The Tour of Flanders: an Effective Demonstration Programme of Electric Vehicles to Local Authorities

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Abstract

The Tour of Flanders for Electric Vehicles, which is the result of the collaboration between CITELEC, the Flemish Regional Government, the intercommunal electricity boards and car manufacturers, is a demonstration programme to local authorities in Flanders, the region (population 6 million) which encompasses the northern, Dutch-speaking part of the Kingdom of Belgium. The programme, aimed on cities and municipalities contains two steps. In the first phase an electric vehicle fleet is presented to the city officials and the executive staff of the municipal institutions. Afterwards one or more electric vehicles are put at the disposal of the municipal institutions with full training and support and are integrated in their fleet. Data of vehicle acceptance and energy consumptions are collected. Until now 33 cities have been visited and about 70 vehicle missions happened in 27 cities.

1. Introduction

In order to introduce electric vehicles on the market, local authorities can play an important role. They have to inform their citizens and set an example. On the other hand, out of questionnaires, we know that a large number of the vehicles of municipal fleets can be replaced by electric vehicles, because these vehicles are not used to travel long distances. Furthermore these vehicles operate in town centres, so they can contribute to a healthier living environment if they become zero emission

These were the main reasons to start the Demonstration Programme “Electric Driven Vehicles to cities and towns”. The main goals of the project are:

- presentation of electric vehicles to the city officials and the executive staff of the municipal institutions within the framework of the” Tour of Flanders for Electric Vehicles”, through test rides with electric vehicles and information sessions in municipalities of the Flemish Region;

- integration of one or more electric vehicles in the municipal , making them available to the municipal institutions so they can evaluate these vehicles in an objective way. This integration of these vehicles takes place after a full training and with support of CITELEC engineers.

- organisation of other sensitising actions.

2. Overview of the executed rides and vehicle missions

Until now 33 cities have been visited and about 70 vehicle missions happened in 27 cities:

Leuven, Aarschot, Brugge, Knokke, Gent, Wuustwezel, Rijkevorsel, Ravels, Aalst, Ninove, Hasselt, Koksijde, De Panne, Blankenberge, Oostkamp, Maldegem, Roeselare, Ieper, Zottegem, Hoegaarden, Tienen, Hamme, Waasmunster, Mol, Geel, Mechelen, Kortrijk, De Haan, Bredene, Sint-Niklaas, Lokeren, Tielt, Deinze.

2.1. The demonstrations

The demonstrations involve an intensive contact between the delegates of CITELEC and the city officials and the executive staff of the municipal institutions. First the cities receive a briefing in which the project is proposed. Afterwards there is a follow-up and as a result of this the interested cities receive further information. Then several meetings take place to further organise the event on an agreed date.

The academic session at which the vehicles are presented to the city elders is organised according to the following scheme:

- welcome and introduction by the honorary president of CITELEC
- addresses by:
  - the mayor or an alderman
  - the CITELEC representative (general secretary, director or expert)
  - chairman of the electricity distribution board
  - director of the electricity producing company
- test rides and drives with the electric vehicles with explanation by CITELEC staff

At every session the regional press is invited and for these journalists and all other visitors an information file is prepared. Several broadcasts on the regional television networks and a lot of written articles in the regional press were the result.

During the practical tests of the vehicles and during the reception afterwards the contacts between the researchers and the politicians and officials on the one hand and with the press on the other hand are strengthened. Also the first steps to the second part of the project are set.

2.2. The vehicle missions

Some time later the second phase is prepared. In consultation with the executive staff of the municipal institutions, CITELEC tries to find the most interesting applications in which electric vehicles can be used. CITELEC emphasises that in this application the electric vehicle has to replace an existing internal combustion vehicle of the municipal fleet. This is the only way to convince people of the capabilities of the electric vehicle.

Putting the electric vehicles at the disposal of the municipality starts with a training. CITELEC engineers (Msc level) explain the working principle of the electric vehicles and show the different (visible) components. Because most of the time the drivers are technicians with an active interest in automotive matters, they are vividly interested and put several questions. A lot of misunderstandings about electric vehicles still exist however. Therefore these explanations are really important.

After the theoretical and technical explanations, a practical on-road test is performed. The engineers demonstrate “electric driving”. This practical demonstration is necessary to show the people how to drive economically and how to maximise the regenerative braking, i.e. to create the “EV” feeling. After the test-drive the charging procedure is shown.

