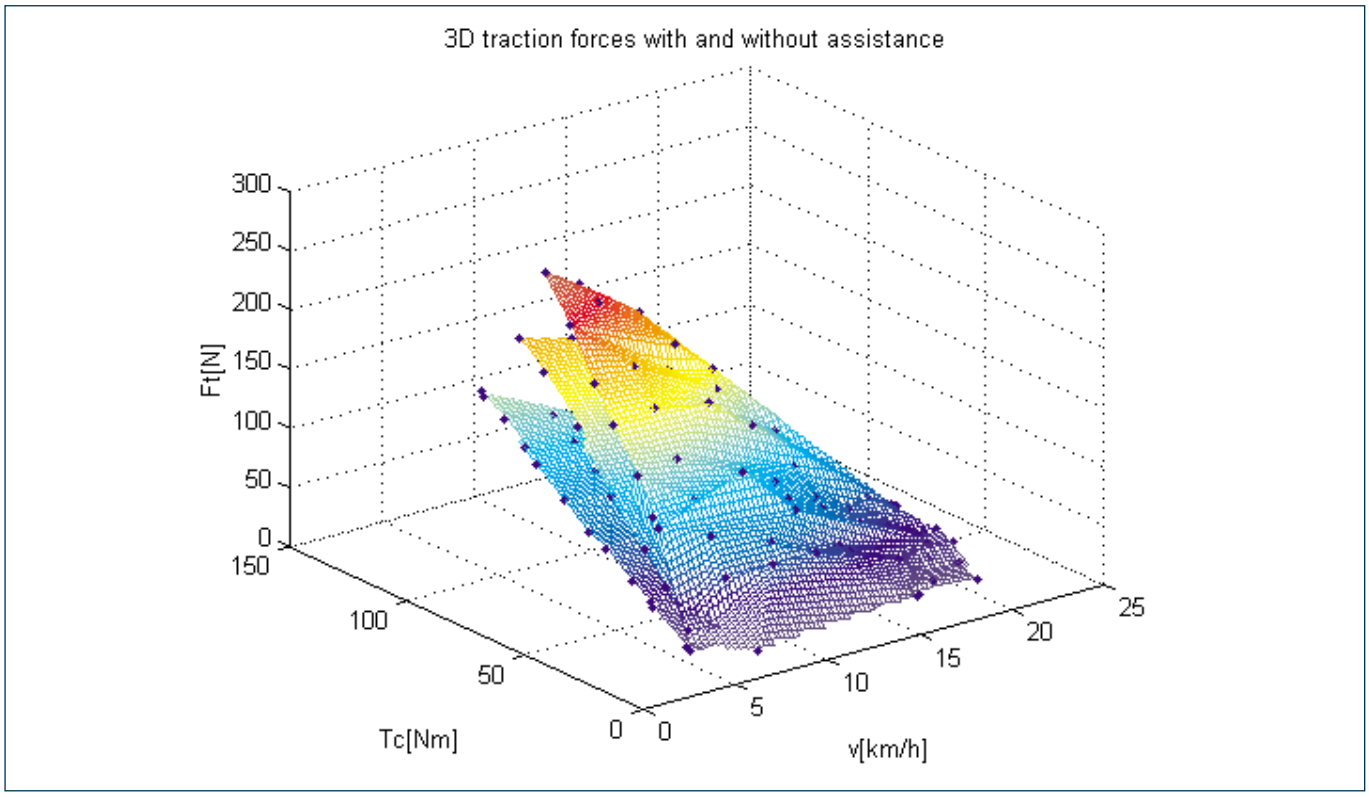
To be able to compare these bicycles to one another and to quantify the performances of electrical bicycles in a controllable environment, a dedicated test bench has been developed, based on a tread-mill principle, where the cyclist is replaced by an electric motor that drives the pedals by means of an angular gearbox and a pulley. The traction force of the bicycle is measured with a load cell. A schematic view of the test bench can be seen on the right



Construction of the test bench

Two types of electric bicycle have to be discerned, whether the motor is located at the crankshaft or at the rear wheel hub. There are also some electric bicycles with the motor in the front wheel hub (not used in **E-TOUR**).

The influence of the assistance is shown very clearly in the figure below, which gives a measurement of the output of the traction force in function of pedal torque and speed, in different operation modes: from bottom to top, without assistance, with “eco” assistance and with full assistance. It is clear that in the latter mode, the contribution of the electric motor to the total traction force is about equal to the contribution of the pedal power.



Output plot of EPAC (Yamaha PAS) in non-assisted, eco-assisted and assisted mode

The measurements on the test bench confirm and quantify the driving comfort experienced on the electric bicycles. The mechanical efficiency of the tested EPACs, measured with assistance switched off, is significantly lower, however, than that of a normal bicycle.

