EVD-POST electric vehicle operation on different sites, Final technical summary report

Van den Bossche Peter
Deloof Wim
De Bisschop Erik
CITELEC
Pleinlaan 2
1050 Brussel
32-2-6292837
32-2-6293620
pvdbos@vub.ac.be
http://www.citelec.org/

1. Abstract

The Thermie project "EVD Post" is introducing a total of 59 electric vehicles for postal operations in several countries (Belgium, Finland, France, Germany, and Sweden). Several types of vehicles are being implemented, for different postal duties. In the framework of this project, CITELEC has been in charge of comparative testing and evaluation of the postal operations with electric vehicles in different project sites. Measurement campaigns have been performed in Finland (Kajaani and Turku), Sweden (Nacka) and Belgium (Brussels, Wavre and Ostend) with the CITELEC data-acquisition measurement system. In Germany measurements are performed with a permanently on-board measurement system. In France, La Poste took care of the evaluation themselves. The paper gives an overview of the results of these measurements, and draws a number of comparisons between sites.

2. Timetable of measurements performed

The following measurement campaigns have been performed up to the completion of this paper:

- Kajaani, Finland February 1998
- Turku, Finland August 1999
- Nacka, Sweden February 2000
- Brussels, Belgium March 2000
- Wavre, Belgium March 2000
- Ostend, Belgium March 2000
- Bremervörde, Germany February 2001

3. Methodology

On every site, a common methodology was followed, proved during the first measurement campaign in Kajaani. One postal electric vehicle was fitted with CITELEC's measurement system. This vehicle was used for several days in normal postal duties, with measurements being taken. The measurements of both mechanical (speed, distance) and electrical parameters allowed to characterise the postal route followed.

3.1. The CITELEC measurement system

Figure 1: The measurement system installed on board an electric vehicle (Elcat)

The CITELEC data-acquisition measurement system is constituted as follows:
An intern serial datalogger, built in a portable 19"-rack, provides all the signal conditioning, multiplexing, discretisation and digitalisation. The rack is small and meets the needs that are demanded for such a device (electric and electromagnetic isolation, proof against external shocks, no obstacle for driver or passengers,...). Voltages, currents and digital speed measurements are converted into load-independent output signals by internal transducers with linear characteristics. Current measurement is provided by LEM shunts for galvanic separation and no interference with the measurement circuit. Data-acquisition is done by a serial logger, consisting of a 16-channel data-acquisition card and a 64 Kbytes buffer microcontroller card. An external 12 V Pb-battery provides the supply of all the electronics and auxiliary devices, even for the speed sensor.

The logger is controlled by a Macintosh PowerBook laptop computer via a serial connection, and is controlled by a specific application, EV-Powerlogger, written in LabVIEW. While measuring, the data are stored in ASCII-files for easy data processing, which is done in an Excel spreadsheet.
The speed sensor is a DATRON lamp based on a correlation optical method with spatial-frequency filtering and produces an excellent result with very high accuracy.

4. Overview of measurements performed

4.1. Finland: mail delivery with Elcat vehicle

In the framework of the EVD-Post project, 11 electric vehicles (type Elcat Cityvan) are being used by Finland Post on post delivery duties.
Seven in post offices in Turku city area (with two additional electric vehicles)

- Two in Raisio, a city to the north-west of Turku
- One in Kaarina, a south-eastern suburb of Turku
- One in Sauvo, a small commune 35 km south-east of Turku
- Two in Kajaani, a city in the centre of Finland
- One in Rovaniemi (Santa Claus post office) located on the Arctic Circle

Furthermore, five EVD-vehicles (also Elcats) have been deployed by the City of Turku for its own services.

