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## **Living Lab Electric vehicles Flanders (Belgium): The influence of testing an EV on the general appreciation of electric mobility.**

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### **Abstract**

Numerous studies have already demonstrated the benefits and social relevance of electric vehicles. But why EVs are not yet visible in our streets? To provide an answer to this question the Flemish government has set up five living labs for the deployment of electric vehicles in 2011. Several studies presented in literature are focused on the consumer and his/her perception, but rarely take into account whether the consumer actually drove an EV. Therefore the iMove- and EVA-platform, as part of The Living Labs, form the ideal environment to investigate the perception of test users. Test drivers were asked to fill-in a same questionnaire before and after the test. Questions included inter alia judging the possible advantages and disadvantages, purchase potential. Many people were interested to test an electric car, although their basic knowledge about EVs was poor. Consumers confirm that the lower cost per kilometer is an important advantage, although it became less crucial after testing. Charging at home is perceived as an important advantage. The limited electric range still remains the main disadvantage, followed by the high purchase price. Consumers clearly underestimated the effect of a limited range. The willingness to purchase an EV within the future is related to the consumer's idea of when an EV will be a full alternative. The majority consider buying an electric car in the near future (within 4 years). Related to this, one-third of the test population is willing to pay more for an electric car.

*Keywords: Electric Vehicles, Living Lab, Driving behavior*

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### **1 Introduction**

Many studies [1] have already proven the benefits and social relevance of electric vehicles (EVs): electric vehicles can play a crucial role in

the reduction of energy dependence, the integration of renewable energy sources, recuperate the economy, improving air quality and reducing noise pollution, combating climate change and a catalyst for new mobility concepts.

However, to assess the impact of driving electric vehicles in real-life conditions it is recommended to create an experimental environment: a living lab [2]. A key element in the living lab approach is the involvement from an open collaboration by all stakeholders: academia, (end) users, public sector and companies.

In 2011, the Flemish government decided to catalyse the developments of such living labs by funding five electric vehicle platforms, each differing in technology, scope, size and use patterns [3] [4]. The Flemish Living Labs Electric Vehicles is a program to facilitate and accelerate the innovation and adoption of electric vehicles in the Flemish region and address a variety of scientific research topics. Not only pure technological topics but also socio-economic aspects are examined. These include topics such as market potential analyses, travel and purchase behaviour and also cover expectations, opinions and attitudes.

The combination of a real-life testing environment with 'real' test users is unique. Many researchers have already assessed the market potential and the expectations of future users without driving an EV [5] [6].

Precisely this element gives research within the living labs an attractive and innovative character.

## 2 The iMove and EVA platform

### 2.1 EVA

The EVA (Electric Vehicles in Action) platform, under the coordination of Eandis, an energy distributor in Flanders, together with 6 core partners<sup>1</sup> aims for a large scale introduction of 200 charging points spread out over 80% of the Flemish region (semi-public and public domain). A lot of municipalities are participating because of the significant impact on the public domain. A wide range of EVs (161 vehicles of different brands and types) will be monitored to study user behavior by using data logging systems (smart phones + vehicle loggers). Other topics to be studied include the geographical coverage needed for public charging stations, the impact on the grid, and methods for charging fees to the user.

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### 2.2 iMove

The platform, coordinated by Umicore, is a consortium of seventeen Flemish companies and research institutions<sup>2</sup> and aims for a breakthrough of electric vehicles and sustainable mobility [8]. A large test population (in companies but also residential) is testing 175 EVs and 180 charging stations in daily use over a period of three years. The innovation projects are focusing on three main themes: renewable energy and smart grids, new battery and vehicle technology and mobility behavior.

### 2.3 Test population

The test population of EVA consists partly of employees of cities and municipalities selected by VUB and partly of employees of the participating partners. Both groups are subsequently monitored and questioned by means of surveys. In this way, not only the travel and charging behavior of the drivers is studied, but the personal impressions and experiences of the EV users are assessed as well.

Within iMove the test group consists of both private persons and employees of companies that use the cars as company, professional or carpool cars. This very diverse user group, spread all over Flanders, will enable us to make an assessment of various (family) profiles, their purchasing behavior and the driving behavior in different weather and road conditions.

This paper will only focus on the private test users of the iMove-platform, as this project can offer the most complete data. Those persons have tested an EV<sup>3</sup> made available by Infrax, a distribution system operator in Flanders.

Data collection within EVA is still running.

## 3 Methodology

After a call in different national media, 2502 people have shown interest in participating in the

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<sup>2</sup> Ernst & Young, Infrax, Free University Brussels, Flanders' Drive, REstore, Belgacom, Delhaize, EDF Luminus, Punch Powertrain, Interparking, Janssen Pharmaceutica, Hendriks, The Plugin Company, P&V, Mobile For, Fleet & DriverCare, Povince Antwerp

<sup>3</sup> Ford Punch, Peugeot iON, Citroën C-zero, Renault Fluence or Renault Kangoo

project. In total, 193 consumers, divided into four groups, have tested an electric vehicle over a period of ten weeks. The test population was selected based on some criteria: technical criteria (owning their own garage or driveway, an approved electric installation...) to insure a correct installation of a Mode 3 charging station, socio-demographic (gender, green attitude, diploma) and driving criteria (average mileages per week, number cars owned) to insure an equal distribution over all variables. Consumers were free to opt out of participation, after enrollment.