This aspect, combined with the heavier weight, makes the EPACs hard to drive when the assistance drops down. The electric assistance factor is constant over a small speed area, diminishes slightly for higher speeds and drops down at a rotational speed of typically about 25 km/h for the bicycles limited at that speed. This speed limitation is a result from regulatory issues and not from technical requirements, as will be discussed in chapter 4.2.

Electric scooters

The electric scooters deployed in **E-TOUR** are designed to displace motor scooters with 50cc engines, having the same performances such as a 45 km/h legal speed limit.

Performances may vary however both on the level of power (with as main implication that some scooters, like the Peugeot Scootelec, are able to carry two persons while other types are not, which may hamper their deployment in markets where two-person use of a scooter is common), and of range, which is dependent on topography and driving style.

The latter presents the main drawback of electric scooters on today's market, with actual obtainable ranges nearly always shorter than manufacturers' values, the latter being measured in laboratory conditions on a test cycle.

The development of the electric scooter is still going on, with research being performed both on motors and batteries. The adoption of wheel hub motors allows to simplify design and to eliminate mechanical transmissions. An electric scooter with wheel hub motor is under development in the framework of the EU-supported Praze project.

Batteries used

The electric two-wheelers used in the **E-TOUR** project used different kind of batteries.

- Valve-regulated lead-acid types were used on one type of bicycles. Their main disadvantages are a limited energy density and a low service life.
- Alkaline batteries are the most widely used, with nickel-metal-hydride types having slightly better performances and displacing the earlier nickel-cadmium types. All bicycles use maintenance-free, valve-regulated batteries, whereas the nickel-cadmium batteries used on electric scooters are of the flooded type and need regular topping up. The future availability of nickel-cadmium batteries may be limited due to environmental regulations such as the European "end-of-life" directive for motor vehicles; it has to be stated however that traction batteries, which can be fully recycled, present a particularly environmentally friendly application of cadmium. One type of scooter also used nickel-zinc batteries.
- For the next generation of electric two-wheelers, new battery types with higher performances are being considered such as advanced nickel-zinc or lithium batteries.

4.2 Market barriers

1°) Market barriers for e-scooter

Over ten million scooters are sold every year in the world, close to 1.5 million units in Europe alone. The development, manufacturing, commercialising and distributing of environmentally friendly, technologically advanced urban passenger and parcel-delivery vehicles, targeting the light-electric vehicle market with two-wheeled electric vehicle ("TWEV") and light-electric vehicle ("LEV") have to compete in terms of performance, price, reliability and maintenance costs, with any existing gas version to permit the existence and the increase of the market share of the e-scooter, presently a $15 billion market. Technology, business concept and management experience to face are needed for a very profitable business able to attract investors in this field.

Even if internal combustion engines are inefficient, some barriers obstruct a large-scale introduction of the e-scooter. In order to understand them, the first thing is the identification of consumer groups (both individuals and organisations) which are potential buyers of electric scooters.

The e-scooters have a range of up to 45 km travel per single charge, which make them fit perfectly for inner-city use by the urban commuter, since many city centres are now off-limits to scooters with internal combustion engines. The problems are arising when one needs to increase this range due to work or leisure reasons. The need of recharging the e-scooter is tremendously more heavy than to have gasoline pump to refill a thermal scooter.

The table below tries to synthesise the positive and negative issues between thermal scooter and TWEV.

Electric Scooter Powered by Ni-Zn		Conventional Gas Scooter	
Pros	Cons	Pros	Cons
• Silent • Zero emissions • Free access to traffic restricted areas • Low maintenance and service costs • Low energy cost • No oil spillage • Availability of subsidies and incentives	• Recharging at home needs plug availability • Recharging time at home is approximately 2 hours • At this time, scarcity of public recharging stations	• 10-15% less expensive (initial cost, excluding subsidies) • Infinite range because of availability of gas distributors	• Noisy • High pollution level • Limited access to down town areas (limitations will expand) • High maintenance and repair costs • High fuel cost • Oil spillage

The need for a recharging time of two hours is a minimum requirement and the scarcity of public recharging stations is another negative issue. Fast charging (from an external D.C. source) could be an option, but scooters now on the market are not equipped for that.

Next to that, the limited non-modifiable speed is a low appealing factor for younger and less young people. However, the same argument applies for thermal mopeds which are limited to 40/45 km/h; otherwise they have to be considered as motorcycles.

Finally, the need for more restricted areas / clean zones where only the TWEV are permitted could become a market factor able to change peoples' attitude, particularly considering the use of 2-wheelers. Operated stores in suitable locations should include fast recharging stations and rental to the public. A leading obstacle limiting market penetration is the lack of places to go, see, and test-ride TWEV products. Bicycle and motor scooter rental organisations are excellent points of distribution for the company's products.

