European Commission

New Solutions in Energy Utilisation

ELCIDIS

Electric Vehicle **Ci**ty **Dis**tribution

FINAL REPORT

ENERGIE

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In loving memory of Joost (†1997)

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Electric Vehicle **Ci**ty **Dis**tribution

FINAL REPORT

TR 0048/97

A project for the Rational Use of Energy in Transport jointly conducted by

City of Rotterdam
Stockholms Stad
Communauté d'Agglomération de La Rochelle
Stadt Erlangen
Regione Lombardia
Stavanger, Lyse Energi AS
CITELEC

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Executive summary

Most European cities are confronted with problems regarding air- and noise-pollution and congestion caused by motorised road traffic. The evolution of urban logistics in the past decades even worsened that situation, due to an increasing use of heavier goods vehicles in city centres. The nuisance caused by these vehicles to traffic fluidity and the environment is growing and becoming less and less acceptable. Shops and businesses suffer from the poor accessibility of the city, residents and shoppers experience the negative effects of the pollution caused by these vehicles. The economic and environmental viability of cities are negatively effected by this present organisation of urban goods distribution.

The ELCIDIS project has tested a better solution for urban logistics by approaching the subject in a dual way, taking into account the interests of all parties involved, in order to set an example for clean and efficient urban distribution in the 21st century.

- By organising urban distribution using quiet and clean (hybrid) electric vehicles, the nuisance caused by distribution activities will be decreased. The improved living climate of the city will benefit residents and shoppers as well as shopkeepers.

- A more efficient organisation of urban logistics is achieved by more efficient routing of the vehicles and the use of urban distribution centres (UDC). This will decrease the number of journeys made by heavy vehicles and increase traffic fluidity in urban areas. The improved accessibility of the city will benefit transport companies, shopkeepers and businesses operating in the city.

ELCIDIS has been running from March 1998 till August 2002 and 6 cities have been testing different possibilities, based on existing or new urban distribution systems.
Overall objective was proving the viability of (hybrid) electric vans and trucks for urban distribution, preferably in combination with the use of an UDC, showing the environmental benefits of such an application and promoting incentives for the use of those vehicles. In the 6 cities, a total of 39 electric and 16 hybrid vehicles were deployed by the participating (transport) companies, comprising 'standard' products with established battery systems and new designs with advanced batteries and prototypic drive trains, see data sheet.

As main result, the project succeeded in verifying the principal merits of using (hybrid) electric vehicles in urban delivery concepts. Although in some sites it took a great deal of time to get the desired application 'on the road', ELCIDIS has provided indisputable proof that there are no predominantly objections to the use of hybrid and electric vehicles in urban distribution, neither from company managers nor from drivers, and certainly not from local authorities.

For company managers, the generated positive publicity for using these vehicles is very welcome, recharging at the home base during the night (or weekend) period for those vehicles does match perfectly with this type of use. For drivers, the performance of the vehicles is very satisfactory. Despite the common view on electric vehicles, the acceleration gives no great problems and was in some cases even better then expected.
For local authorities (regional and municipal), the view on a realistic future solution for their transport related environmental problems is very much welcomed.

The impact on energy-use and environment is considerable. Despite the fact that the present generation of electric vehicles is still not perfectly developed, they proved to be more energy efficient than their ICE counterparts. This is partially due to their ability in using regenerated energy from braking, but also the much higher energy-efficiency of the electric engine plays an important role, as well as the complete absence of energy use during stops.
Operating hybrid and electric vehicles in urban distribution has to be combined with a UDC based approach. For battery electric vehicles, a UDC near the city-centre with ‘home-recharging’ equipment is necessary. For hybrid electric vehicles, the UDC may be located further away from the city, but at a reasonable distance.

Data sheet of city projects

Site	Logistics		Vehicles		
	Distribution service	**Operating area**	**Number & type**	**Battery type**	**Payload in kg**
Rotterdam	parcels & packages	city centre	3 electric vans Mercedes Sprint	6 x sodium nickel chloride ZEBRA Z5C	1250
			4 electric vans Mercedes Sprint	12 x sodium nickel chloride ZEBRA Z5C	1000-1500*
Stockholm	delivery of goods such as parcels, packages, food and clothes	city centre & region	6 hybrid electric trucks Mercedes ATEGO 1217	6 x lead	2300
			3 electric vans Citroën Berlingo	3 x nickel cadmium	440
La Rochelle	parcels, packages & messages	city centre	6 electric vans Citroën Berlingo	6 x nickel cadmium	500
			1 FAAM Jolly 1200 electric van	1 x lead	900
			1 electric car Citroën Saxo	1 x nickel cadmium	300
Erlangen	delivery service of goods & documents	city centre & region	10 hybrid electric Audi Duo	10 x lead	400
Regione Lombardia	mail delivery & services	city & city centre	13 electric vans Citroën Berlingo	13 x nickel cadmium	500
Stavanger	mail, packages, documents & equipment etc.	city centre & region	3 electric vans Peugeot Partner	3 x nickel cadmium	500
			2 electric vans Citroën Berlingo	2 x nickel cadmium	500
			2 electric cars Citroën Saxo	2 x nickel cadmium	300
			1 electric van Mercedes Sprint	1 x lead	500**

* If more than 1000 kg, Gross Vehicle Weight exceeds 3500 kg, meaning the van becomes a truck.
** With a Gross Vehicle Weight of 3500 kg.

From the transport companies point of view, small and large electric vans are applicable for both postal and package deliveries, delivery of large(r) parcels and/or voluminous goods needs large electric vans and hybrid trucks.

To conclude, urban distribution concepts using (hybrid) electric vehicles are not utopian, but still far away, so substantial barriers have to be taken, before they can be applied generally. Both vehicle manufacturers and public authorities can provide the key-elements for cleaner urban distribution in future.

The manufacturers have to provide mature products where the price performance ratio and reliability as well as after sales servicing and maintenance meets the high standard that has been reached with ICE vehicles. Despite the in some sites proven considerable savings in fuel costs, the vehicles investment costs will remain a very important obstacle as long as these remain on a level substantially higher then for ICE vehicles. Another obstacle is the product diversity of electric vans on the market, which is very unfavourable in comparison with the broad range of applicable ICE vehicles; this also caused unforeseen procurement problems during the first project phase.
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 vehicles can still play an important role in future, providing that battery technology is further improved.

All public authorities, whether they are local, regional, national or European, must really emphasise their desire for a future with clean vehicles, by introducing beneficial incentives for buying as well as using zero emission vehicles.
In this respect, the request from transport companies to receive advantages in exchange for the use of clean and silent vehicles in future, should be granted.
Most important for them are extensions of delivery hours and possibilities to enter areas, which are, or should be closed for ICE vehicles, like pedestrian areas and public transport lanes.

1 Introduction

1.1 Promoting sustainable transport means

Motorised traffic is the main source of pollution in most European cities.

Electric vehicles offer a clean and energy-efficient alternative to vehicles with an internal combustion engine. In congested urban traffic, the varying demand for power can be met more energy-efficiently by an electric motor. Battery electric vehicles have a range of around 80 km, making them very suitable for trips within urban areas. These vehicles are particularly suitable for use in urban distribution activities, where vehicles only run daily routes and can be recharged overnight.

In general, urban distribution vehicles cover a daily distance of also around 80 km, meaning that the range of electric vehicles is sufficient for the delivery of parcels and packages in urban areas. Besides that, urban distribution vehicles make up to more then a hundred stops a day, for such use an electric motor provides the power for stop-and-go traffic much more efficiently than an internal combustion engine.

Due to the large battery weight, there are no electric vehicles with a payload of more than 1500 kg on the market. For companies planning to use clean urban distribution vehicles with a payload of over 1500 kg, hybrid electric vehicles are an alternative. Hybrid electric vehicles are equipped with an internal combustion engine and an electric motor, enabling them to drive in the electric mode over short distances, in particular suitable for city centres. In this respect, they are able to combine the advantages of local clean transport with a high(er) payload and a large range.

1.2 ELCIDIS - a European initiative

Based on previous experiences with electric vehicles, the **ELCIDIS** (**El**ectric vehicle **Ci**ty **Dis**tribution) project was set up in co-operation between a number of interested European cities in different countries and CITELEC (the European Association of cities interested in electric vehicles), and was approved for funding under the Energy Programme of the European Commission.

The overall objective of ELCIDIS was to demonstrate a varied set of hybrid electric trucks and electric vans in the heavy application of urban goods distribution, where necessary combined with the creation of an urban distribution centre (UDC). More concretely the following targets have been distinguished:

- To demonstrate the economic, technical and social viability of urban distribution with electric vehicles.
- To analyse the environmental benefits of the deployment of electric vehicles for urban goods distribution.
- To gain insight into the technical specification of (hybrid) electric vehicles, operating in urban distribution activities.
- To analyse the logistic efficiency of a newly created UDC.
- To demonstrate the acceptance of urban distribution with (hybrid) electric vehicles by transport companies, shopkeepers, businesses, residents and shoppers.
- To investigate the value of incentives to promote environmentally-friendly vehicles.

For the long term, ELCIDIS aimed at making a contribution in opening up the market for (hybrid) electric vans and trucks, taking into consideration the interests of all parties involved, and setting an example for clean urban transport in the 21st century.

The execution of the project involved 6 European cities in the Netherlands, Sweden, France, Germany, Italy and Norway, CITELEC and a group of 6 observer cities from Sweden, Belgium, England, Ireland, Switzerland and Monaco. The deployment of (hybrid) electric vehicles is common to all cities involved in the project. The project was co-ordinated by the Public Works Department from the city of Rotterdam, the Netherlands.
The organisation of the logistic system varied according to the local situation in the participating cities.

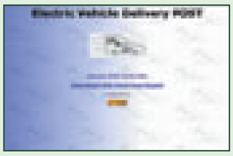
- The site projects in Rotterdam and Stockholm focused on the deployment of large electric vans (payload 1000-1500 kg, Rotterdam) and hybrid electric trucks (payload max. 2500 kg, Stockholm) in the fleets of existing transport companies. These transport companies already had efficiently working logistic systems, functioning like a UDC.
- The site project in La Rochelle focused on the development of a new, clean and efficient distribution system. A special company has been set up, operating from a newly created UDC. The smaller scale made it most efficient to deploy electric vehicles with a payload of 500 kg.
- The site projects in Stavanger, Milan and Erlangen focused on the deployment of (hybrid) electric vehicles for in-house goods and mail distribution for companies operating within the urban areas of these cities. Electric and hybrid electric vehicles with a payload of 500 kg were very suitable for this purpose.

Suggested links on the Internet

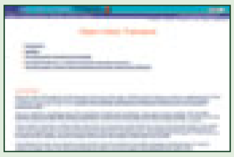
www.elcidis.org


www.citelec.org


www.cordis.lu/eesd/home.html


www.evdpost.com


www.thermie-transport.org


www.europa.eu.int/comm/energy_transport/en/cut_en.html

In the 6 cities, finally a total of 55 hybrid and electric vehicles were deployed by the participating (transport) companies between 1998 and 2002, comprising both “standard” products with established battery systems and new designs with advanced batteries and/or prototypic drive trains.
The demonstration project in each city has been evaluated by CITELEC and ECN, Energy research Centre of the Netherlands, on the basis of a joint evaluation method, this included:

- Energy consumption of vehicles, environmental and energy benefits
- Information on charging facilities and battery performance
- Measurement of logistic data: Distance covered, number of stops, payload factor, goods transported
- Investments in vehicles, charging facilities, logistics system
- Evaluation of market, driver and public acceptance
- Various questionnaires among all parties involved


European Commission, DG XVII, Alternative Urban Freight Strategies, Thermie Type B Action No DIS-0154-95-Fr, August 1997

ELCIDIS formed an additional part to the Transport Targeted Projects (TTP) cluster, and collaborated closely with the EVD-POST (Electric Vehicle Deliveries in Postal Organisations) project, due to comparable objectives.