Figure 2: Kerbside delivery in Finland

Let us first consider the way postal distribution is organised in Finland. In city centres, the mail carriers usually go on foot, with an average tour length of 4,3 km. In the suburbs, bicycles are also used (average tour length 9,0 km). Where cars are used for delivery, the average tour length is 43,5 km, including both urban and rural routes. One car route is thus equivalent to 3-5 bicycle routes.
In the residential suburbs, clusters of mailboxes are grouped on kerbside. The number of mailboxes together can be between 1 and 30.
The postman drives by and serves the boxes from his vehicle window.
Only for some multiple dwellings, he has to leave his vehicle for delivery inside the building

The actual characteristics of the mail delivery in Finland can be derived from table I, which mentions average values (over several delivery cycles) in the two sites concerned:

		Turku	**Kajaani**
Trip length	m	33768	23556
Total time spent	h:mm:ss	2:53:18	3:39:15
Stop	h:mm:ss	1:09:45	1:59:22
%stop	%	40%	54%
Run	h:mm:ss	1:43:33	1:39:53
%run	%	60%	46%
Number of stops		240	311
Stops per km		7.1	13.2
Average interval	m	141	76
Commercial speed	km/h	11.7	6.4
Maximum speed	km/h	63.4	60.8
Average speed (when moving)	km/h	19.6	14.1

Table I: Comparison Turku – Kajaani

These data enable to determine some typical characteristics of postal delivery traffic in Finland:

- The actual stop time is about 50 % of total mission time; it is higher in Kajaani, due to the fact that the delivery round in that place contained more apartment buildings, where the postman had to leave the vehicle for mail distribution inside the building. This takes more time, of course, than kerbside delivery.
- The average distance between stops is 75 m in Kajaani and 141 m in Turku (higher there due to longer feeder trajects from the post office to the delivery area)
- The commercial (end-to-end) speed is very low, even down to walking speed, due to the long stop times
- The average speed when running is about 15 km/h, corresponding to urban traffic
- The maximum speed of the vehicle rarely exceeds 60 km/h

4.2. Graphical representation of postal delivery cycle

The following graphs give some examples of postal traffic curves in Finland. Figure 3 shows a 10-minute extract of a typical delivery run. One can clearly see the progress between the stops deserved, as well as the stop time between them. The speed can also be plotted against the distance covered; this gives the results in figure 4. This figure gives a better image of the geographical distribution of the stop points (i.e. mail boxes)