The use of the EV's was not limited to the individual test drivers, but was extended to create an opportunity for others (family and friends) to learn more about this 'new' vehicle technology. Creating awareness among the Flemish consumer is also the objective of iMove and by extension of all the platforms electric vehicles.

Before and after a test period the users were asked to fill in a questionnaire. This before-and-after comparison allows exploring the influence of the use of an EV on the perception, behavior and knowledge of the test population, which is the strength of this research.

Questions included the following topics that are related to the (electric) driving: judging the possible advantages and disadvantages, purchase potential, experiences with charging, etc.

The questionnaire was pre-tested within a previous study concerning the market potential of electric vehicles in Flanders [9]. Hereby both substantive and practical shortcomings could be intercepted. After this pre-test the survey was administered by 1196 Flemings. The difference between this study [9] and the study described in this paper, is the test period of 10 weeks during which the test population has been able to drive an EV.

## 4 Results

### 4.1 Demographics

72% of the test panel were male, 18% had the female sex. This distribution is not representative for Flanders: respectively 49% versus 51% [10]. This had several reasons beyond our control:

- More males have registered (76% versus 24%)
- Men show more interest in the automotive industry
- After pre-selecting the population, people were shed out because of the previous mentioned reasons (see methodology).

### 4.2 Knowledge about electro-mobility

After testing the electric car, consumers know more different EV types (figure 1). Especially the Renault range became more familiar. Once the consumer is confronted with electric mobility in a pleasant way, their basic knowledge will increase.

### 4.3 Advantages of an EV

The low cost per kilometer, the availability of (eventual) governmental incentives and the environmental friendliness of an electric vehicle are the most important advantages (figure 2), without having driving experience. After the testing period the possibility to charge at home becomes more important, instead of the environmental friendliness. This could be explained by the lack of public infrastructure. 'Silent comfort' and a 'high acceleration' were perceived as more important after testing, to the prejudice of 'styling and looks' and 'being a pioneer'. By using the electric car people were probably surprised by the relaxing effect of a silent motor and the performance.

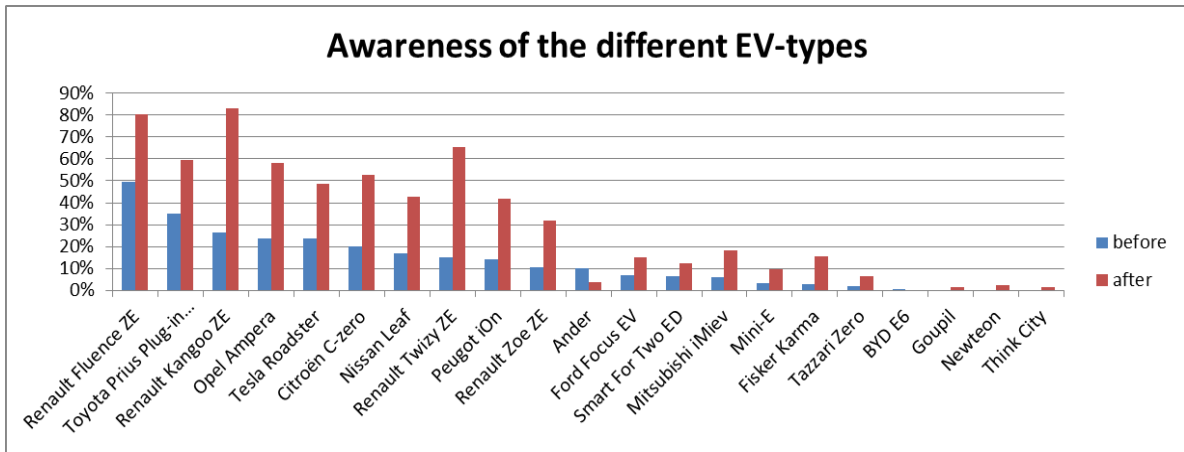


Figure 1: Awareness of the different EV-types, before and after the test.