Cities participating in Elcidis

City of Rotterdam

Stockholms Stad

Communauté d'Agglomération de La Rochelle

Stadt Erlangen

Regione Lombardia

Stavanger, Lyse Energi AS

CITELEC

Local Site Projects

2.1 Rotterdam

Erasmus bridge, the present symbol of this modern city

Problems faced

Rotterdam, with about 600.000 inhabitants, has the largest port in the world and is the central main-port for goods distribution in Europe. Rotterdam's transport policy aims at facilitating these economically very important distribution activities whilst reducing the environmental impact of traffic.

To achieve this objective, goods transport is being shifted towards environmentally-friendly transport by rail and water. However, trains and ships mainly offer an alternative for long-distance transport, most regional transport and urban distribution activities are and will be based on road transport.

The best way of solving the inner-city environmental transport problems is by introducing clean, quiet and energy efficient vehicles, especially for specific niche-applications, which may be considered as inevitable road transport.

In Rotterdam, the urban distribution activities do not suffer from congestion problems in the inner city. Partially this is due to the fact that the inner city has been rebuild in a spacious pattern after the demolition in the 2nd World War. Also the fact that the 3 main transport companies for urban distribution, TNT-Post group (TPG), Van Gend&Loos (VGL) and Nederlandse Pakket Dienst (NPD) were already performing on a UDC-based approach for years, plays an important role. These companies, transporting at least 70% of all parcels & packages, are operating from their own UDC situated at the edge of the city. They use large trucks for long-distance transport to and from the UDC and distribute goods in and out of the city by means of vans and small trucks.

In this efficiently organised urban distribution system a further reduction in emissions of noise and air pollution can only be reached by introducing clean and silent vehicles.

Solutions adapted

Electric vehicles offer a very clean alternative to the diesel engine vehicles and are very suitable for the short trips and many stops, characteristic for urban distribution vehicles. It could also be expected that such vehicles operate more energy-efficient.

The Rotterdam approach has been adapted to the specific needs of the 3 mentioned transport companies, meaning that electric vans were needed which could operate as a full replacement for the used ICE-vans, and so proving themselves in the existing logistic systems of these companies. ELCIDIS made it possible for Rotterdam to introduce large electric vans for this purpose. In the preparation phase of the project it became clear that only Mercedes Benz (now DaimlerChrysler) was able to deliver vans, which could cope with the demands of the participating companies. In their logistic system, a van has to serve up to 150 addresses a day in one single trip, demanding 1000 - 1500 kg payload and 12-16 m^3 loading volume.

For these demands the use of a van in the size of the Mercedes Sprint and of high-performance, relatively lightweight batteries was essential. For the batteries, the only suitable option was the so-called ZEBRA battery, a high temperature sodium nickel chloride battery developed in Derby, England, supported by the Mercedes Benz concern and to be produced by AEG Anglo Batteries in Ulm, Germany. The vans had to be ordered at a special department of Mercedes Benz, the centre for low emission vehicles (KEN) in Mannheim, Germany. Such a type of electric vehicle had not yet been widely tested in practice, so the ELCIDIS project offered a unique opportunity for this purpose.

1st Electric Mercedes Sprint: Inauguration of the 1st Electric Mercedes Sprint for TNT in Rotterdam.

Results obtained

In the original work-plan from Rotterdam 9 vehicles would have been launched for the test in summer 1999, but unfortunately the choice for the ZEBRA batteries turned out to become the source of great problems in the proposed time-schedule. In October 1998, with the final arrangements for the procurement of the Mercedes vehicles by Rotterdam in preparation, AEG Anglo announced the imminent closure of the main production facility in Ulm, due to the withdrawal of its main investor. The search for a new partner by AEG Anglo remained unsuccessful, which led in December 1998 to the message by DaimlerChrysler KEN, that the desired vehicles could not be delivered anymore. The search for possible alternatives (batteries as well as vehicles) has partially been performed in close co-operation with the project co-ordinator from the EVD-Post project. The acquisition of the ZEBRA technology by MES-DEA, an automotive supplier from Stabio, Switzerland in March 1999, enabled a restart of the activities in Rotterdam for the procurement of the desired vehicles. After negotiations with MES-DEA and DaimlerChrysler KEN, which were finalised in summer 1999, a new time-schedule has been set up for the delivery of the vehicles. During this interruption, the situation in Rotterdam had also been altered. One of the participating companies (VGL, part of NedLloyd in the mean time taken over by Deutsche Post) had to move its UDC to another area, further away from the city centre and had to adapt their demands to the new situation. After consultation of the other transport companies, the leasing company (Roteb-lease) from the Rotterdam municipality discussed the orders of the vehicles with the DaimlerChrysler concern in the end of 1999. Based on these alterations and on the determined budget, finally 7 electric vans Mercedes Sprint were ordered at DaimlerChrysler KEN in March 2000, from which 4 vans had to be equipped with 3 ZEBRA Z5C batteries each and 2 vans with 2 ZEBRA Z5C batteries each.

Sprint from Van Gend & Loos

However, it appeared that the new time schedule did not last very long, due to starting problems at the MES-DEA ZEBRA battery plant and an overloaded order portfolio for DaimlerChrysler KEN. A new time-schedule with the vehicle provider has been discussed on September 4th, 2000 in the 6th ELCIDIS management committee meeting, confirmed in writing on September 15th, 2000.
After this long period of problematic procurement, the first van for TNT finally came into operation in April 2001.

The other 6 vans were delivered in a more or less regular time schedule of 6 weeks, the last van (for NPD) has been delivered to Rotterdam in December 2001. Since January 2002, all 7 vans are in operation at the 3 transport companies. When the vans are working, both drivers and transport managers are very pleased with their performance, so potentially the use of large electric vans in this transport niche is very viable.

Unfortunately the vans still suffer from technical problems, most likely the price one has to pay for using prototypic vehicles. The improvement of the overall vehicle reliability for the future use of all 7 vehicles is crucial and has been discussed with the DaimlerChrysler concern. On July 18th, 2002 it has been agreed to double check all vehicles and charging systems again in order to prevent any new serious failure. Possible new problems of the same kind may cause a definite draw back from the participating companies, in that respect endangering the local sites planned test-period extension in another framework.

The final installation of the monitoring software and consequently the reading out of the data per vehicle, took place in February 2002, when all vehicles should have been running to the satisfaction. All registered data have been sent electronically to ECN (Energy research Centre of the Netherlands), working on the overall European evaluation. Unfortunately, the registered data appeared to be unreliable, because they were not in line with the obtained information from the drivers / users, especially with regard to the driven distances. This means that the registered data could not be used for the overall evaluation of the European project. The reliability of the data collecting system will be improved by the DaimlerChrysler concern in close co-operation with the Swedish supplier, in order to provide better data registration for the extended test-period (2 years) in the local project.

Because of the very short demonstration period and all described problems, the evaluation material is incomplete. However, it has been agreed with the European Commission (DG TREN) to make the Rotterdam ELCIDIS project part of the TELLUS project (in the CIVITAS programme). In this new project, the extension of this projects test-period will be realised in combination with investigating the incentives to promote environmental friendly urban distribution vehicles.

The companies using the vans and especially their drivers have in general a positive opinion of these new vehicles, to be summarized as follows: The van is easy to handle and operates well. There is no engine noise, very pleasant for the driver, but a possible disadvantage for pedestrians, who do not always hear the vehicle. Both customers and other drivers have shown an interest in these environmentally friendly large vans.

Recommendations

In principle, there are no predominantly objections to the use of EVs in the urban distribution of parcels & packages in the city of Rotterdam, neither from the company managers nor from the drivers.

For the managers, the generated positive publicity for using these vehicles is very welcome, recharging at the home base during the night (or weekend) period for those vehicles is no problem at all. When the schedules for inner-city deliveries would be shifted to a (partial) night use (such alterations are still in discussion in The Netherlands), the recharging facilities should be adapted to that by providing fast charging possibilities during the loading-period of the vehicles, which takes normally about 30-45 minutes.

For the drivers, the performance of the vehicle is very satisfactory, especially with regard to the acceleration of this heavy van. Also the smoothness of driving and the quietness in the drivers-cabin is very well appreciated as well as the positive attitude from shopping people in the inner city. Due to the silence of the vehicle it is however necessary to have a "bleeper" on the vehicle for driving on pedestrian routes, since people are not used to these very silent delivery vehicles.

Based on the gained experiences, it is nevertheless obvious that price performance ratio, reliability, maintenance and servicing must be set at the same (high) standard as for ICE equivalents, in order to attain a larger market share in this specific niche.

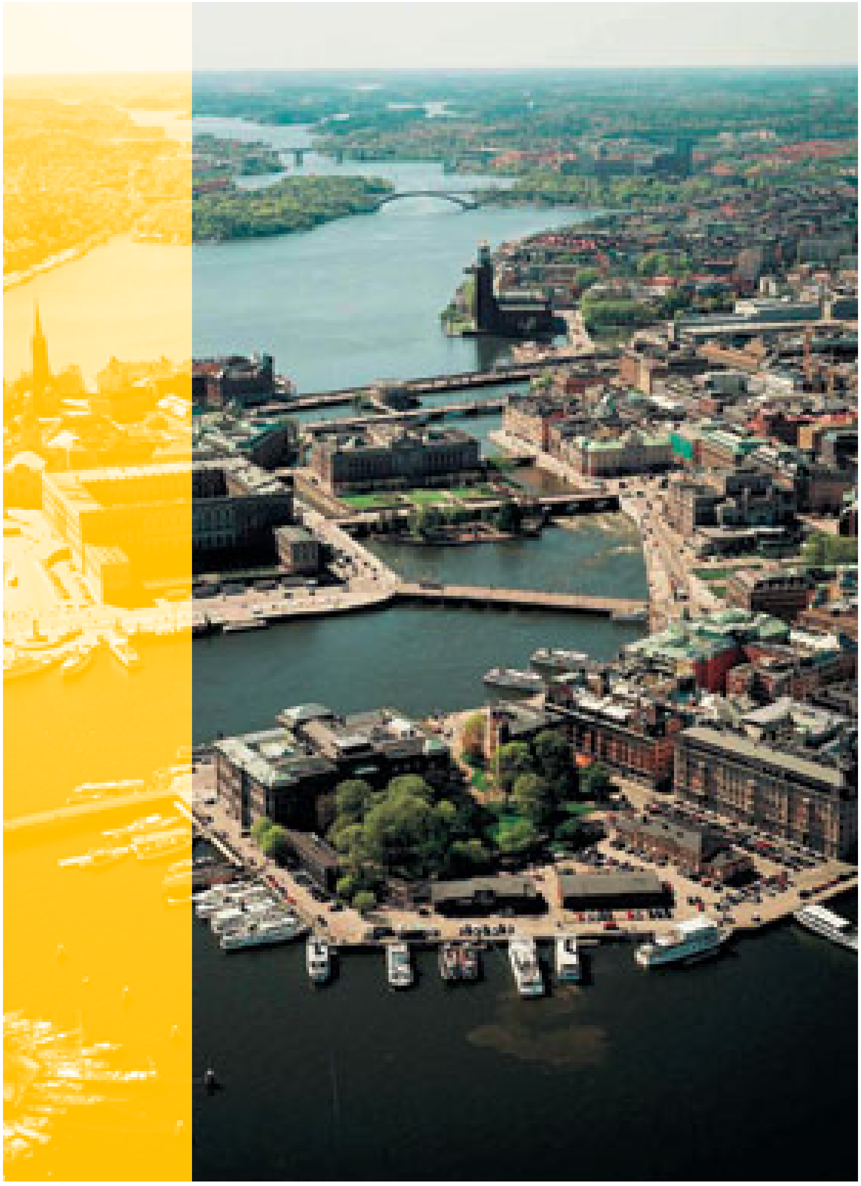
Especially the vehicles investment costs will remain a very important obstacle if a substantial reduction sizing is not foreseen. The French approach where a split in costs is made between the vehicle and its batteries, is a good step in the right direction, but has not (yet) been widely followed.