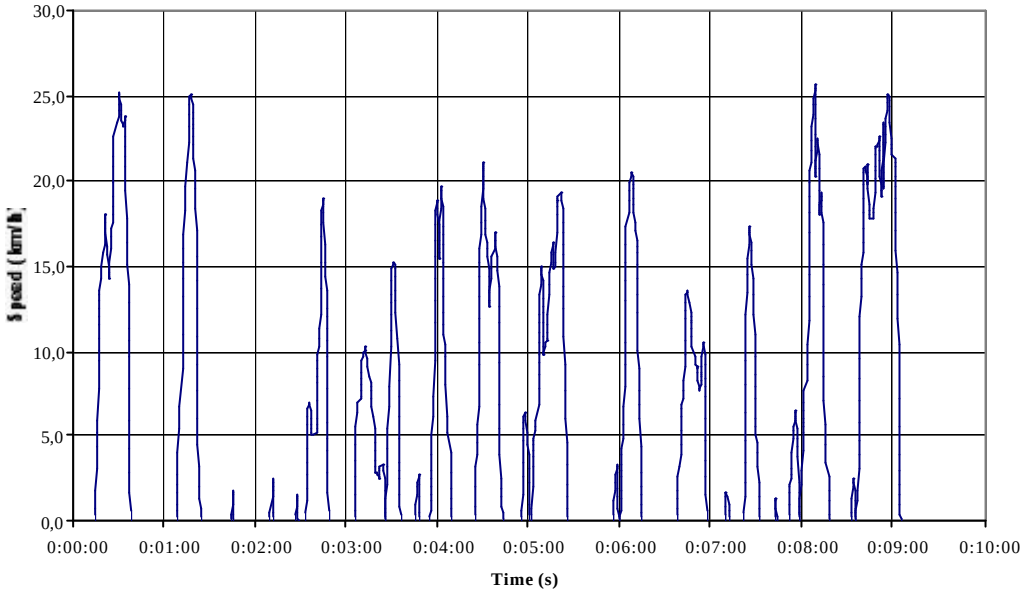

Figure 3: Typical delivery profile

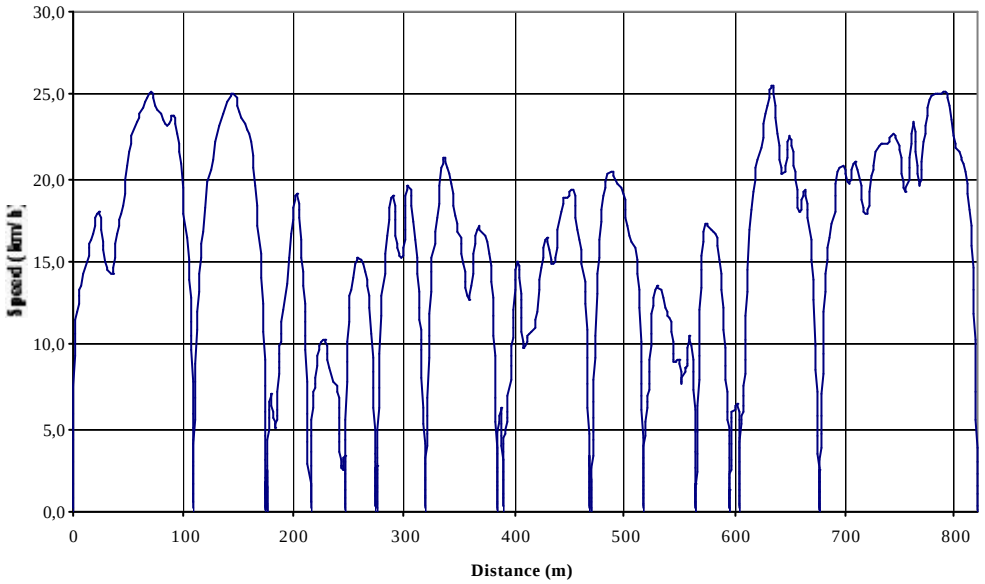

Figure 4: Speed/distance profile

4.3. Kajaani: electric vehicles used in arctic conditions

In Kajaani, the opportunity was also taken to assess the influence of wintry road conditions on the electric vehicle. It has been seen above that cold temperatures do not affect the battery, due to the battery heating system provided, allowing use of the notoriously cold-sensitive lead acid battery. But what is the influence of the road surface? During the test period, weather in Kajaani was quite variable and included both cold and dry periods (down to –25 °C), as well as "warm" periods (0 °C to –5°C) with snowfall.
Road surfaces are being treated with sand and salt to keep them practicable in winter; furthermore, virtually all vehicles, including the tested Elcat, are fitted with studded winter tyres. Normal traffic is possible on main roads; however, fierce accelerations may lead to loss of adhesion (spinning weals) and driving has to be done carefully. Furthermore, a special test has been done on a secondary road, which was covered, with fresh snow, at a temperature of –7°C.This resulted in frequent loss of adhesion during acceleration, and significantly higher energy consumption. The road-keeping abilities of the electric vehicle were exemplary however, and safety of vehicle operation was never compromised (providing the driving style is adapted to the circumstances of course).

Figure 5: Driving on snow in Kajaani, Finland

4.4. Sweden: mail delivery with compact delivery vehicle

Swedish Post is using about 500 electric vehicles for delivery duties. Most are small three- or four-wheelers derived from industrial vehicles. In the framework of EVD Post, a Club Car Carryall vehicle was tested in Nacka, a southern suburb of Stockholm. This vehicle delivers mail in a residential area. The characteristics of the delivery are given in Table II.

Trip length	13940
Total time	2:22:33
Stop time	1:08:34
%stop	48%
Run time	1:13:59
%run	52%
# stops	320
Stops/km	22.9
Average interval	44
Commercial speed	5.9
Maximum speed	32.7

Table II: Delivery in Nacka

Figure 6: The Club Car Carryall in use in Nacka, Sweden

The covered distance is about 14 km per day, with a large number of stops due to the nature of the delivery. The commercial speed is accordingly low; also the maximum speed is limited due to the nature of the vehicle used. Although this vehicle is not to be considered compatible with road traffic, it is used very efficiently for mail distribution. Its small size and high manoeuvrability make that it can go where a full-sized automobile could not. This kind of small vehicle is particularly favoured by Swedish Post: besides the Carryalls, they have a number of three-wheel “Tugger” vehicles in use.