2°) Market barriers for e-bikes

The general experience gained from the e-bicycle in operation is that it improves biking considerably. Cycling is easier and demands less human power, so one will not get "overheated", wet and/or tired and it is quite easy to cycle uphill or against strong winds. It is a very convenient and easy way to get around in a city. In some sites, the e-bikes attract a lot of interest from other cyclists, car drivers and pedestrians, even from the youth. However, it is also clear that some of the e-bikes are mainly targeted to a group of people with reduced biking capacity. In those cases, youth and healthy middle-aged people are not strictly the target group, which most likely explains part of the negative comments given below.
Negative comments emerging in some sites are:

- The power assistance is being experienced as too weak in a number of cases and for some types of bicycles, particularly the maximum speed in power-assisted mode is disappointing, especially for the younger and sportive individuals; confirming so the above mentioned statement about the target group.

- The performance regarding energy content of some batteries, and thus vehicle range, can also be less than announced by the manufacturers data, and it seems that some batteries are deteriorating faster then expected. In those cases, actions for better batteries are clearly a must.

These observations are not valid for all electric bicycles. In that respect a very important result of the **E-TOUR** project is the right determination of users (target groups) and matching (technical) specifications for a "desirable" electric bicycle, as well as the determination of the list of materials matching these criteria.

Other market barriers for e-bikes come from legislative issues. Currently every European member has a legislation of its own. As shown in the table below, not all member states give to the EPAC (Electric Power Assisted Cycle) the legal status of a bicycle. In some cases, they are submitted to a speed limit, in others to a motor output limit. This can cause problems for the manufacturers; it's not easy to design an electric bicycle with an optimal effect for the user and which is recognised by every EU-member. The consequence is that most commercially exploited bicycles in Europe have a maximum speed of 25 km/h and a maximum power of 250 W. The table shows the current European legislation on EPAC's.

Country	Legal Status	Type approval	Speed limit	Motor output limit	Insurance	Helmet	Age limit
Austria	Bicycle	no	25 km/h	n.a.	no	no	no
Belgium	Bicycle	no	no	300 W	no	no	no
Denmark	Bicycle	no	25 km/h	250 W	no	no	no
Finland	Bicycle	no	25 km/h	250 W	no	no	no
France	Bicycle	no	25 km/h	500 W	no	no	no
Germany	Bicycle	no (2)	24 km/h	250 W	no	no	no
Holland	Bicycle (1)	no	25 km/h	250 W	yes (3)	no	no
Italy	Bicycle (5)	no	25 km/h	250 W	no	no	no
Luxembourg	Bicycle	no	no	no	no	no	no
Spain	Bicycle	no	25 km/h	500 W	no	no	no
Sweden	Moped	yes	30 km/h	no	yes	yes	15
Switzerland	Moped	yes	no	500 W	yes	no	14
UK	Bicycle	no (2)	15 mph	200 W	no	no	14

(1) Based on a gentlemen's agreement between the industry and the national government and only for as long as the European Commission does not rule otherwise
(2) Germany : vehicles sould comply with the DIN-standard for bicycles
UK : homologation according to Britisch standard for bicycles
(3) moped insurance
(4) Without pedal assistance : 20 km/h
(5) for the moment still "atypical vehicle", e-bicycles will be regulated by a Ministerial Decree

European legislation on the EPAC's

The European Commission made an agreement to exclude EPAC's up to 250 W and 25 km/h from type approval; this proposition was submitted in 1999 into the Council of Europe and the European Parliament. The final approbation has not yet been given. European type approval went into force on June 17, 1999. From that date, homologation of electric bicycles would be required; in practice however, this is not possible (no relevant standards or regulations are in existence) and does not happen. There have been some adjustments to the formulation of the exception. The current proposal states a maximum continuous rated power of 250 W.

The European Parliament and the Council have released the EU-Directive 2002/24/EC concerning the Type approval for two and three wheeled vehicles on March 18, 2002.

In Article1 (h) - cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0,25 kW, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h, or sooner, if the cyclist stops pedalling - are excluded from type approval.

One should note however that the directive text specifies this power as a "continuous rated power", and not as a "peak power". It could thus be acceptable to have a higher peak power level during limited time (e.g. for acceleration). Any definition of "rated power" of an electric motor becomes quite "hollow" , if no reference is made to standards describing how this rating is to be defined and measured.

EPACs that exceed the technical specifications must have a type approval and are classified as "mopeds", and must consequently abide by all additional laws, i.e. motorcycle helmet, adequate brakes, mirrors etc. The EU Directive 2002/24/EC will come into effect on May 9, 2003 and will replace the current Directive 92/61/EEC. Until May 9, 2003 the current national regulations concerning the status of EPACs will remain unchanged. After May 9, 2003, the EU Member States have the choice of either keeping their current regulations for another 6 months or changing over to the EU-directive. By November 9, 2003 all Members of the EU are required to integrate this Directive into their national legislation and abolish their previous regulations.