Another point of attention in that respect is the market availability of large electric vans, in fact there is no question of any product diversity, which is very unfavourable in comparison with the broad range of applicable ICE vehicles.

In exchange for the use of clean and silent vehicles in future, the transport companies have expressed their desire to receive advantages. Most important for them are extensions of delivery hours and possibilities to enter areas, which are, or should be closed for other vehicles.

The further elaboration of this idea is also integrated in the TELLUS project.

2.2 Stockholm



Stockholm is the capitol of Sweden and is often referred to as 'a beauty on water'. The constantly increasing number of vehicles is, however, causing major environmental problems. Introduction of electric en electric hybrid vehicles in smart goods distribution is a way to reduce air pollution and noise.

Problems faced

The city of Stockholm, 750.000 inhabitants, is the economic heart of Sweden. The inner city covers an area of approximately 5 x 7 km, where 250.000 people live and 280.000 people work. In the city centre of Stockholm goods distribution activities cause major problems with regard to noise and air pollution.

The city has an extensive traffic policy to improve the environmental and living quality of the area. In 1996 access restrictions for the city centre for diesel driven trucks and buses over 3,5 tons was introduced. Only vehicles not older than eight years are exempted from these access restrictions. The results of this measure are positive; noise peaks have been reduced and air pollution has decreased.

The introduction of zero and low emission vehicles (electric, bio-gas 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 aims at introducing hybrid/electric vehicles for goods distribution. In Stockholm the most important environmental effect can be gained by replacing heavy diesel trucks, causing most of the pollution, with electric hybrid trucks, driving emission-free in the city centre.

Solutions adapted

Six trucks and three vans are tested:

ELCIDIS in Stockholm has focused on the introduction of nine vehicles, six hybrid trucks (weight 12 tons) and three electric vans for goods distribution in the city centre and region. The nine environmentally adapted vehicles have replaced regular diesel and petrol vehicles and thus helped to improve the environmental situation in Stockholm by reducing pollution and noise.

Six Mercedes Benz 1217 Atego hybrid trucks have been used in Stockholm for goods deliveries. These hybrids can run about 30 km on one electrical charge, the pay-load capacity is approximately 2.300 kg and the loading volume about 30 m^3.

The first truck was delivered in February 2001 and the last one in December 2001. These hybrid heavy vehicles are new to the Stockholm traffic. They have been operated in electric mode when delivering goods in the city centre and, if required, switched to diesel mode on the traffic routes outside the city centre.

The six hybrid trucks have been used by four companies: Danzas ASG Eurocargo AB, Green Cargo Road & Logistics AB, Grönsakshallen Sorunda AB and Transportfirma Trabé AB.

The six hybrid trucks have been used for various distribution purposes in the Stockholm area. Some examples of the goods that are delivered with these new vehicles are ice cream boxes, clothes, fruits and vegetables, general cargo (parcels as well as pallet loads) and bread.

Three electric vans (Citroën Berlingo Electrique) have been used by Riksbyggen Stockholm. The Citroën Berlingo has a cargo capacity of 440 kg, and can be driven approximately 60 km on a single charge. These vehicles were delivered in the autumn of 2000 and have been in operation since then.

One of the companies (Grönsakshallen) delivers fruit and vegetables to restaurants in the Stockholm area, and thus requires refrigeration equipment in their trucks. In this Atego a new more environmentally friendly kind of refrigeration system with CO_2 instead of diesel is installed. The CO_2 is stored in the small tank located behind the rear wheel of the vehicle.

Results obtained

Unique hybrid trucks for city distribution:

In the beginning of the project no vehicle manufacturer was really interested in supplying the relatively large hybrid trucks required by the project participants. Eventually Mercedes-Benz was contracted as supplier.

There have been some technical problems with the Atego hybrid trucks due to the fact that these vehicles have a new design and construction. Two types of recurring technical failures have been charger breakdowns and a malfunctioning switch when changing from electricity to diesel mode and vice versa. Another problem has been to get proper service support from the vehicle supplier.

The distribution trucks have had an average driving distance between 50 and 100 km per day. The electricity consumption has been approximately 1,2 kWh/km and the fuel consumption about 0,26 l/km. The share of the daily distance driven on electric mode is 30-45 % depending on the transport routes.

The hybrid trucks can not carry loads as heavy as regular diesel vehicles. This has, however, not met any problem for the participating companies. They have used the hybrid trucks for transport assignments where the weight restrictions not have influenced the transport efficiency.

Heavy hybrid trucks are still in a developing phase, and the hybrid trucks in Stockholm have not been in operation for very long yet. Further evaluation would therefore be very interesting.

Electric vans very reliable:

The electric vans (Berlingo) have been very reliable. Two of the vehicles have not had any electricity related malfunctions during the whole demonstration period. The only major technical incident is that one of the cars twice has had problem with the electric box that regulates the battery system.

Riksbyggen the property management company which owns the Berlingos, and their drivers, are satisfied with the electric vans. This type of vehicle is very well adapted for property management. The main disadvantage is the limited driving range. This also forced Riksbyggen to relocate one of the vehicles to another area since the first driver was unwilling to drive the van when he was uncertain if the charging would be sufficient for the whole day.

Riksbyggen, a large real estate owner in Stockholm, uses three electric vans (Citroën Berlingo Electrique) as service vehicles for equipment and goods in between their different buildings.

One of the Berlingo drivers has had some concern regarding the electro-magnetic radiation in the car. He was, however, reassured when informed about a previous study in Stockholm showing that the electric magnetic fields in the electric car is not higher than in a regular petrol car and below the level for work at a computer screen (Stockholm MFO,1999).

The electric cars have had an average driving distance of 15 km per day. The energy consumption has been approximately 0,45 kWh/km. Compared to results from other Swedish studies this is somewhat high, and the most important explanation to this is that the three electric service vehicles in Stockholm are only used for very short distances, with frequent stops and starts.

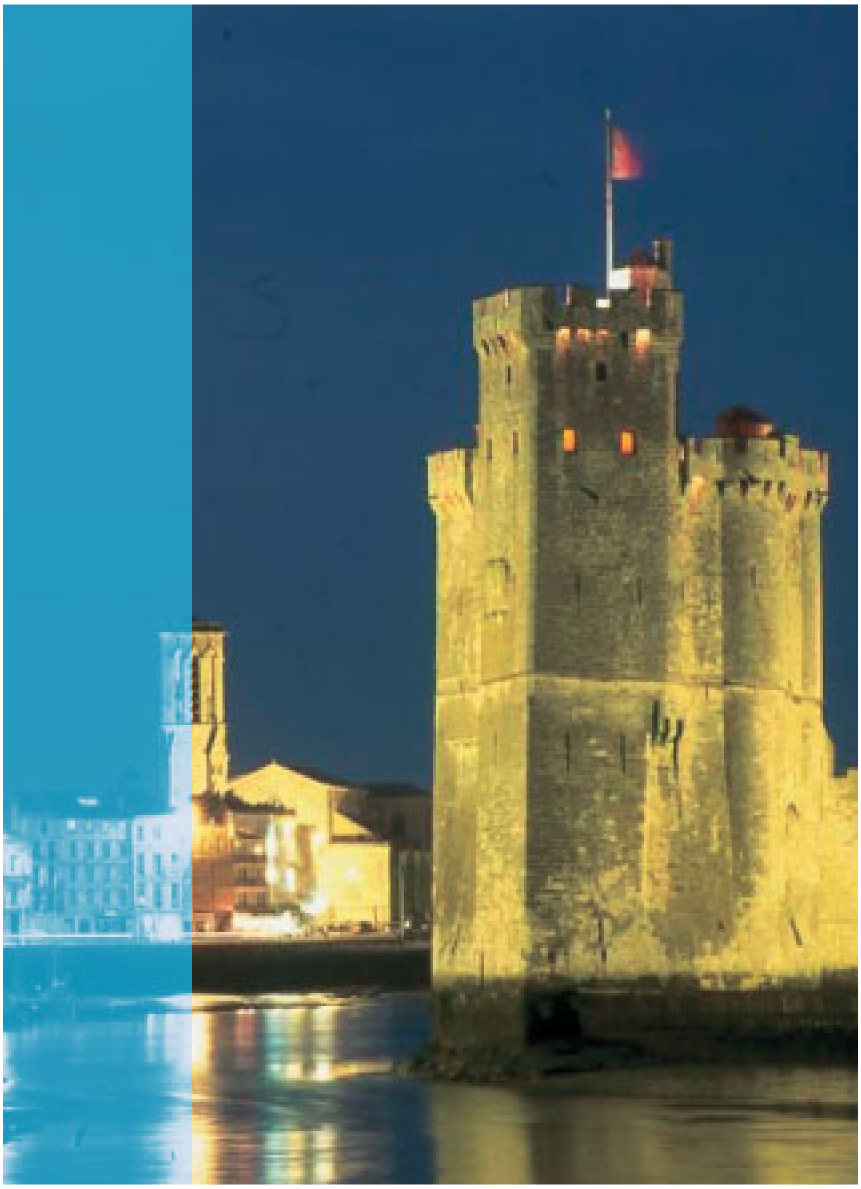
Recommendations

The introduction of electric vehicles is delayed by the fact that the purchase cost is relatively high, charging stations and service facilities are scarce, and the range is rather limited. However, the tests in Stockholm show that these environmentally adapted cars are very reliable and could be used for many different transport purposes.

The hybrid trucks have dual systems (electric and diesel), therefore the manufacturing cost is high. The transport companies have suggested different incentives that would increase their interest in using these vehicles, e.g. permission to drive in the public transport lanes and marketing in the media to enhance the awareness of these new vehicles.

The companies using hybrid trucks and their drivers have in general a very positive opinion of these new vehicles. One of the drivers, Thomas Petersson driving for Danzas, summarises the experiences. - The truck is very easy to handle, and it operates well. In steep rises it is, however, sometimes necessary to use the diesel engine for additional power. There is no engine noise on electric mode, which is good, but it can also be a disadvantage because pedestrians do not always hear the vehicle. The battery capacity is enough for almost one day's city distribution (about 30 km). Both customers and other drivers have shown an interest in these environmentally adapted heavy vehicles.

La Rochelle



Problems faced

La Rochelle, a city of 135.000 inhabitants on the French Atlantic coast, was one of the first European cities with a traffic policy aimed at reducing environmental pollution. As a part of this policy the municipality has been promoting the use of electric cars, bicycles and public transport.