4.5. Belgium: delivery and collection with Peugeot Partner

For about one year and a half, 15 Peugeot Partner Electric are operating at different locations, 2 in Brugge, 2 in Gent, 2 in Ostend, 4 in Wavre , 4 in Brussels and 1 in Antwerp. The introduction of electric vehicles is expected to strengthen the image of the Belgian Post as a responsible enterprise caring for the environment. The tests were performed in Brussels, Ostend and Wavre, as to tackle different topographical characteristics on one hand and different aspects of postal operation on the other hand. The characteristics of the local operations are as follows:

- Brussels: delivery round in residential urban area. Normal delivery is followed by delivery of registered mail.
- Wavre: delivery mainly in industrial estate; hilly topography
- Ostend: collecting of mailboxes; flat topography

An overview of the delivery routes in the three locations is given in Table III.

		Brussels	Wavre	Ostend
TIME	total time (hh:mm:ss)	2:44:41	1:45:47	4:17:24
	stop time (hh:mm:ss)	1:48:32	0:51:43	2:02:33
	% stop	65.9%	48.9%	47.6%
	run time (hh:mm:ss)	0:56:09	0:54:05	2:14:51
	% run	34.1%	51.1%	52.4%
DISTANCE	total distance(m)	20175	49265	57931
	# stops	140	220	163
	stops per km	6.9	4.47	2.8
	average interval(m)	144	448	356
SPEED	Commercial speed	7.4	13.6	14.0
	Maximum speed	64.7	76.6	72.72
	running average	21.6	27.3	25.77

Table III: Delivery routes in Belgium

The differences between the three sites are obvious. Brussels is characterised by a very high stop time, due to the nature of the delivery (registered mail, which is to be delivered in person); the large number of stops there is characteristic for urban areas. Deliveries in Wavre, being more focused on industrial areas, has larger distances between stops, while as for the operation in Ostend, involving mail collection, the distances are even longer between stops. Overall stop time however is high, due to long service stops at sub-offices.

Figure 7: Delivery of registered mail in Brussels, Belgium.
(Note the speed measurement device attached to the back door of the vehicle)

4.6. France: from door to door delivery with Peugeot Partner and Citroen Berlingo

In the framework of this project La Poste is operating 11 Citroen Berlingo and 7 Peugeot Partner. La Poste tested both vehicles in such a way further testing with the CITELEC measurement system would not result in any addition.

In September 1997 a Partner was tested not only in normal postal operation, but also in standard test procedures, like ECE-15, and even in performance tests. Furthermore, a special issue with another limit on the depleting current has taken part of this test in order to see the influence on the range. In addition to the tests carried out with the Peugeot Partner, a Citroen Berlingo has been tested in the same manner as done with the Peugeot.

Although some tests took place in real postal delivery, majority was done on the roller-bench. In order to have a real idea about the range in postal service, some postal cycles were driven on the bench. In Figure 8 one can see an extract of this cycle. The results obtained are summarised in Table IV.

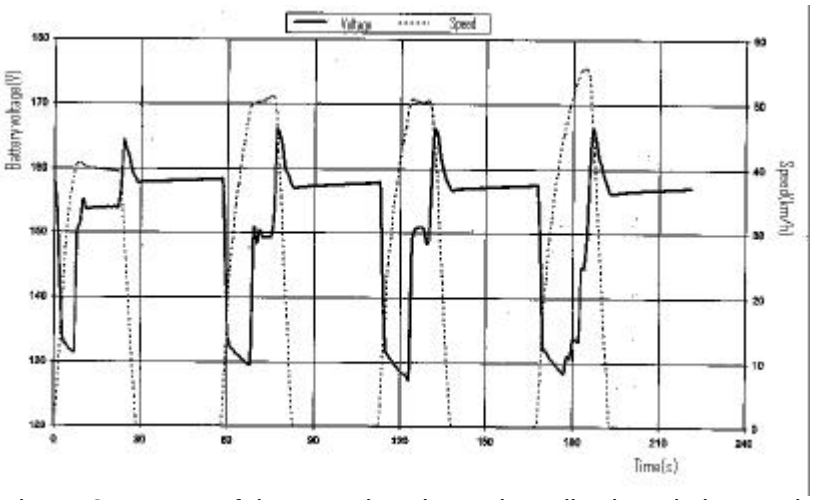

Figure 8: Extract of the postal cycle on the roller-bench (France)