Now the drivers can use the electric vehicles to do their jobs. From time to time the engineers of CITELEC contact them to evaluate and to check if there are no questions or problems. The drivers also have a telephone number at which they can get support. At least one time during the lending period an engineer of CITELEC passes by to exchange ideas with the drivers. Out of the registration forms, it has been shown that this intermediate evaluation has a positive influence on the electricity consumption pattern in some cases.

At the end of the lending period a debriefing session with the drivers is organised. Therefore, two questionnaires have been developed. The first one is meant to evaluate the personal opinion of the driver. The second one evaluates the possibility to replace the existing internal combustion engined vehicle by an electric vehicle.

The system to fill in the questionnaires is the same for both. A number of characteristics is enumerated and the driver gives a score (from -2 (“very bad” or don’t agree at all”) to +2 (“very good” or “agree for 100%”)). Then some space is left to make comment.

The first questionnaire has two goals: first we want to find out if the driver is convinced about the advantages of electric vehicles and if his vision about these vehicles is positive. The second goal is educational. By listing the different properties and putting different questions related to them the drivers reflect on all aspects of electric vehicles.

The second questionnaire gives an answer to the question “Are you able to do your job with this kind of vehicle?”. If the application is chosen well, the answer should be “yes”. In practice, this is not always the case. Most of the time the answer is “yes, but...”. The reason for this is psychological. Although these drivers never drive more than 100 km a day, they want a vehicle which is able to do 150 or 200 km a day, without intermediate charging. They are used to drive a vehicle with a so-called unlimited range. For them it is difficult to put a step back.

Another argument people give is that the acceleration capability is unsatisfactory. Again, the background for this argument is psychological. Because they don’t here the noise of an accelerating engine, they think the vehicle does not accelerate.

For most of the people the maximum speed, although limited to about 100 km/h, is sufficient for transportation in cities.

The other properties of these vehicles don’t cause any problems: almost every driver “likes” to drive electric, has no problem with the charging procedure and thinks there is enough loading capacity.

In conclusion most of the drivers think the electric vehicle will be their future vehicle. They also think that electric vehicles have a positive influence on the image of their service.

3. Energy measurements

3.1. Introduction

During the lending periods energy measurements have been carried out. For these measurements CITELEC has constructed professional energy counter systems. These counters are mounted in a box with several sockets and can be used with different plugs. All possible security measures are foreseen: safety fuses, GFCI (ground fault current interrupter) and mounting in a moisture-proof box.

In comparison we also show the global energy consumption measured during the CITELEC measurement campaigns.

The measurements in the cities are performed by installing the measurement system and adding a form which has to be filled by the drivers. The problem we found out almost every time was that these forms were not filled in in an accurate way. The results of the measurements day-by-day are not unusable. Fortunately the necessary data are always recorded when the lending period starts and ends. In that way we can calculate the average energy consumption.

Working with the average energy consumption has the advantage that peaks are shaved. These peaks in energy consumption can be caused for example by discharging the battery partially (less than 30%). In that case the charging time consists essentially of the final charge, which has a much lower efficiency.

We can not eliminate these measurements; on the other hand we don't want to do so, because we are doing a real-life test. If people charge the vehicle every day, although the battery still contains 80% of its energy, then we have to be aware of this. We can try to educate them not doing so, but if they continue treating the battery that way, we can't change it. Furthermore, these observations are very useful for further adaptation of the design of the battery management system.