Carriage of goods in cities, where most logistics chains begin or end, is an activity that generates increasingly severe problems for local authorities. Especially in the narrow streets of the historic city centre of La Rochelle, distribution activities cause environmental as well as congestion problems. How goods are carried to their urban destination or from their urban producers affects many people and has far-reaching implications.

These problems raise three major questions:

- How can we foster development of services to the local community that will enhance the city and its activities?
- How can we avoid over-occupation of public areas by large vehicles stopped or moving through the streets?
- How can we minimise the disturbance caused by delivery vehicles as a whole (congestion, noise, pollution, damage to streets and sidewalks, etc.)?

The answers lie in a reorganisation of urban logistics, i.e. recognising the legitimate place of goods carriage in urban areas while integrating this activity into the city's overall operation. Many cities have already adopted such an approach to the issue.

The Urban Community of La Rochelle is one of them, as reflected in its Urban Transport Plan. Yet it has actually gone a step further, focusing particular attention on new, more environmentally sound transport technologies. In this sense, the project launched by the Urban Community is genuinely innovative. Its aim is to seek cross-pollination between the issue of "city freight distribution" and La Rochelle's experience in the use of electric vehicles.

Solutions adapted

The operation involved setting up an urban distribution platform near the city centre, from which electric-powered commercial vehicles (e.g. Citroën's Berlingo) deliver and collect parcels. Their design makes them well suited for the narrow streets of the city's historic centre. During the initial phase, only express delivery-type parcels were handled.

Goods carriage is clearly not a business falling within the scope of La Rochelle's Urban Community. Accordingly, management of the platform was outsourced, following a Europe-wide consultation process and then a negotiated contract. The company commissioned for this task was Transports Genty, a private company operating regionally but already established in La Rochelle.

Management responsibilities cover not only co-ordination of operations as a whole, flow control, and participation in the various activities, but also acting as the partners' primary interface. Furthermore, the manager needs to examine possible areas of development and create new services (buffer inventory, home delivery, etc.).

The ELCIDIS platform

Citroën Berlingo

ELCIDIS was designed not only to promote delivery in electric vehicles, but also to relieve traffic congestion in the centre by reorganising deliveries. To that end, a new traffic regulation was passed: heavy freight-delivery vehicles (i.e. GVW exceeding 3,5 T) are allowed to deliver within the perimeter between 6 and 7:30 a.m.

To assist ELCIDIS in the start-up phase, the Urban Community decided to provide the manager with premises (some 750 m^2), vehicles, handling equipment, computer hardware (not including software), a fast-charge port, and office furniture.

To give the manager incentive for expanding the platform's operations, in terms of both number of consignors and auxiliary services, it was also decided that Transports Genty would be remunerated on the basis of the number of parcels handled on the platform (pick-up and delivery).

Results obtained

The ELCIDIS platform engages in two distinct types of activities: delivery of parcels handed over by consignors and auxiliary services. The main auxiliary services are storage for staggered delivery to shop owners, and business-to-business or business-to-consumer deliveries, in particular for marine hardware vendors, caterers and florists.

Judging from a year and a half of operation, the results are highly encouraging and confirm that the ELCIDIS platform experiment is well worth pursuing.

The carriers' viewpoint was polled in several interviews:

- the platform is accessible and well-situated,
- operation is considered the same as for any other platform,
- relations with ELCIDIS staff are very satisfactory,
- the time saved per day and per lorry is estimated at 3 hours,
- by eliminating the stress of centre-city delivery, working conditions have improved,
- the service provided by ELCIDIS delivery personnel is considered good,
- no complaints were registered on the part of shopkeepers.

The only negative perception concerned the platform's rates, considered too high.

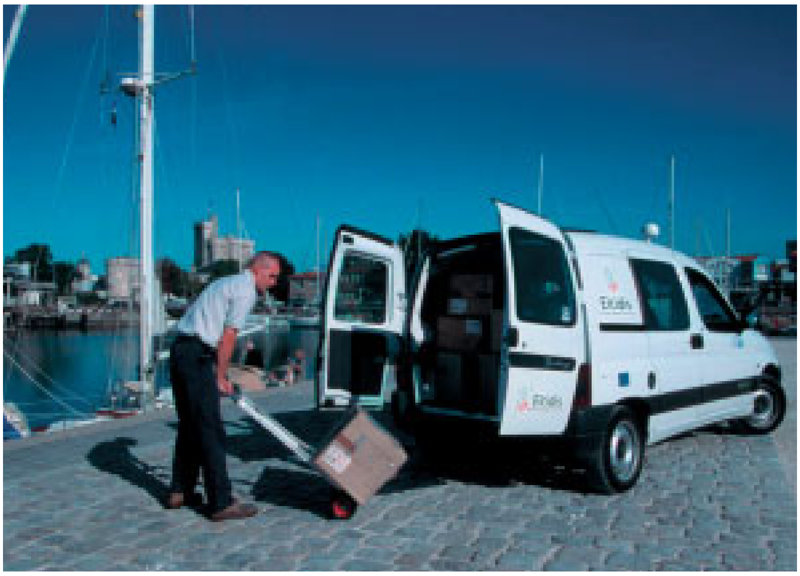
As for the shop owners:

- 58% of the businesses located in the restricted area received deliveries via ELCIDIS.
- the main activities involved are clothing and footwear (21%), services (19%) and cafés-hotels-restaurants (17%).

What is their perception of ELCIDIS:

- very high quality service by delivery personnel,
- substantial reduction in noise observed,
- noticeable decrease in delivery-related traffic congestion,
- set-up fitting the requirements of the city centre.

Some noted, however, that the vehicles were not suitable for certain types of goods delivery (roll-tainers, clothes on hangers).



Citroën Berlingo at work

Recommendations

Three major recommendations can be made:

- For such a system to be implemented successfully, it takes conviction on the part of the partners of the operation's validity and genuine determination in policy making.
- The various parties involved – the manager, municipal authorities, carriers, shop owners, and Chamber of Commerce and Industry – need to co-operate closely not only during the preparatory phase but, just as importantly, in the course of the operation. Collectively, they can react swiftly and, where required, make organisational changes.
- Compliance with regulations implemented in conjunction with the system must be enforced. To do so requires constant pressure on the part of the municipal police force. This has been the case in La Rochelle ever since February 2001, resulting in much less traffic congestion in the centre city's streets.

2.4 Erlangen

Problems faced

Erlangen is Bavaria's 8th largest city with about 100.000 inhabitants.
The three neighbouring cities of Nuremberg, Fürth and Erlangen, the Greater Nuremberg Area, rank among the ten largest economic regions in Germany.
In Erlangen motor traffic is the main source of air pollution and in the following years its volume will even increase. Within the city area the present concentration of pollutants such as ozone, diesel soot and benzene, which arise in traffic, spreads a risk for people's health.

Goods deliveries in the centre of Erlangen are organised using diesel trucks and vans, causing environmental stress and making the city less attractive to both shoppers and residents. However, besides important national distributors such as Deutsche Post, United Parcel, etc. there is no transport service especially for Erlangen or its adjacent area. Companies and organisations deliver and dispose goods and provide services by themselves.
For commercial traffic there are much less alternative means of transport. A dynamic and flexible economy makes very high demands on mobility. There is an enormous demand on the commercial economy for rapid, flexible and always available mobility.

Solutions adapted

In Erlangen the first task was finding an appropriate vehicle for being operated in the project. The market for electric and hybrid vehicles is very thin because only few suppliers provide for this segment. Some typical features of the Audi Duo supported selecting the Duo technology. This vehicle with a payload of 400 kg and its flexible usage combines the demands of various companies. It is not the transport of heavy and large goods that is carried out via this means of transport but the flexible, daily necessary transport of lightweight and small goods that must be purchased or delivered in local traffic. The combination of an internal combustion engine with an electric motor offered both the possibility of driving emission-free within the city centre and other densely populated areas plus the potential of guaranteed mobility over large distances. The limited capacity of the vehicle's batteries was used only for the emission free short distances and has no influence on its range. In contrast to the latest state of the art of electric vehicles the Audi Duo concept offered a fully adequate substitute to conventional vehicles.

The usage of a standard vehicle guaranteed that concerning its driving performance, safety, range, space and comfort, no cuts had to be made. These were the advantages of using a station-wagon, providing enough room and load-carrying capacity for goods transport and allowing a comfortable passenger transport.
The vehicles were operated by commercial users who were interested in environmentally friendly driving systems and also paid a rent for them.
Audi AG, manufacturer of the Audi Duo, was also in charge of the technical support. The costs which incurred for repairs and Duo-specific spare parts were completely paid by Audi. Because of their intricate technology, the Audi Duo cannot be repaired in every garage. The specific technologies of both the hybrid vehicle and the utilised data analysis system require a special technical support. As a result repairs on the electronic and the battery system were carried out by EDAG in Ingolstadt.
Biemann, Audi trader in Erlangen, was in charge of repairs and maintenance of the Audi Duos' conventional components. In addition to that, first failure forecasts of the electronic and the battery system were also made. The Erlangen city management was in charge of organisation and logistics for transport and repair of the vehicles.

Besides the operation of hybrid vehicles in Erlangen, solar systems and recharging stations were planned to be constructed, with which regenerative energy sources should be tapped for the vehicle's electric power consumption. Considering certain preconditions, operating the Audi Duo would have been possible at 100% using regenerative energy. However, because of internal disagreements in decision-making and the time which already had passed these facilities were decided not to be constructed any more. Because of the German laws a direct feeding of regenerative energy was not guaranteed either.

Results obtained

The trial for the ELCIDIS project vehicles in Erlangen was started in spring 1999, with 6 vehicles in March and all 10 since April 1999. In August 2000 Audi drew back one of the vehicles because of several accidents and did not replace it any more.

This drop in the number of vehicles was also considered when settling the leasing costs. In Erlangen the fleet trial ended as agreed on August 31st, 2001. The vehicles were tested over a period of 30 months. In Erlangen, the ELCIDIS project comprised 287 vehicle test months altogether. 13 companies and organisations were involved in the trial and on the whole 15 test periods were run.

On the average 38% of the total mileage (this roughly applies to a distance of 91.960 km) was covered in the electric mode. Note that the measurement technology did not record all days and covered distances and therefore the indicated distance is extrapolated. Concerning their operating in the electric mode there is a considerable dispersion area between the individual users. The distances covered in the electric mode vary between 12% (subject to the failure of the battery charging set) and 95%. Irrespective of the failure of the battery system it becomes clear that the usage of hybrid vehicles highly depends on the attitude of the respective users towards the electric motor.

The consumption values of the operated vehicles strongly diverge. Note that the driving customs of the respective drivers had a decisive impact on the consumption values. Both type and length of the distance covered daily, driving providently as well as the user-specific acceleration all influenced the consumption.

The average diesel consumption referring to the distance covered only with the internal combustion engine showed values between 6,4 and 13,5 l per 100 km. The evaluated average of the trial vehicles amounted to 8,8 l per 100 km. According to the Technical University Munich in 1999 these values amounted to 7,7 l per 100 km.

The established electric power consumption referring to the distance covered only with the electric motor showed values between 12,8 and 69,8 kWh per 100 km. The evaluated average of the fleet amounted to 36,3 kWh per 100 km. In 1999 the average values amounted to 39,9 kWh per 100 km.