In its current form, the directive 2002/24 may be a hamper for the deployment on the European market of EPACs exceeding an assisted speed of 25 km/h. This will confirm the EPAC's image to be a "bicycle for elderly and less mobile people", particularly in countries where a strong bicycle culture exists. The relevance to safety of the 25 km/h speed limitation can be questioned, since trained cyclists on conventional bicycles are routinely able to exceed this speed.

4.3 ENERGY/ENVIRONMENTAL IMPACT

The energy and environmental benefit of introducing electric two-wheelers is clear. Both electric scooters and electric bicycles can contribute to the reduction of primary energy consumption and emissions. The energy consumption of these vehicles has to be compared with the vehicles they displace, which can either be cars or petrol scooters. The fear that electric bicycles will mainly be displacing normal bicycles is incorrect, as can be concluded from the experiences in Rotterdam.

The comparison of energy consumption, the resultant CO_2 and pollutant emissions have to be calculated with the emissions from electricity production; the table gives the energy consumption and emission values for the considered vehicles, compared with conventional vehicles.

One can conclude immediately that the conventional petrol scooter (with 50cc engine) is a vehicle, which has a very high energy consumption for its size of engine and consequently high emissions; even the advanced types corresponding to today's technology pollute more than a conventional car. The energy consumption of an e-scooter is typically 80 Wh/km, this means that the energy for users will also be considerably lower. At only about 10 Wh/km, the energy consumption of an e-bike can be considered as negligible.

	Consumption per 100 Km	Energy cost (E/Km)	CO_2 g/Km	CO g/Km	HC g/Km	NOx g/Km
Conventional 50cc scooter (2-stroke)	3,6 l/100Km	0,039	84,2	2,2	2,3	0,05
Advenced 50cc scooter (direct injection)	2,0 l/100Km	0,022	48,8	0,8	0,8	0,2
Small city car (petrol)	6,2 l/100 Km	0,067	145	0,38	0,12	0,12
Electric scooter	8kWh	0,0096	23,2	-	0,004	0,04
Electric bicycle	1kWh	0,0012	2,9	-	0,0005	0,005

Clearly there will be an immediate positive impact in terms of lowering emissions in city centres, since the electric two-wheelers have zero local emissions.

For the electric vehicles, it is of course necessary to take into account indirect emissions. The electricity generation can itself produce emissions, depending on the mix of gas & coal burning, hydro-electric, nuclear and other forms of power stations in the particular country. The table shows emission values for the various vehicles taking into account an average electricity production mix (Belgium 2001).

It is clear that the introduction of electric two-wheelers has a dramatic potential to reduce emissions, this becomes even more clear when one considers electric energy delivered by "green" current (as is the case in the municipality of Rotterdam), which is not dependent on fossil fuels and which renders the indirect CO_2 and pollutant emissions to zero.

Another environmental aspect where electric two-wheelers bring substantial benefits is noise.

Small combustion engines as used in conventional scooters are notorious noisemakers, as a visit to any South European city centre, where two-wheel motorised vehicles are buzzing around like annoying insects, will clearly demonstrate.

The negative impact of two-wheeler noise is particularly high during the night, when background noise is much lower. The translation of this noise burden to external costs, which gives a quantification of the societal impact of the noise, gives dramatic results, as can be seen in the following table:

	External cost of noise (E/100 Km), day	**External cost of noise (E/100 Km), night**
Motorcycle	2,40	7,40
Petrol car	0,30	0,80

Marginal costs of urban transport in Berlin, recent European studies on transport externalities, R. Friedrich, University of Stuttgart

The silent electric scooter will eliminate this noise and will cause a considerable improvement in the quality of life in urban areas.

The energy and environmental benefits of electric two-wheelers are thus evident, and the large-scale introduction of this type of vehicle will improve local conditions in cities on one hand, whilst contributing to reduced primary energy consumption and CO_2 emissions on the other hand.

4.4 HEALTH AND SOCIAL IMPACT

The complete reports on these subjects, physiological and biomechanical aspects, with method description, graphics and tables, produced by the VUB can be obtained on request by contacting the VUB directly, see contacts on the last page.

1°) PHYSIOLOGICAL ASPECTS

* INTRODUCTION

There has been a growing recognition that reduced levels of physical activity can partly be explained by the dominance of the car as a mode of transport in the urban society, especially in the way in which it inhibits walking and cycling. Physical active commuting to and from work (PACW) provides a promising manner to reach a large number of people. Incorporation of the electric supported bike could help to overcome the barrier towards PACW.