		Berlingo	Partner
Distance	km	48.7	46.7
Instantaneous Consumption	Ah/km	1.93	1.92
# stops		201	196
# stops/km		4.1	4.2
Average interval	m	242	238

Table IV: Energy consumption from the grid

4.7. Germany: prototype-vehicles in postal services

In Germany 5 Mercedes Vito E, equipped with the advanced ZEBRA-batteries, are currently running in postal services. The tests performed pointed special attention on the differences between two different generations of batteries. (Z5B and Z5C). The tests on these vehicles have been performed in January and February 2001; final processing of the data have however been delayed due to formatting problems between different computer systems. Notwithstanding results on this campaign will fulfil this report in the near future.

5. Grid energy consumption

The values for energy consumption out of the grid obtained at the different sites are shown in Table V The reference values are averages measured by CITELEC with similar vehicles in ordinary traffic.

Site	Vehicletype	Wh/km	Wh/Tkm	Ref. kWh/Tkm
Kajaani	Elcat	523	387	204
Turku	Elcat	420	311	204
Nacka	Carryall	398	613	N/A
Brussels	Partner	474	279	191
Wavre	Partner	456	268	191
Oostende	Partner	357	210	191
France	Partner	535	330	191
France	Berlingo	523	322	191

Table V: Energy consumption from the grid

One can see immediately that the energy consumption in postal use is significantly higher then for ordinary use of the vehicle. This is particularly the case when the vehicles are used for actual delivery. In Kajaani, the low temperatures (and additional energy consumption for battery heating) push up the values even more; on the other hand, the values obtained in Ostend are only 10% higher than for average traffic. The vehicle has been used there in fact for mail collection, with relatively few stops, which offers a use pattern not differing too much from urban traffic. Comparing the same technologies (Belgium, France) one can see that the influence of the driver can still be of extreme influence on the energy consumption, even if both are postal services. However one has to be carefully with this results since tests in France were done when vehicles were delivered from the manufacturer and not after several months of experience with these cars.

The consumption value obtained for Nacka may seem relatively high taking into account the small size of the vehicle; however, small vehicles always present a relatively higher consumption then larger ones; furthermore, the charger used for this vehicle is one of simple design, and probably not optimised for low energy consumption.

The higher energy consumption in postal traffic will of course have its repercussions on the attainable range of the vehicle, which for heavy postal delivery duty may be as low as half the range attainable at constant speed. This is a mere result of the laws of physics: stop-and-go operations use a lot of energy. It should not be considered a drawback of electric vehicles; similar rises in consumption can be witnessed with thermal vehicles. When planning the deployment of electric vehicles in postal duties, the prospective operator should beware however when assessing the performances of a vehicle: the range and consumption values given by manufacturers always refer to operation at constant speed or on standardised “urban” cycles (e.g. ECE-15 cycle). The real range to be expected in heavy postal delivery duty will invariably be lower, and the vehicles will have to be deployed according to this. A failure to meet the expected “standard” range should be no ground for disappointment or disapproval of the electric vehicle: the postal delivery service just isn’t comparable to normal traffic, putting a much heavier burden on the vehicle.

6. Conclusions

The measurements campaigns performed by CITELEC in the framework of the EVD-Post project have used common methodology developed during the first campaign in Kajaani (Finland). The comparison for the different sites has highlighted the operational and geographical differences between them. Notwithstanding these differences, the opportunity to use electric vehicles for postal duties has been highlighted in all cases. The postal service however is a demanding one however for the vehicles, and vehicle deployment shall be done taking into account the range for stop-and-go traffic. The use of electric vehicles for postal distribution continues to show itself as an ideal opportunity to improve the energetical and environmental characteristics of postal services. The commitment of the postal organisations participating in EVD Post project towards the electric vehicle is providing a major showcase for other postal operators.

7. Annexes

In annex, the evaluation report for all the different sites are given:

- Evaluation d'un véhicule électrique Peugeot Partner, France, Octobre 1997
- Evaluation d'un véhicule électrique Citroën Berlingo, France, Novembre 1997
- Measurements performed in Kajaäni, Finland, February 1998
- Measurements performed in Turku, Finland, August 1999
- Measurements performed in Nacka, Sweden, February 2000
- Measurements performed in Belgium, March 2000