The evaluated mixed consumption, meaning the used amount of diesel fuel and kilowatt-hours of electric power, which was necessary to cover a distance of 100 km in the mixed mode amounted to 5,5 litre of diesel and 13,7 kWh of electric power for 100 km. In 1999 these values amounted to 5,1 l of diesel fuel and 13,5 kWh.

The energy consumption of the A4 1.9 TDI roughly corresponds to that of the Audi Duo without considering the electric energy. Besides the losses in individual components (battery charging set, battery) the main reason for the increased energy consumption is the difference in weight. The Audi

Duo approximately weighs 400 kg more than the A4 1.9 TDI above all due to its onboard batteries. Concerning the generated electric power there are considerable differences between the individual countries. In comparison to countries with a high percentage of hydroelectric power stations, where the supply efficiency is very high, in countries with heating power stations, it is much lower.
Comparing the operated hybrid vehicles with conventional vehicles makes clear that even the best hybrid vehicle uses more energy in contrast to the Audi A4 1.9 TDI standard vehicle. Detailed studies about the emission behaviour were not conducted during the fleet trial. Therefore the diesel fuel and electric power consumption values must be involved and converted.

Nearly all users emphasised that the noise and emission-free driving in the electric mode was positive. They accredited its high acceleration as well as its driving characteristics in the electric and diesel mode. The feeling of driving economically was described as very pleasant. The statements about the battery capacity strongly diverge. After new batteries had been installed, capacity and range of the vehicles were considered sufficient. In other cases, the batteries were older or had defects which led to criticism on the vehicle.
Generally the Audi Duo was considered comfortable and well equipped. Even its payload met the demands of the users. Regarding its high empty weight, the vehicle's road holding and braking power was considered very good.
Operating the Audi Duo during wintertime was valued undecidedly. One user accredited its road behaviour during the winter, but added that it was not suitable for driving uphill. Other users gained negative experiences from driving in wintertime.

Recommendations

Besides the positive and negative valuations, the users also mentioned various improvement proposals. It has been suggested that the vehicle should have been designed all-automatic. According to another proposal, a second generator might compensate the slow battery charging during operation. A similar proposal aimed at designing part of the battery quick-chargeable, in order to compensate better for the high energy losses when braking, by increasing the charging power and thus the braking power of the motor.
Furthermore it has been proposed that the Audi Duo should be constructed more lightweight in future, this proposal was a bit premature, since Audi decided during the project period, that the concept of the Duo would not be produced any more in this configuration.

2.5 Lombardy region / Milan

RegioneLombardia COMUNE DI MILANO

Problems faced

Milan, with about 1.500.000 inhabitants, situated in the heart of the Lombardy region, is the largest industrial city in Italy. Due to its central function in northern Italy, Milan attracts a lot of traffic, which almost constantly congests and pollutes the city streets. Milan's urban transportation plan focuses on promoting public transport and introducing clean individual transport.

Regione Lombardia accounts for 35% of all Italian inter-modal transportation of goods, and this volume is expected to increase further on: recent estimates forecast over 23 million tons for the year 2005. The major part of goods are transported on roads contiguous to the towns, or even through them, often transiting through obsolete terminals located in heavily urbanised environments.

In Milan, the goods distribution calls for 15% of total vehicles in the city; 65% of charge-discharge operations is done in no-parking areas, and goods distribution companies account for 14% only of the vehicles used for the distribution, while the other 86% belong directly to shops and wholesalers. Most goods transportation companies are also very little and use their vehicles for both urban short-range delivery and for long-range town-to-town distribution.

In short, the logistic system (routing, inter-ports, distributing companies) is not adequate, both at regional and towns level, and calls for a substantial reorganisation.

In this situation, a project on the goods distribution systems of Milan Metropolitan Area, called "Milan as Experimental Centre for Goods Distribution" was launched in the last years under the aegis of Milan Municipality and the Italian Ministry of Industry, in co-operation with Regione Lombardia. This project aimed at defining possible reorganisation scenarios, and whose issues will set a reference for Milan as well as for other Italian cities, both in terms of a better management, control and rationalisation of the traffic flows and in terms of environmental improvement.

It is expected that appropriate interventions could produce a reduction of about 7% of air and acoustical pollution, and also 7 to 10% of energy saving as a result of the more efficient fluidity of traffic flows.

The analysis so far carried out, related to Milan and its 38 hinterland municipalities, totalling about 2.400.000 persons, over 190.000 firms and 36.000 commercial activities, points out different critical aspects, ranging from the widespread lack of warehouse areas pertinent to commercial activities, the insufficient availability of parking areas reserved to loading and unloading of goods, the trend to an increase of goods categories dealt in by the shops.

Solutions adapted

The definition of possible measures is still in progress: in the short-medium period they will focus on setting up specific loading-unloading areas for goods, access regulation for commercial vehicles and the possibility of overnight distribution of goods. For the medium-long term it is under evaluation the possibility of building up new logistic platforms or improving the existing ones (in the Milan metropolitan area no inter-port exists, while there are 9 inter-modal exchange platforms), and of separating commercial and private traffic.

Of course, the above study includes the assessment of the optimum role that ‘clean’ vehicles - including electric and hybrid ones - can have in the overall goods transportation system, also taking account of Regione Lombardia policy, that since many years supports the introduction of these vehicles.

This situation gave a strong boost to the participation of Regione Lombardia and Milan Municipality in the EU ELCIDIS program, as the two projects integrate each other perfectly.

In past years Regione Lombardia already granted various projects for the use of electric vehicles for the distribution of goods by private companies; despite the potential of application of such vehicles, the unsatisfactory experience they had, namely the technical unreliability of old-generation electric vehicles and their high operating costs, made it difficult to involve again, in the ELCIDIS program, commercial companies of goods distribution. Instead, the approach of Regione Lombardia participation to the project was rather intended at assessing thoroughly the functionality, reliability and economics of today electric vehicles, which was strongly necessary to “remake” the image of electric vehicles and then encourage again transport peoples.

This action has been performed by putting the vehicles of ELCIDIS project in other niches of transport, where the operating conditions are very close to that encountered for the distribution of goods. These niches were selected within the company fleets of the Milan Municipality and of AEM SpA (the energy company of the city).

Specifically, 9 vehicles were put into different departments of Milan Municipality (Water supply; Sewerage system; General services; Parks and Gardens; Informatics and Telecommunications; Environment) and 4 into AEM (General affairs and services; Building services), whose missions match very well the requirements of urban goods distribution: 5 to 6 working days per week; up to 15 missions per day, typically for the delivery of material and mail to plants, offices and customers; wide range of payload; up to 80 kilometres per day.

Both Milan Municipality and AEM focused the choice of the vehicles on van Citroen Berlingo, as its characteristics fit at best the technical requirements of the electric city goods distribution systems: speed up to 90 km/h, so as to be compatible with the high-speed belt roads of the town; urban range around 100 km (60% of present goods distributors have daily total mileage within 60 km); nickel-cadmium batteries, that allow the use of the vehicles also in cold winters; presence of an extended assistance network in the area. It was specifically excluded the recourse to high-technology prototypes that have not yet reached the phase of industrial production, in order to avoid mixing technological R&D problems to the intended demonstration of operational capability.

Results obtained

The overall adequacy of the vehicles has been checked by an in-depth monitoring of their conditions of use and operational results: their technical reliability, the energy consumption and running costs, the acceptance by fleet owners and by drivers.

The monitoring was performed by means of paper questionnaires filled-in daily by the drivers, according to a procedure already adopted by Regione Lombardia for the fleets financed in previous experiences. Every vehicle was equipped with its own on board electricity meter for the measurement of the consumption. The processing of data has been carried out by CEI-CIVES - the Italian Section of AVERE, in strict co-operation with ECN, CITELEC and Acinnova, the society of study and services of the Automobile Club of Milan.

The operation of the vehicles was started in March 2001, and the monitoring was ended in August 2002, while the operation of the fleet continues.

So far, no major fault or problem occurred. As a whole, the fleet has run about 50.000 km, with values scattered from 2000 to 9000 km for the individual vehicles. The average daily mileage of the vehicles is about 40 km (it has to be considered that in the “commercial” speed of traffic in Milan, this mileage corresponds to driving times of about 3 hours), and 97% of the daily mileage is within 70 km. The vehicles have been used in the 84% of the working days; in the missing days they were mainly stopped for the installation of internal fittings or repair of the on-board electricity meters, which occurred on 4 of the 13 devices installed.

Only 3 minor vehicle faults have occurred: one to the drive system, one to the recharging cable, and one to the battery charger; the repairs have been performed by the servicing workshop of the car agent. As a whole, this picture suggests a good maturity and reliability of the vehicles.

The recharge of vehicles was done typically overnight, with few opportunity charges during the day-time (less than 10% of the days for the whole fleet). The consumption of electricity has been on the average of about 350 Wh/km, with individual values scattered between 290 and 410 Wh/km, depending on the vehicle and the environmental conditions. Low temperatures seem to affect significantly the energy consumption: in fact, the consumption measured on the same vehicle increases of 15-20% passing from 20°C to 3-5°C.

These results permits now to evaluate in an objective way the running cost of these vehicles, which represents one of the most important issues for the fleet operators. Of course, a complete picture will be reached when data on the average life duration of the batteries will be also available.

According to the interviews carried out, both fleet managers and the drives declare to be satisfied of the vehicles: the opinion about the vehicles and their performance is between ‘sufficient’ and ‘excellent’, although a certain lack of comfort due to the want of the air conditioning, and the limited range capability, are stressed; on the same time the ease of operation in the city traffic is explicitly appreciated.

In fact, Milan Municipality, apart from other actions for the introduction of electric vehicles within goods transportation companies, has accepted that these vehicles can carry out basically the same kind of services that were previously assigned to thermal vehicles within their respective Departments, and intend to extend their introduction in its own fleet.

As a whole, the results of the ELCIDIS project confirm the maturity of present generation of electric vehicles and support their introduction in the goods distribution system as well as in the general system of urban mobility. Therefore, as mentioned, the proposals of the Milan as Experimental Centre for Goods Distribution Project will take into account these issues, taking into consideration as well the logistic experiences carried out by the other European partners participating in the ELCIDIS program. In the meanwhile, contacts with the goods distribution organisations and companies have already been established.

Recommendations

From the fore-mentioned contacts, it appears clearly that, in addition to the technical adequacy and acceptable costs of the vehicles (the legislation of the Italian State and of Regione Lombardia support financially the purchase of low-pollution vehicles for different categories of operators, typically public ones), they consider as strongly necessary to foster the use of electric and hybrid vehicles through additional measures: in general, they do not perceive for their companies significant advantages in using these vehicles. What they would need in order to change their attitude is some form of competitive advantages, like fiscal benefits, or benefits in terms of circulation, parking, access to restricted areas, hours for distribution in town.

In this respect, a Working Group has been appointed within the Milan as Experimental Centre for Goods Distribution Project, aimed at evaluating and proposing what kind of incentive measures could be adopted in order to increase the appeal of non polluting vehicles in terms of a plus for the end users.

In the view of Milan Municipality, good possibilities in this respect will arise after the realisation of the town electronic gates for traffic monitoring and control, which are in the projects of the town and that would permit to identify and acknowledge the vehicles to be admitted to benefits in terms of regulation.

As a preliminary issue, the Milan Municipality is presently adopting new regulations for goods loading and unloading and for the access and parking of heavy vehicles in the town; in a next phase, possible facilitation for low-polluting vehicles will be assessed.