These features open the discussion for which sustainable transport strategies and physical activity promotion could be combined to produce a more effective prescription for interventions designed to promote electric supported cycling for health.

However, the question remains if the spontaneously selected physiological loading of electric supported cycling meets the requirements of health and fitness enhancing activity.

The purpose of this study is to assess the effects of physical active commuting to work using an electric supported bicycle, on health related parameters and aerobic fitness in a sedentary population.

* Conclusion

Based on the performed final study with 20 healthy sedentary subjects (10 male and 10 female) the results clearly show that the intensity used by the subjects in our study, was sufficient to improve general condition. Regular physical activity has positive effects on an individual's health and functional capacity. Therefore increasing the physical activity level of the general population is one of the key issues in today's health promotion. In this respect the conclusion remains that the electric supported bicycle can help overcome the barrier towards physical activity, for those who will benefit the most in terms of health related fitness.

2°) Bio-mechanical aspects

* Introduction

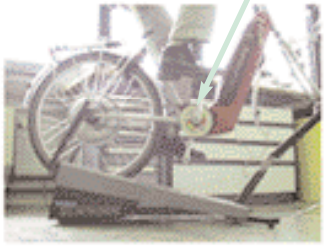
The electric power assisted bicycle not only offers the potential to reduce environmental impact, but could also be an effective way to encourage active living. However, the question remains if it can reduce the sometimes vigorous intensity needed for cycling related to topographic characteristics. The purpose of this study is to evaluate the power output and heart rate variables in electric cycling compared to non assisted cycling, when environmental conditions are standardised.

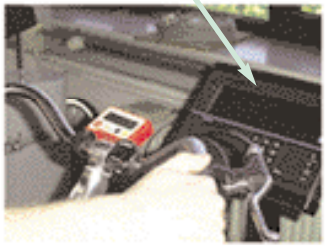
* Materials

First tests where carried out with a Sachs Elo Touring (SACHS fahrzeug und motorentechnik Nürnberg) mounted on a Schwinn Velodyne training system (Schwinn Corp. Chicago).

Since measuring the total power output at the rear wheel did not tell us the effort performed by the cyclist when the electric engine was working, we mounted a standard crankset with a built-in power measuring system (SRM Training System, Ingenierburo Schoberer, Germany) on a SACHS Elo Touring. This set-up was used for all tests. This instrument calculates the torque and angular velocity and averages and records the power output of every complete revolution performed by the cyclist (Grazzi et al 1999; Paton & Hopkins 2001). Power output measurements of the SRM system reflect the intrinsic effort of the cyclist and not the support delivered by the engine. It also records the cyclist's heart rate every 5 sec with the help of a pulse transmitter (Polar eco Electro, Finland), to establish power output heart rate relationship. The Schwinn velodyne system can simulate the actual physical demands of road cycling. During calibration the velodyne accounts for different rolling resistance caused by changes in rider weight, type and weight of wheels, and wear on the resistance unit, establishing the total power output at the rear wheel (Marsh et al 1998).Combination of both measuring systems enables us to make the distinction between the effort put in by the cyclist and the support delivered by the electric motor.

- Sachs alo touring
- SMR system
- Velodyne
- Heart rate monitor
- Online data acquisition

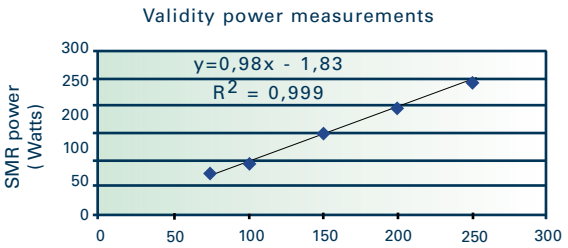




3°) Methods & results

The study has been carried out with 7 experienced male cyclists and 9 less trained non-cyclists, all recruited from a student population. Group classification was based on responses to a personal interview. All subjects performed two trials within ten days.

The results showed that a significantly lower intensity was needed at all power outputs in both groups when the electric power assistance was in use. The amount of support delivered however was not as put forward by the manufacturer. The support was not 50% at all stages, but increased systematically when a higher cycling intensity was needed. The support ranged from 15% at 75 Watt up to 47% at 250 Watt.