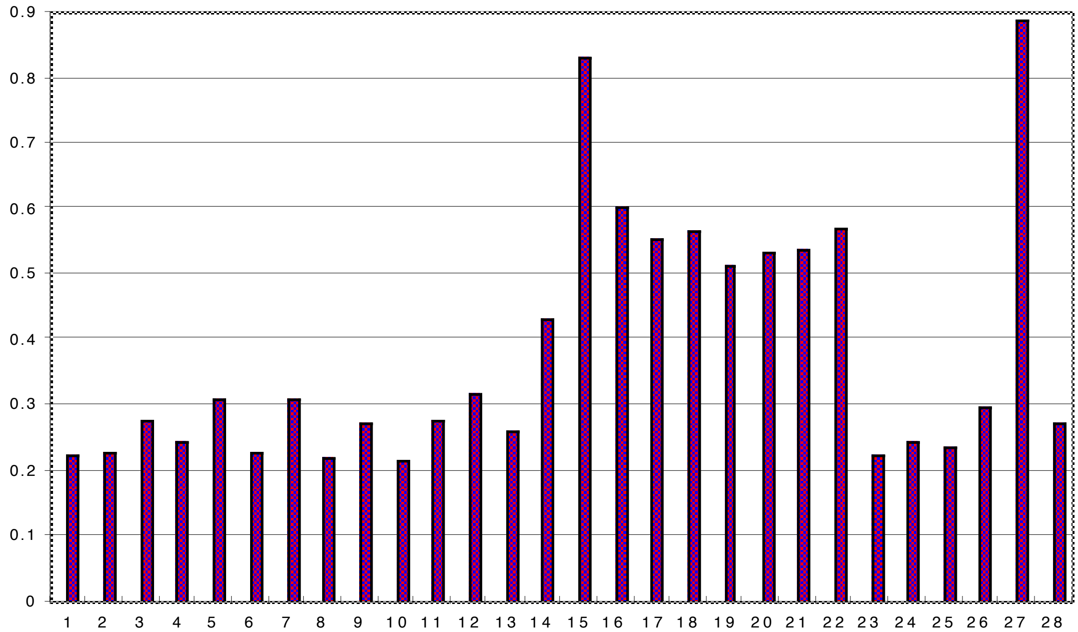
3.2. Results

The results can be found in the following table:

Table 1

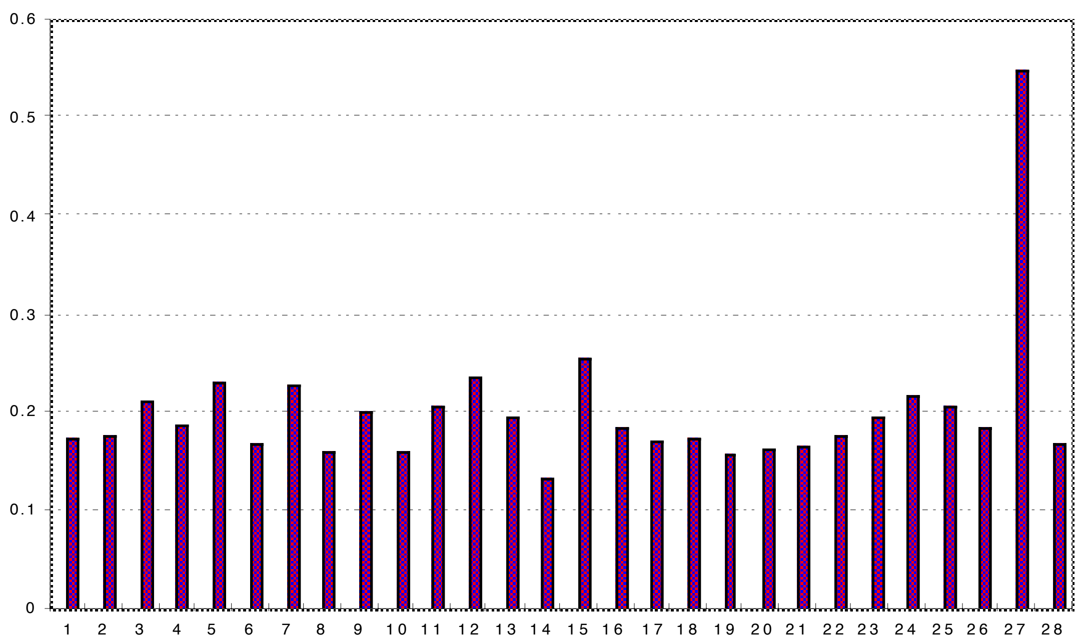
Measurements in municipal departments

Type of vehicle	N° on Graph	Place	Consumption kWh/km	Consumption kWh/Tkm
Clio (Renault)	**1**	**Citelec**	**0.223**	0.172
Clio	2	Hasselt	0.230	0.177
Clio	3	Maldegem	0.274	0.211
Clio	**4**	**Average**	**0.242**	**0.187**
Express (Renault)	**5**	**Citelec**	**0.310**	**0.229**
Express	6	Rijkevorsel	0.228	0.168
Express	7	Wuustwezel	0.309	0.228
Express	8	Oostkamp	0.218	0.161
Express	9	De Panne	0.271	0.200
Express	10	Hasselt	0.215	0.159
Express	11	Ravels	0.276	0.204
Express	12	Blankenberge	0.318	0.235
Express	**13**	**Average**	**0.262**	**0.194**
Master (Renault)	**14**	**Citelec**	**0.432**	**0.133**
Master	15	Rijkevorsel	0.828	0.255
Master	16	Wuustwezel	0.600	0.185
Master	17	Oostkamp	0.551	0.170
Master	18	Ravels	0.564	0.174
Master	19	Blankenberge	0.512	0.158
Master	20	Zottegem	0.533	0.164
Master	21	Koksijde	0.536	0.165
Master	**22**	**Average**	**0.570**	**0.175**
106 (Peugeot)	**23**	**Citelec**	**0.221**	**0.195**
Peugeot 106	24	Rijkevorsel	0.244	0.215
Peugeot 106	**25**	**Average**	**0.233**	**0.205**
Golf Cityströmer (VW)	**26**	**Citelec**	**0.298**	**0.184**
Golf Cityströmer	27	Aalst	0.886	0.547
Golf Cityströmer	28	De Panne	0.273	0.169