As an additional side support, in order to encourage the use of electric vehicles in the town both by public agencies and private individuals, Milan Municipality is also planning the installation of a number of public recharging stations, in areas having an high affluence of peoples: municipals buildings, universities, the court of justice, etc. This action is carried out by AEM in co-operation with Milan Polytechnic, and is supported by a partial granting of Italian Ministry of Environment.

Finally, Regione Lombardia is considering to issue a Regional Act granting support for the introduction of non-polluting and new-technology vehicles to private figures, so as to complement the laws of the State, that typically are addressed to public bodies and organisations only.

Stavanger

Problems faced

The city of Stavanger, 100.000 inhabitants, is located on the south western coast of Norway. It is part of a region with a population of over 225.000. Although the oil industry is the main employer in the region, Stavanger is looking for alternatives to vehicles powered by internal combustion.

The introduction of electric vehicles is part of this policy, one of the items being focused on a cleaner and more efficient urban distribution. Congested traffic in the city, air pollution and half-empty goods transportation vehicles triggered the interest of this project. This was further fuelled by the wish to signal solutions and not barriers. The focusing itself on logistics and new clean vehicle technology, can inspire others than the project partners, to take action.

Two main issues were raised :

- Better co-ordination of the goods transportation to reduce driven kilometres.
- New technology (electric vehicles) to reduce CO_2 and other emissions.

Solutions adapted

The first phase introductory study to define the problems and challenges took into account the Thermie B project document "Alternative Urban Freight Strategies" and its conclusions.

The project partners in Stavanger then studied their need regarding routing and logistics after which the actual user group or department in the individual organisation were defined. The users defined the necessary vehicle performance needs to be :

- Driven km: Maximum 70 – 80 km per day.
- Speed: Maximum 90 km/h. Most of the time 30 – 50 km/h.
- Goods type: Packages, documents, equipment. Max. 40-80 kg.
- Goods volume: Varies; the largest 1 m^3 but up to 3 metres long.

Based on the above, studies of routes to find most suitable stretches for electric vehicles (avoid steep hills, avoid traffic light stops etc.) have been studied. It was concluded that the need for a fast charging station that was planned was not present. The vehicles could perform their task without access to fast charging. Instead, a new "normal" charging station was introduced and built in the city centre. The function was twofold: Charging and signalling effect to passers by.

Studies of typical available electric vehicles on the market were carried out, procurement initiated and the following choice of vehicle and battery were made by the applicable project partners:

Citroën Saxo / NiCad:	1 for Lyse Energi AS (energy utility) and 1 for Statens Vegvesen Rogaland (State Road Authority)
Citroën Berlingo / NiCad:	1 for Lyse Energi and 1 for Stavanger Kommune (Municipality)
Peugeot Partner / NiCad:	3 for Posten (The Post Office)
Mercedes Sprint / Lead:	1 for Posten, last vehicle to be introduced in the project.

Results obtained

The electric vehicles have been introduced fast in order to be running for as long as possible in the project period, while monitoring is going on.

Due to the fast introduction of seven of the eight vehicles in Stavanger, the energy monitoring period and evaluation period have been long. The results are as follows:

The charging station has been used only rarely. Most vehicles are charged at each company's own base. This has been sufficient for the users. But the station has helped marketing the ideas and making the project visible.

One of the vehicles (Mercedes Sprint) has had a lot of technical problems that have hampered monitoring, but it is now running well. The other seven vehicles have had surprisingly few technical problems in spite of running for several years. Figures for one year shows that the seven vehicles ran 54.000 km in sum. This is equivalent to the distance run by one typical Norwegian private vehicle in 4 years.

The record driving distance for one vehicle per battery charge is **90 kilometres.**
However, the average driving distance for each vehicle has varied from 20 to 53 km per day.
The ”limited” driving range that often have been used as an argument against electric vehicles have hence not been a limiting factor in this project. In fact the vehicles could have been run twice the length every day if the need was there. Battery type electric vehicles are thus even today performing well in niche markets meaning distances up to 90 km per charge and speeds below 100 km/h.

The total electric energy need for the seven vehicles per year is only 16.800 kWh.
Per vehicle average 2.400 kWh, equivalent to the energy needed of a tiny electric resistance heater in a small 2m^2 toilet room in a house switched on year round.
Based on the current electric energy price in Norway (NOK 0,50/kWh = 0,07 Euro) the energy needed per 10 km city centre driving cost only NOK 1,55 (0,22 Euro).
A similarly sized and used petrol driven vehicle currently costs NOK 9,00 /10 km (1,20 Euro). Running costs for city driven goods vehicles with combustion engines are hence **five times more costly** than electric powered vehicles.

Savings per electric vehicle per 10 km running is thus **NOK 7,45 (1,00 Euro).** The project results could hence be headlined: ‘The Euro Saving Electric Vehicle.’

Increasing the daily use of these vehicles slightly, resulting in annual driving distance of 20.000 km per year per vehicle, results in annual fuel savings compared to combustion engine of NOK 15.000 (2.000 Euro).
In Norway the typical 3m^3 goods volume Peugeot / Citroën electric vehicle costs NOK 35.000 to NOK 80.000 (4.600 – 10.600 Euro) more than its combustion engine based sister. The **savings in fuel costs** alone will therefore pay for the extra initial vehicle cost in slightly more than two years or four years depending on vehicle type but based on today's fuel costs.

Provided the batteries are well maintained, maintenance costs for an electric vehicle are far less than for combustion engines that need oil etc.
Including these savings and savings in omitted toll road fees, free parking etc. could lower the **pay back time for the extra vehicle costs down to 1,5 years or 3 years.**

The driving pattern is confirmed to be extremely important in relation to energy need. One of the Posten vehicles (Peugeot Partner at Sola) has been used in a non-ideal route demanding very frequent stops and starts, every fifty or hundred meters. Compared to most of the other vehicles in the project needing 0,20 – 0,35 kWh/km, the Sola vehicle needs 1,20 kWh/km. This is three to six times more than average and running costs per 10 km arise to close by those of a petrol car. It is even higher than the large Mercedes Sprint and solely a result of driving pattern.

Internal motivation among drivers has been a demanding issue in the project since the vehicles have been manned by several shifts and many different drivers. Every week the seven vehicles have been handled by 20-25 different drivers. In the project period these drivers have been exchanged by totally new drivers leading to training over and over again.

Obtaining media coverage for the project was easy in the beginning when it was looked upon as a novelty in the city. As the project proceeded well, it has turned out to be extremely difficult to get coverage since the media seem to have an agenda being more interested in conflict and problems than in a smooth running operation. This has been a surprising experience.

Recommendations

Most vehicles (Peugeot and Citroën - seven out of eight) have been running well, although some hick-ups were registered with one of these seven, as the battery broke down in the Citroën used by Stavanger Kommune. First the battery supplier refused to replace the whole battery, instead insisting on only replacing the broken cells. Shortly after the replacement the rest of the battery failed - as predicted - and the whole battery had to be replaced. The time consumed in this process was very high. The vehicle first broke down in the end of June 2001. It was mid-October until the car came back on the road. Three and a half months repair time, which is unacceptable.

The vehicle that has not been running well (Mercedes Sprint), has suffered badly from lack of action from the supplier/manufacturer in handling the technical problems fast enough. The technical problems themselves have been relatively ‘small’, but the consequences for the user have been at intervals huge, annoying and threatening to the atmosphere in the whole project.
In the future it is necessary to demand as early as in the contract negotiations that vehicles based on new technology being manufactured and marketed must be given the same priority in terms of repair time, spare parts availability, as other vehicles. They must not be classified as prototypes, if they are going to be used in daily traffic. If prototypes are sold based on brochures not making it clear that the vehicles in question are prototypes, the dissatisfaction among the users can hit back badly.
Not only towards the specific manufacturer or supplier, but it can also damage the reputation of the whole electric vehicle sector. It can be set back by years if rumours of bad experiences are allowed to spread unattended. Numerous meetings have been held in Stavanger regarding this and today, finally, the manufacturer seems to be handling the vehicle and the customer as they should be handled. Lessons are learnt.
All partners express that they will keep the vehicles in use after the project period has expired.

A final general remark:

The discussions now going on around hydrogen / fuel cell technology might inhibit the extensive use of battery electric vehicles. Potential users seem to be given the impression that a ‘new’ technology is just around the corner and they should wait for it. Our experience and recommendation is that ‘the corner’ could be a long one and that battery electric vehicles could also play a role in the future, certainly in urban goods transportation. The two technologies are not that different. Electric propulsion seems to be a common feature in both. It is just the energy storage (hydrogen versus battery) that provides a choice in the future. The difference, though, is this: Electric battery vehicles are commercially available and reliable already. However for long distance driving hydrogen / fuel cell is the hope of many, provided the energy is produced from clean energy sources.

3.1 Used technologies

Vehicle types

The ELCIDIS project deployed a total number of 55 vehicles, 39 battery electric and 16 hybrid electric. These vehicles (6 different types) present a good overview of the European electric vehicle market as of today.

1. Electric Citroën Berlingo/Peugeot Partner in Stockholm, La Rochelle, Regione Lombardia/Milano and Stavanger and electric Citroën Saxo in La Rochelle and Stavanger. These French-built vehicles may be considered the only ones in the project being a serial industrial line product, specifications:

Berlingo/Partner	
Payload	440-500 kg
Gross vehicle weight	1950 kg
Volume	3 m^3
Top speed	90 km/h
Range	80 km
Batteries	Nickel cadmium

Saxo	
Payload	300 kg
Gross vehicle weight	1400 kg
Volume	1,5 m^3
Top speed	90 km/h
Range	75 km
Batteries	Nickel cadmium

2. Electric Mercedes Sprint in Stavanger and Rotterdam in different versions

a. Lead-acid battery in Stavanger, specifications:

Payload	500 kg
Gross vehicle weight	3500 kg
Volume	12 m^3
Top speed	70 km/h
Range	60 km
Batteries	Lead acid

b. Sodium nickel chloride batteries (ZEBRA Z5C) in Rotterdam, specifications per transport company:

	3 x TNT	2 x VGL	2 x NPD
Payload	1250 kg	1500 kg	1000 kg
Gross vehicle weight	3500 kg	4000 kg*	3500 kg
Volume	12 m^3	16 m^3	12 m^3
Top speed	90 km/h	90 km/h	90 km/h
Range	75 km	90 km	90 km
Batteries	2 x Zebra Z5C	3 x Zebra Z5C	3 x Zebra Z5C

* For these 2 vans, a truck drivers license is needed.

3. Hybrid-electric Mercedes ATEGO in Stockholm, specifications:

Payload	2300 kg
Gross vehicle weight	12000 kg
Volume	30 m³
Top speed diesel	110 km/h
Top speed electric	70 km/h
Range electric	30-40 km
Batteries	Lead acid

4. Hybrid-electric Audi Duo in Erlangen, specifications:

Payload	400 kg
Gross vehicle weight	2000 kg
Volume	2 m³
Top speed diesel	170 km/h
Top speed electric	120 km/h
Range electric	35 km
Batteries	Lead acid

5. Electric FAAM Jolly 1200 in La Rochelle, specifications:

Payload	900 kg
Gross vehicle weight	3300 kg
Volume	8 m³
Top speed	50 km/h
Range	50 km
Batteries	Lead acid

The most common vehicle in the project is the small electric van Citroën Berlingo / Peugeot Partner (these two versions are technically identical). This vehicle is a mature commercial product, with several thousands being produced. It is fitted with a direct-current drive train and nickel-cadmium batteries.
The Citroën Saxo, a small passenger car, incorporates the same technology.