SMR power meter validation. SMR power was related to power delivered to the rear wheel by the velodyne, by the following equation :

SMR power = 0.98 Velodyne power - 1.83
R2 = 0.999

Group 1			
power output (watt)	**power input test 1 (watt)**	**power input test 2 (watt)**	**% difference**
75	73	62,6	14,2
100	94,4	74,8	20,8
150	147,5	93,3	36,7
200	194,7	110,8	43,1
250	242,6	126,6	47,8
	heart rate test 1	**heart rate test 2**	**% difference**
	101	99,4	1,6
	115,7	103,4	10,6
	124,6	106,2	14,8
	143,3	111,3	22,3
	157,5	116,4	26,1

Group 2			
power output (watt)	**power input test 1 (watt)**	**power input test 2 (watt)**	**%difference**
75	75,9	64,85	14,6
100	101,125	79,26	21,6
125	123,6	88	28,8
150	149,6	97,8	34,6
175	173,95	103,75	40,4
	heart rate test 1	**heart rate test 2**	**% difference**
	115,1	107,3	6,8
	129,8	116,4	10,3
	139,2	120,7	13,3
	142,9	120,9	15,4
	159,3	127,4	20,0

4°) Conclusion

In the context of public health issues, one could argue that, since even moderate leisure-time and occupational physical activities are associated with increased health and fitness, figures concerning organised involvement in vigorous physical activity are less relevant than figures regarding the other end of the spectrum. The systematic increase of support deliverance related to cycling intensity however, makes that the physiological loading of electric supported cycling could meet the requirements of a health and fitness enhancing activity. At the same time it can reduce the sometimes vigorous intensity needed for cycling, which could lead to drop-out among sedentary individuals.

4.5 LESSONS LEARNED

In the project specific lessons have been learned, especially with regard to the difference between information about available products and real experiences in this field. Apart from all the experiences and learned lessons which are been described in most local site projects, some very specific items have to be highlighted in more detail:

- Products have to be produced in quantity, if there are only prototypes available, the time risk in getting the vehicles for a specific project is too great.
- Do not rely on promises of potential manufacturers. The problems of bringing a prototype into production can be grossly under-estimated, both with respect to sub-suppliers and to starting volume production.
- The "fleet" of vehicles must be backed by competent manufacturers and competent service partners.
- With some of the quantity produced vehicles, manufacturers data appeared to be too optimistic, causing problems when confronted with real heavy use.

The site specific culture plays a very important role, which can lead to remarkable surprises in comparison with the plans up-front.
This has to be taken into account when setting up new projects with these transport means.
More concretely:

- It was foreseen that for the selected target groups, commuters and employers, electric bicycles would be very acceptable in cities with a high bicycle culture and electric scooters in cities with a motorised two-wheeler culture. This can certainly not been taken for granted. On the contrary, the opposite seems to be applicable as well, since in Rotterdam (a bicycle city) electric scooters were appreciated more then electric bicycles and in Barcelona the demonstration ended up with electric bicycles instead of the planned electric scooters.
- Nevertheless, the number of electric bicycles being sold in the Netherlands is around 7.000 per year (although not growing anymore), despite the fact that these bicycles are being identified with the aging or otherwise physically incompetent part of the population. In contrast with the efforts in Switzerland, promoting activities are very low in the Netherlands. So it can be concluded that this still is the result of the real bicycle culture, people who are not able to ride a normal bicycle anymore as they used to do, prefer a transport mobility means, which is closest to their normal habits.
- In Capri, it appeared that the notion of scooter-sharing has received a different interpretation than usual. In the beginning of the project, scooter renters tried to use the one person electric scooters for riding with two or even three people at the same time. After that period, problems arose in the renting service, stating to be due to disappointing performances, but more probably caused by this incorrect using practice.

Finally it has become clear that prudence is needed where it concerns special technological features to be included in the demonstrations. These should be of a practical nature and of proven usefulness. Extreme configurations including new developments are very difficult to realise in a more practical demonstration project.

The E-TOUR project aimed to demonstrate, evaluate and promote electric two-wheelers.

Most of all, the viability of using electric bicycles, electric tricycles and electric scooters as a practical mobility means in urban and/or other restricted areas had to be proved, by testing around 1300 electric two-wheelers and facilitating infrastructure in 10 different sites.

These demonstrations have also shown the (local) environmental benefits and in that respect paved the path for promoting the advantages of these clean personal transport means.

In total more then 1300 electric two-wheelers (almost 700 e-bikes and more then 600 e-scooters) have been introduced and tested in the 10 sites.

Although in several sites the test did not completely match with the original plans, the overall demonstration results have nevertheless shown that e-bikes and e-scooters are a suitable means of transport for short ranges in urban traffic and on small islands.

All in all, the project succeeded in proving the viability of electric two-wheelers in urban transport concepts, although in some sites it took great difficulties to get the desired application going "on wheels". In that respect, the intention to also provide knowledge for large scale market penetration cannot be considered as completely successful. Nevertheless, a lot of learning points about necessary improvements on this point could be gained.

The project has provided proof that there are no sound objections to the use of electric bicycles and scooters in urban transport, neither from users, nor from the general public and local authorities. These overall results have been highlighted in the final **E-TOUR** workshop which was organised in the city of Rotterdam on 16 December 2002.