Graph 1

Measurements in municipal departments in kWh/km



Graph 2

Measurements in municipal departments in kWh/tkm

3.3 Discussion

The measurements in the cities are comparable with the results of the CITELEC measurement campaign. Two measurements are out of range: the one of the big delivery van (Renault Master) in Rijkevorsel en the one of the person car VW Cityströmer in Aalst.

The measurement in Rijkevorsel has to be eliminated, because it was found out there was a “mysterious load” when the vehicle was not charging. This could be concluded from the registration forms in the vehicle: the counter had changed after the vehicle had been charged and before the vehicle was charged again at the end of the day. So there had been a consumption when the vehicle was gone.

The second exceptional measurement took place in Aalst with the VW Cityströmer. The lending period in Aalst was at the of December 1996 and the beginning of 1997. In Belgium the weather was very cold at that time. The average temperature at that moment was negative (-0.5°C). This is important because the VW Cityströmer has a sealed lead acid battery and a battery-management-system which conserves the temperature of the battery. This “heating-system”, which blows heated ambiant air trough the battery box, consumes energy and that is why the average energy-consumption was that high. In this period the vehicle was almost not used and was parked outside in the cold for several days and nights (1 time 6 days, 1 time 4 days and 2 times 3 days), because of the holidays. These are exceptional circumstances. When we eliminate these measurements, the average consumption drops to 54.6 kWh/100km. This is also high, but we have to consider that among the not eliminated measurements there were several days the vehicle was used only for 4 km and then charged. This explains the high consumption and leads once more to a strong indication for reconsidering the desigh of the battery management system on this vehicle

The following table gives a summary of the measurements after eliminating these abnormal cases:

Table 2

Summary of the measurements

Type of vehicle	Consumption kWh/km	Consumption kWh/Tkm
Clio	0.242	0.187
Express	0.262	0.194
Master	0.570	0.175
Peugeot 106	0.233	0.205
VW8	0.298	0.184

The primary energy consumption of electric vehicles can be much lower than that of the combustion engined equivalent model. A small calculation gives the following result for the Renault Express:

consumption gasoline model: 8.9 l/100 km [1]

consumption diesel model: 7.6 l/100 km [1]

energetic capacity gasoline: 43.5 MJ/kg [2]

[1] Data catalogue Renault
[2] Data “Automotive Handbook” - Bosch

energetic capacity diesel: 42.5 MJ/kg [2]

density gasoline: 0.740 kg/l [2]

density diesel: 0.835 kg/l [2]

Which gives

energy consumption gasoline model: 2.865 MJ/km

energy consumption diesel model: 2.697 MJ/km

1 MJ is equivalent with 0.278 kWh, so

energy consumption gasoline model: 0.796 kWh/km

energy consumption diesel model: 0.750 kWh/km

This is respectively 3.04 and 2.86 times the energy consumption of the electric Express, measured at the mains. For a final comparion of primary energy consumption the efficiency of electricity generation and transport has further to be considered. The minimum efficiency to realise in view to “equalise” the energy consumption is then respectively 33% and 35% if the power plant is fuelled in the same way as the vehicle. Furthermore, the real production mix has to be considered country per country or continent per continent as well as the advantage of becoming really local zero emissions. For the impact on global emissions, consideration of the real production mix has also to be considered.

We have to remark that in the calculation for the internal combustion engined vehicles we used data from the catalogue of the constructor. These data are no reference for real life applications, for which the consumption pattern is much higher. The data used for the electric vehicle are real life data.

We are convinced that if the ICVs are used for the same application as the EV’s, the consumption level will be much higher.

4. General conclusions

The “Tour of Flanders” has shown to be a valuable demonstration concept for electric vehicles in municipal services. The real-life practical experience with electric vehicles which has been offered in this project enabled drivers to appreciate their intrinsic qualities; furthermore, the monitoring of the electricity consumption has highlighted the energetic benefits of electric vehicles. The programme has demonstrated political decision makers that electric vehicles show the way for sustainable and less polluting use of energy in the field of mobility.

5. Acknowledgements

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