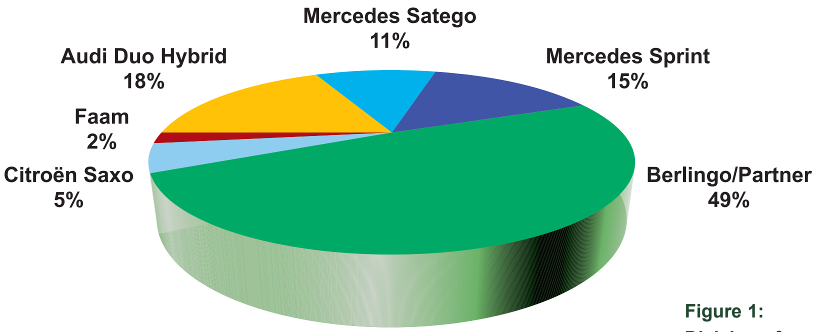


Figure 1:
Division of
vehicle types

The Mercedes Sprint, a large van, is to be considered a limited prototype vehicle, of which only small numbers have been built/converted by hand.

Three different battery configurations for this vehicle were present in the ELCIDIS project: one vehicle in Stavanger was fitted with lead-acid, whereas the vehicles in Rotterdam were fitted with either two or three ZEBRA battery packs.

The FAAM vehicle deployed in La Rochelle represents the proven technology of industrial battery-electric vehicles powered by lead-acid batteries.

Two types of hybrid-electric vehicles were used in ELCIDIS, both having a parallel hybrid configuration: the Audi Duo estate car and the Mercedes Atego truck. The Audi Duo is not being produced anymore, the hybrid Mercedes Atego truck is, like the electric Mercedes Sprint, to be considered a very limited prototype vehicle, the hybrid system for the six examples in the Stockholm project has been handmade

Batteries

Batteries represent the most critical component of the electrically driven vehicle, and it is thus interesting to have a closer look at the batteries used in the project. The majority of these vehicles (i.e. all the French-manufactured ones) are powered by nickel-cadmium batteries. This battery provides good performance and life-cycle, but is quite expensive however.

New battery technology is represented by the ZEBRA battery, used in the Mercedes Sprint of Rotterdam.

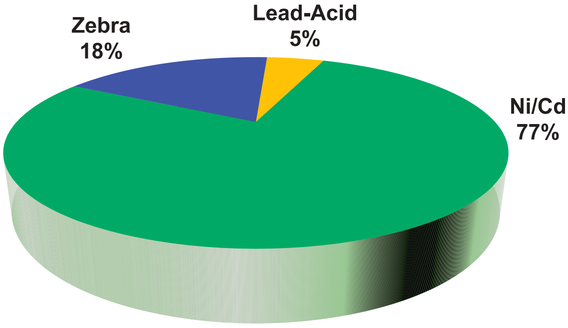


Figure 2: Batteries used by battery-electric vehicles in ELCIDIS project

Two vehicles are using lead-acid batteries: one Mercedes Sprint and the FAAM.

The latter vehicle represents the evolution of the industrial electric vehicle technology, which produces proven and reliable products, albeit for low speed applications which however can be ideally suited for delivery duties in historical city centres where high speeds are not a necessity.

The two types of hybrid vehicles in the project also make use of lead-acid batteries. Their performance may not match the most advanced new batteries, but they have the advantage of a low cost, and they can perform acceptably well in hybrid applications.

Additional equipment

Besides the vehicle technology, in some sites specific recharging equipment, like fast charging and solar panels, has been or was already installed.

For data-monitoring the Mobibox from the Swedish company Mobilsystem AB has been installed in 22 vehicles. In the cases of Rotterdam and Stockholm the vehicle delivery was far too late and typical data collecting problems were discovered in the final project period, therefore a decent result could not be measured anymore with these devices. In these two cases it appeared that the registered data were not in line with the obtained information from the drivers/users, especially with

regard to the driven distances. It is obvious that energy measurements on those base will be leading to a completely distorted image. In this respect the evaluation of energy and environmental impact regarding the whole project can only be considered as a provisional state of affairs.
The reliable registered data have been elaborated in the final report from ECN “Performance and acceptance of Electric and Hybrid Vehicles“, dated October 2002, report no ECN-C-02--080.

Despite these shortcomings and despite the fact that, in the present generation of electric vehicles, most of them are still far from perfectly developed, it has become clear from the succeeded measurements that nowadays battery electric vehicles are already more energy efficient than their ICE counterparts. Partially this is due to their ability in using regenerated energy from braking, but also the much higher energy-efficiency of the electric motor plays an important role. This part of the conclusion underlines particularly the inefficiency of ICE-engines, but is no guarantee for a smoothly large scale transition to electric and hybrid vehicles.
Even with the parallel hybrid configurations, used in this project, the overall energy-use is, despite their increased weight, only a fraction higher then is the case with similar diesel alternatives.

Market barriers 3.2

In principle, there are no predominantly objections to the use of hybrid and electric vehicles in the urban distribution, neither from company managers nor from drivers.
Based on the gained experiences, it is however obvious that price performance ratio, reliability, maintenance and servicing must be set at the same (high) standard as for ICE equivalents, in order to attain a larger market share in this specific niche.
Especially the vehicles investment costs will remain a very important obstacle if a substantial reduction is not foreseen. The French approach where a split in costs is made between the vehicle and its batteries, is a good step in the right direction, but has not (yet) been widely followed.

Another obstacle is the product diversity of electric vans on the market, which is very unfavourable in comparison with the broad range of applicable ICE vehicles.
Vehicles for goods delivery applications must comply with a broad set of requirements representing the diversity of corresponding tasks and surroundings, which are strongly mission-dependent. Payload requirements can vary, and other key aspects like reliability, ergonomics, running costs including energy consumption and maintenance, and the availability of leasing and full service arrangements have to be taken into account. The current practices of fleet procurement and management in the goods distribution sector will usually aim to obtain vehicles with maximum versatility to best cover the respective user needs with a minimum of different types and sizes. The specific case of inner-city deliveries, where low emission and noise signatures are paramount, may create however the opportunity for battery-electric or hybrid vehicles to gain a share of the goods distribution vehicle market.

The main issue encountered when confronting the current offer of electric vehicles with the needs of the operators is the available payload and loading volume for battery-electric vehicles. Vehicles like the Berlingo/Partner for example deliver good performances for payloads up to 500 kg. Operators however face the need to transport larger weights and volumes, many parcels are indeed delivered on pallets, which demand a larger vehicle, preferably provided with a loading platform.

Such vehicles – referring to a payload class of 1000 to 1500 kg – are not offered in the catalogue (as commercial line products, not converted) of major European manufacturers.

The specific market situation of the different batteries must also be taken into account. The most common battery now on the European market, the nickel-cadmium battery, gives good performance but is hampered with two problems.

On one hand, this battery is quite expensive, representing over 50% of the cost of the vehicle without battery. This makes the cost of the vehicle, batteries included, non-competitive and creates the need for appropriate battery financing and leasing schemes, which also present the advantage of ensured battery maintenance.

On the other hand, the nickel-cadmium battery is threatened by the European "End-of-life"-directive, which bans cadmium from automotive applications. A derogation to this directive, up to 2005, has been proposed for nickel-cadmium batteries for electric vehicle traction purposes, due to the fact that there is no ready alternative available now on the European market: nickel-metal-hydride batteries are not offered in Europe, lithium batteries are not yet commercial products and the ZEBRA battery is only appropriate for heavily used fleet vehicles.

Facing this ban however, it is interesting to state that the use of cadmium in traction batteries is a very environmentally friendly one, the cadmium being confined inside of the battery and being fully recycled after use. Furthermore, there will always be a production of cadmium as an inevitable by-product of zinc refining. This cadmium should be used in a sensible way. Electric vehicle traction batteries are a prime example of such a sensible application.

The venerable lead-acid battery still can provide good services, especially in hybrid and industrial-type vehicles. Its energy density is not too high, but it presents the advantage of a proven technology at a relatively low cost.

New types of batteries, like the ZEBRA, offer substantially higher performance but are still in the process of gaining sufficient maturity to have a true market impact as a commercial product. This applies as much to peripherals such as chargers and control systems as to the battery itself. The energetic balance of the high-temperature ZEBRA battery makes it particularly suitable for vehicles which are used in an intensive way, such as commercial goods distribution vehicles.

An interesting feature concerning batteries is presented by the Rotterdam vehicles, which were fitted with either two or three ZEBRA battery packs, thus offering a trade-off between payload and range and allowing the customer to select the best vehicle in function of the desired mission. This choice is also possible with industrial vehicles using lead-acid traction batteries.

Successful applications 3.3

All applications may be considered as successful, especially with regard to the main objective, proving the suitability of hybrid and electric vehicles in urban distribution. In this respect, the projects in **Erlangen, Lombardia/Milan and Stavanger** have provided a very important part in proving the vehicles suitability over a long trial period, where in Erlangen and Stavanger the testing even lasted at least 2 years and 6 months.
However, when the specific logistic approach is taken into account, the projects in **Rotterdam, Stockholm and La Rochelle** deserve special attention. In these sites the combination of using hybrid and electric vehicles from urban distribution centres (existing or newly created) has proven to be a very suitable concept. In that concept, the generally prevailing opinion about the technical disadvantages of hybrid and especially electric vehicles are of no concern. In these sites, vehicles are operating from a home base, the UDC, are able to run daily routes without interruption and are being recharged during their inactive night period.

Rotterdam:

Despite the very problematic procurement and apart from the annoying vehicle breakdowns which have been tantalising this local site project, company managers and drivers were nevertheless enthusiastic about the vehicles performances for this type of use. The project has very consciously made use of the existing urban distribution centres from the three largest transport companies for (inner) city delivery of parcels and packages. Providing that market availibility, quality and reliability of large electric vans equalises the high standard of ICE vehicles, this solution can be easily adopted by all larger cities, where a similar logistic system is already available. In order to provide extra support for such environmental friendly based urban distribution systems, beneficial measurements for the use of electric vehicles, like extension of delivery hours and possibilities to enter restricted areas, are strongly recommended incentives.

Stockholm:

Also the city of Stockholm has experienced a very problematic procurement for their hybrid vehicles, followed by annoying unexpected breakdowns. Despite the negative experiences, company managers and drivers are still enthusiastic about the vehicles performances for this type of use. The project has made use of existing urban distribution centres from large transport companies for (inner) city delivery of goods. In combination with the cities extensive traffic policy to improve the environmental and living quality of the area, where access restrictions for the city centre for diesel driven trucks and buses over 3,5 tons was introduced in 1996, the specific environmental benefits of the hybrid trucks are very well appreciated. The applicable companies are now able to deliver goods in the city centre with hybrid trucks, driving emission-free. This concept can be introduced in all larger cities, if similar restrictions are implemented and comparable logistics are available.

La Rochelle:

In La Rochelle, the reorganisation of urban logistics has been seeking cross-pollination between the issue of “city freight distribution” and La Rochelle’s experience in the use of electric vehicles. The operation involved setting up an urban distribution platform near the city centre, from which electric-powered commercial vehicles (Citroën Berlingo/Peugeot Partner) deliver and collect parcels. Their design makes them well suited for the narrow streets of the city's historic centre. The purpose of the project was not only to promote delivery in electric vehicles, but also to relieve traffic congestion in the centre by reorganising deliveries. To that end, a new traffic regulation was passed: heavy freight-delivery vehicles (i.e. GVW exceeding 3,5 T) are allowed to deliver within the perimeter between 6 and 7:30 a.m. Strict maintenance of this regulation has been performed since February 2001, resulting in much less traffic congestion in the city centre streets.
The project in La Rochelle is an excellent example, which should be followed by all small and medium sized cities, where urban distribution can be organised according to a comparable logistic system.