E-BIKE

The appreciation of the tested e-bikes is highly dependent on the site specific mobility culture. In most sites they were well appreciated, but in Holland electric power assisted bikes were not very well appreciated by the majority of the sites population, mainly due to the well established bicycle culture. On the other hand, this also proves that the electric bicycle is certainly not a simple alternative for normal bikes (the great fear from the Dutch ministry of Environment), but a new mobility means, which has still to conquer its own market share.

With this conclusion in mind, special attention should be paid to the VUB pilot study regarding the physiological aspects of using power assisted bicycles (chapter 4.4).

The results of this study showed that for persons with a low initial fitness level, frequently cycling on an electric supported bike will improve their physical performance, a very positive outcome which needs to be heavily promoted. It also means that the electric supported bicycle can help to overcome the barrier towards physical activity, for those who will benefit the most in terms of health related fitness, thus part of the elderly and the physically less-abled population.

Despite their rather heavy weight, e-bikes are easy to handle and very convenient for hilly trips. In addition, the necessary physical effort and the energy use are very low. Recharging can be rather easily done at home or in the office, as most types of batteries can be taken out for that purpose and are not that heavy.

Negative remarks about e-bikes concern the performance which could be disappointing (speed and range) and the purchase costs which are considered too high. A lot of people still think that e-bikes are too heavy and not attractive enough (low emotional value). In addition, they are frightened by the uncertain battery lifetimes.

Apart from the Dutch situation, it is also clear that electric bicycles do need separate safe route networks like normal bikes, so in that respect they need the same treatment.

The market availability of e-bikes seems to be sufficient. The (European) legislation, however, is rather on the strict side; a lot of people would like to see them approved for higher speeds.

E-SCOOTER

In contrary to the e-bike, the electric scooter is an almost perfect alternative for the ICE scooter or moped, "only" in need of further performance improvement and supporting policy measures in order to conquer a larger market share.

For a lot of applications, recharging facilities are only needed at the home base for nightly (or weekend) recharging, when it matches with the use. In that respect, the general lack of public recharging stations does not seem to be the first major concern. However, in specific cases like electric scooter use in rental services (Capri and Rome), or in extended urban areas (Barcelona and again Rome), the necessity of public recharging facilities is highly valued. In Rome the first public recharging stations have been opened in September 2002, in Capri the first station still have to be realised, whilst in Barcelona the lack of such facilities has caused a shift in the local site project from electric scooters to electric bicycles.

The overall experiences with e-scooters are basically very positive, their strong points, no noise and no exhaust gases, are very well appreciated. It has also concluded that they even can contribute to traffic calming. Also very well appreciated are the low service costs, mainly due to the relatively simple maintenance and the considerable savings in fuel costs. This latter point is mainly the result of a much better energy efficiency than their ICE counterparts. This part of the conclusion underlines the inefficiency of ICE-engines, but is of course no guarantee for a smooth large scale transition to electric scooters, even if the future use of renewable/sustainable energy sources must be leading to a far better energy/environmental balance for these transport means.

Some negative remarks about e-scooters concern disappointing performances (speed and range) and the purchase costs which are considered too high. The e-scooters are also considered too heavy and people seem to be frightened by the uncertain battery lifetimes. The market availability for e-scooters has proven to be problematic, since there are only very few electric scooter providers on the market, which is very unfavourable in comparison with the broad range of available ICE scooters.

Last but not least, the evaluation has shown that the lack of (secure) recharging facilities is considered a problem in some sites. Also from the evaluation activities it has become clear that all public authorities, whether they are local, regional, national or European, must really emphasise their desire for the use of clean vehicles, by introducing beneficial incentives for the users. Most users have expressed their wish to receive advantages in exchange for the use of clean and silent vehicles. It concerns possibilities to enter areas, which are, or should be closed for ICE vehicles, like city centres and other environmentally sensitive areas.

First in line is the necessary product improvement of the electric two-wheelers themselves, this concerns not only the vehicles, but most importantly their batteries.

For both electric bicycles and electric scooters the development of a more reliable and better performing battery could really cause a breakthrough for this type of vehicles for a larger market share. However, the price of e-bikes and e-scooters will remain an obstacle, if a substantial reduction is not foreseen. This concerns mainly the price of the batteries, which seem to be the determining factor for the whole vehicle price. Although better and more reliable batteries will basically have a higher price when produced in the same numbers, better products may lead to substantial higher sales, which can lower the overall prices.

Better insight in user needs is crucial for new e-bike and e-scooter developments, although it might already be obvious that daring but functional designs are needed for a large scale market introduction. Dealers can play an important role by improving their involvement, for example by introducing more rental promotions.

For e-bikes, new developments should also be leading to products with a high emotional added value (daring but functional designs), otherwise the market share will only stick at a very small part of the population, who are really in need of power assisted cycling. Also the very positive health effects when using power assisted electric bicycles should be wisely exploited. For specific niches, like postal services and municipal maintenance further development of power assisted three-wheelers is a must.

For e-scooters, developments for specific niches like courier services and meal deliveries (pizza and other meals) can be of great importance for showing the public these alternative transport means. These developments are already started in the Netherlands (Designer Springtime in co-operation with OXYGEN Benelux) and were presented at the final **E-TOUR** workshop on 16 December 2002 in Rotterdam.

The public authorities, whether they are local, regional, national or European, will have to play an important role in these developments and should emphasise their desire for a future with clean vehicles, by introducing beneficial incentives for buying as well as using these clean and silent vehicles. In this respect, most users would be very happy when they could enter areas, which are, or should be closed for ICE vehicles (ban on filth & noise), for example city centres and other environmentally sensitive areas.

In particular small islands are a perfect setting for the use of electric two- and three-wheelers, since these can not be entered by vehicles from the outside, making it easier for local authorities to have the courage to allow only these transport modes on their roads.

Although public recharging stations are not the first necessity for electric bicycle users and most electric scooter users, general introduction of electric vehicles is nevertheless delayed by the fact that public recharging stations and service facilities are not widely established.

In this respect, the general actions undertaken by the project partner CITELEC, in order to create a future market for electric vehicles, are and will remain of great importance.

CITELEC, the European Association of cities interested in the use of electric vehicles (EVs), was founded on February 2nd, 1990 under the aegis of the European Community. The association now unites over 60 member cities in various countries.

CITELEC and its members are studying the contribution of EVs in order to solve their traffic and pollution problems. CITELEC's main tasks are;

- to inform cities about performances and characteristics of EVs
- to help cities with the deployment of EVs and give user-training
- to accompany the realisation of infrastructures for EVs
- to organise test demonstrations with EVs in urban traffic, e.g. the "12 Electric Hours"
- to perform tests and assessments of EVs in the European market
- to partake in actions to study and demonstrate EVs and hybrid vehicles in European cities

There is still the possibility that hydrogen / fuel cell technology might inhibit the extensive use of battery electric two-wheelers. But especially for urban rides, battery electric two-wheelers can still play an important role in future, providing that battery technology is further improved. The two technologies are not that different, since electric propulsion is a common feature in both. It is only the energy storage (hydrogen versus battery) that provides a choice in the future, but for the near future battery electric two-wheelers are already available and further developed. Normally these vehicles are not intended for long distances and in that respect a small but efficient battery pack will be sufficient enough.

The dissemination activities regarding the follow-up of the **E-TOUR** project will be continued by the concerned partners from the project. Especially the partner network-organisations CITELEC and ISLENET will have to play an important role in those activities, but this goes also for the affiliated European two-wheeler branch network organisations COLIBI/COLIPED and ETRA and for the EUROCITIES transport related networks ACCESS and POLIS.

The website -www.etourproject.org- will remain on line, and the project will certainly be presented at future relevant conferences and events.

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NOTICE TO THE READER

Extensive information on the European Union is available through the EUROPA service

at internet website address: http://europa.eu.int

The overall objective of the European Union's energy policy is to help ensure a sustainable energy system for Europe's citizens and businesses, by supporting and promoting secure energy supplies of high service quality at competitive prices and in an environmentally compatible way. European Commission DG for Energy and Transport initiates, coordinates and manages energy policy actions at transnational level in the fields of solid fuels, oil & gas, electricity, nuclear energy, renewable energy sources and the efficient use of energy. The most important actions concern maintaining and enhancing security of energy supply and international cooperation, strengthening the integrity of energy markets and promoting sustainable development in the energy field.

A central policy instrument is its support and promotion of energy research, technological development and demonstration (RTD), principally through the ENERGIE sub-programme (jointly managed with DG Research) within the theme "Energy, Environment & Sustainable Development" under the European Union's Fifth Framework Programme for RTD. This contributes to sustainable development by focusing on key activities crucial for social well-being and economic competitiveness in Europe.

Other DG for Energy and Transport managed programmes such as SAVE, ALTENER and SYNERGY focus on accelerating the market uptake of cleaner and more efficient energy systems through legal, administrative, promotional and structural change measures on a trans-regional basis. As part of the wider Energy Framework Programme, they logically complement and reinforce the impacts of ENERGIE.

The internet website address for the Fifth Framework Programme is :
http://www.cordis.lu/fp5/home.html

Further information on DG for Energy and Transport activities is available at the internet website address:
http://europa.eu.int/comm/dgs/energy_transport/index_fr.html

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