4 Conclusions

The ELCIDIS project aimed to prove the viability of using (hybrid) electric vans and trucks for urban distribution, in combination with the use of urban distribution centres, by demonstrating these applications in several variations. These demonstrations have also (partially) shown the (local) environmental benefits and in that respect paved the path for promoting incentives to benefit the use of these clean vehicles.

All in all, the project succeeded in verifying the principal merits of using (hybrid) electric vehicles in urban delivery concepts, although in some sites it took a great deal of time to get the desired application "on the road".

The project has provided indisputable proof that there are no predominantly objections to the use of hybrid and electric vehicles in urban distribution, neither from company managers nor from drivers, and certainly not from local authorities.

For company managers, the generated positive publicity for using these vehicles is very welcome, recharging at the home base during the night (or weekend) period for those vehicles does match perfectly with this type of use. If schedules for inner-city deliveries would be shifted to (partial) night use, recharging facilities could be adapted by providing fast charging possibilities during the loading-period of the vehicles.
For drivers, the performance of the vehicles is very satisfactory, despite the common view on electric vehicles. The acceleration gives no great problems and was in some cases even better then expected, the smoothness of driving and the quietness in the drivers-cabin is very well appreciated, as well as the positive attitude from shopping people in the inner city. Especially in Stavanger, where the longest testing period in the ELCIDIS project has been achieved (more then 3 years), this is a striking result. Initially most of their drivers had very low expectations, but during the project the appreciation for the vehicles has greatly improved.

For local authorities (both regional and municipal), the view on a realistic future solution for their transport related environmental problems is very much welcomed, as well as the generated positive publicity and the positive attitude from inner city dwellers and shoppers.

Based on the gained experiences, it is however also obvious that price performance ratio, reliability, maintenance and servicing must be set at the same (high) standard as for ICE equivalents, in order to attain a larger market share in this specific niche.
Despite the in some sites proven considerable savings in fuel costs, the vehicles investment costs will remain a very important obstacle if a substantial reduction is not foreseen. The French approach, where a split in costs is made between the vehicle and its batteries, is a firm step in the right direction, but has (unfortunately) not (yet) been widely followed.
A not to be underestimated obstacle is the product diversity of electric vans on the market, which is very unfavourable in comparison with the broad range of applicable ICE vehicles. Vehicles for urban delivery applications must comply with a broad set of requirements representing the diversity of corresponding tasks and surroundings, which are strongly mission-dependent.

Since "home-recharging" has proven to be most suitable, the general lack of public recharging stations is of no major concern. The availability of nearby maintenance or service facilities, whether they are dealer related or not, are however of the utmost importance, certainly in relation to solving unexpected break-downs.

The effect of the pilot on the average fuel consumption, has been measured by means of Mobiboxes, a specialised data-collection system and by means of on-board electricity metres (in Milan). Although the data collection has not been functioning impeccable in all sites, meaning that the evaluation of energy and environmental impact regarding the whole project can only be considered as a provisional state of affairs, the result may still be considered very positive. Despite the fact that the present generation of electric vehicles is far from perfectly developed, they are already more energy efficient than their ICE counterparts. This is not only due to their ability in using regenerated energy from braking, but also the much higher energy-efficiency of the electric engine plays an important role as well as the complete absence of energy use when the vehicles have a standstill, which is quite relevant when making 100 stops or more in one routing. This part of the conclusion also underlines the inefficiency of ICE-engines, but is of course no guarantee for a smoothly large scale transition to electric vehicles.
The future use of renewable/sustainable energy sources must be leading to a far better energy/environmental balance for these vehicles than now calculated.
Even with the parallel hybrid configurations, as used in the project, the energy-use is, despite their increased weight, only a fraction higher then is the case with similar diesel alternatives.

In exchange for the use of clean and silent vehicles in future, the transport companies have expressed their desire to receive advantages. Most important for them are extensions of delivery hours and possibilities to enter areas, which are, or should be closed for other vehicles, like public transport lanes and pedestrian areas.

Recommendations for future developments

First in line is the necessary improvement of the hybrid and battery electric vehicles themselves, this concerns not only the vehicle, but certainly also the batteries.
Second is the upgrading of the product diversity, which should be leading to much more "choice" on the market of these types of clean vehicles.

A possible solution in this respect is the deployment of battery-electric vehicles based on industrial vehicle design. These are available for higher payloads and can be fitted with custom body-work as desired. Their technology is proven and reliable, but they are generally of a strictly utilitarian and Spartan finish. Furthermore, their technology limits them to lower speeds (typically up to 40 km/h), but for those delivery duties which are concentrated on city centres and where the approach routes from the UDC to the delivery area are short, this can still be feasible. These limitations against competing vehicles in the market can be compensated by other tangible benefits (e.g. environmental friendliness), or gradually eliminated by applying lessons of industrial vehicle design, development, production and marketing to this class of vehicles.

For this type of approach, also the development of an electric (or possibly hybrid) tow-truck concept, where the body-work is part of a trailer-concept, could be considered.

The price of electric and hybrid vehicles will remain a very important obstacle, if a substantial reduction is not foreseen, especially the price of the batteries is very high.
The French approach, a split between the vehicle and its batteries, is a very good step in the right direction and should be followed by other providers.
All in all, the price performance ratio and the reliability of these vehicles should meet the high standard that has been reached with ICE vehicles.

Operating hybrid and electric vehicles in urban distribution has to be combined with a UDC based approach, such a UDC could also be located near waterways/harbours or rail distribution centres, for extra possibilities regarding ship-car and train-car transhipments.
For battery electric vehicles, a UDC near the city-centre with "home-recharging" equipment is a pure necessity. For hybrid electric vehicles, the UDC may be located further away from the city, but still at a reasonable distance. In the project, parallel hybrid configurations have been used and these have a somewhat increased energy-use on long distances, due to their heavier weight.
From the transport companies point of view, small and large electric vans are applicable for both postal and package deliveries. For postal deliveries, also the use of (electric) two- and three-wheelers can be considered. Delivery of large(r) parcels and/or voluminous goods need large electric vans and hybrid trucks.

For local authorities, wishing to set-up similar distribution concepts, the following major recommendations can be made:
In order to implement such distribution concepts successfully, it takes conviction on the part of the partners, of the operation's validity and genuine determination in policy-making. All parties involved need to co-operate very closely, not only in preparation, but also in the operational phase.

All public authorities, whether they are local, regional, national or European, must really emphasise their desire for a future with clean vehicles, by introducing beneficial incentives for buying as well as using zero emission vehicles.
In this respect, the request from transport companies to receive advantages in exchange for the use of clean and silent vehicles in future, should be granted.
Most important for them are extensions of delivery hours and possibilities to enter areas, which are, or should be closed for ICE vehicles, for example pedestrian areas and public transport lanes.

This specific niche does not need public recharging stations as a first necessity. However, a 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 and hybrid vehicles, are and will remain of great importance.

There is still the possibility that hydrogen / fuel cell technology might inhibit the extensive use of battery electric vehicles. Especially for urban rides, battery electric vehicles 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 vehicles are already available and reliable.

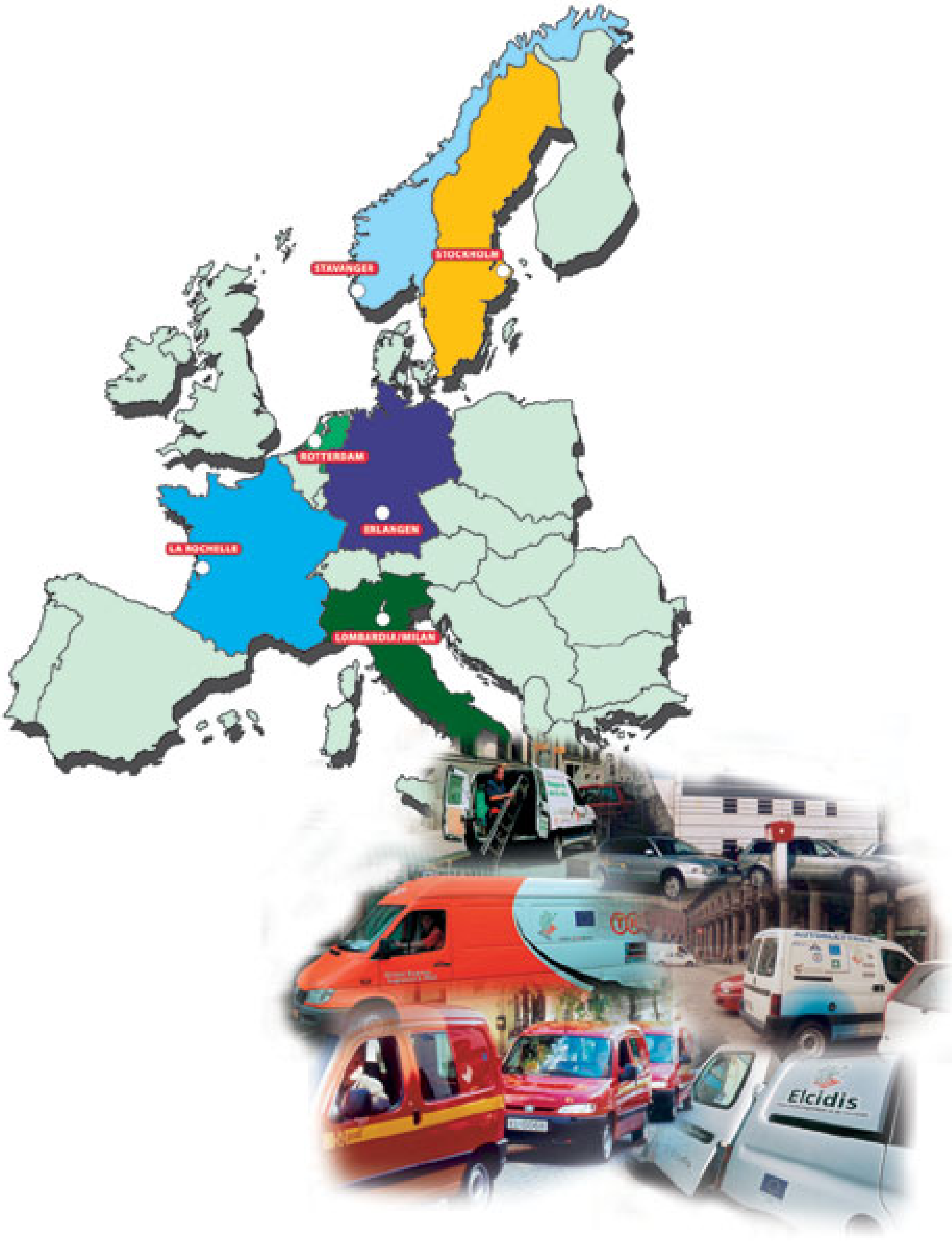
The dissemination activities regarding the ELCIDIS project will be continued by CITELEC and the concerning partners. The website - **www.elcidis.org** - will remain on line, and the project will be presented at future applicable conferences and events.

CITELEC

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 thier 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 the European market**
- **to partake in actions to study and demonstrate EVs and hybrid vehicles in European cities**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