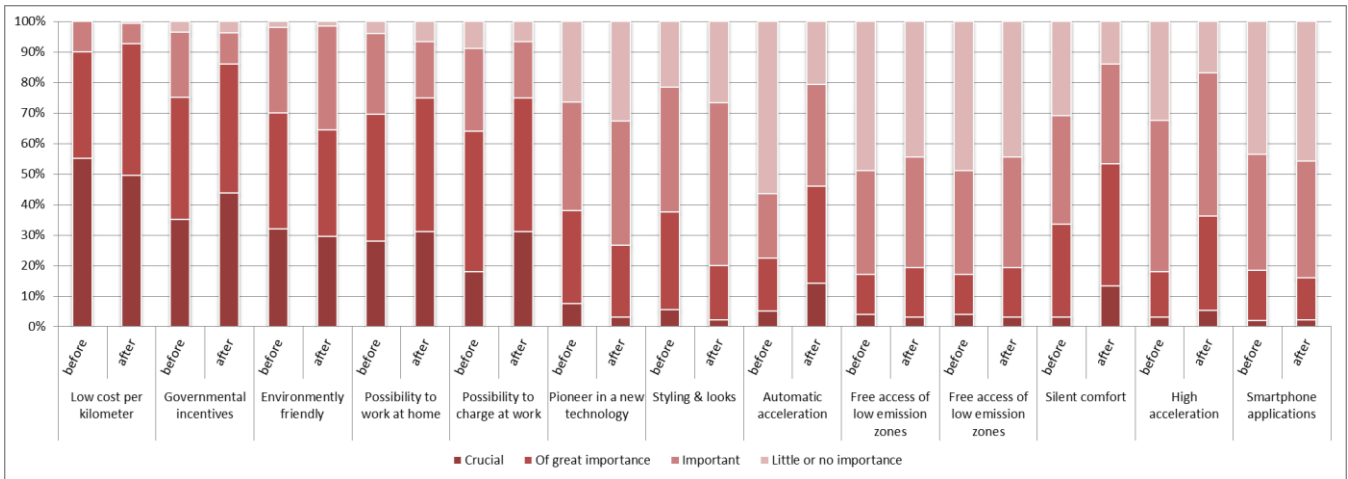


Figure 2: The importance of the advantages of an EV, before and after.

#### 4.4 Disadvantages of an EV

The limited range and high purchase price remain the biggest thresholds in the adoption of electric mobility, as expected [3] (figure 3), especially after testing. Consumers clearly underestimated the effect of a limited range. It is possible that price became a more important element after test driving with regard to the price-quality ratio: less driving range for a higher price.

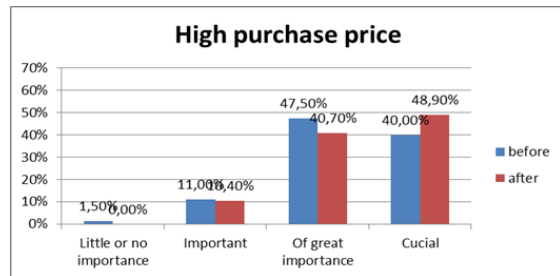
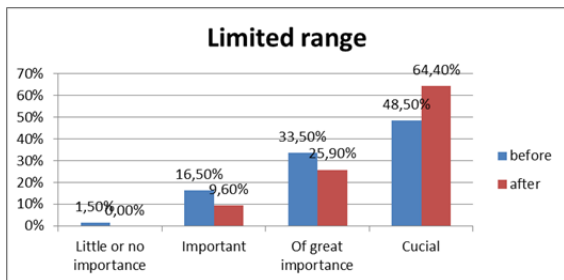


Figure 3: 'Limited range' and 'high purchase price' as a disadvantage of an EV: the importance of it before and after testing.



The ideal driving range fluctuates between 200 and 500 kilometers as well as well as before as after the testing period (figure 4). The current EV fleet is situated well under this range (120 to 200 km/battery charge [5]). Only 7% of the test

population is satisfied with this current range. One-third would be satisfied with a range of maximum 300 km.

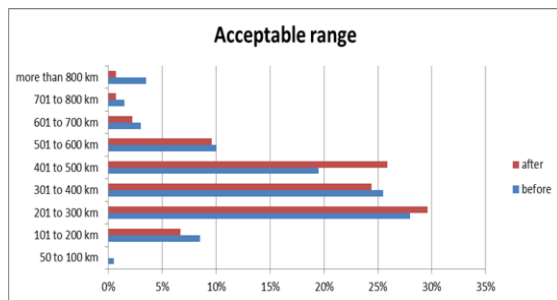


Figure 4: Acceptable driving range for an EV, before and after testing an EV.

Though everybody perceived the limited range as the biggest disadvantage; only 5% doesn't want to buy an EV in the future. Most consumers want an EV as a second car (62,5%).

#### 4.5 Price & purchase potential

After testing the electric car, the majority wants to pay the same price as a comparable conventional car (figure 5). One out of five wants to pay up to 2.500€ more and another 12% is willing to pay 5000€ more. One-third of the population is willing to pay a higher price, which is a little bit less than before. Merely 2% is not willing to buy an EV.

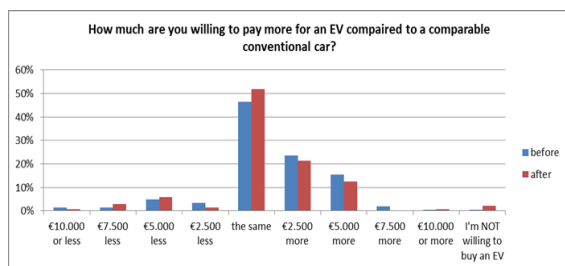


Figure 5: Desired price for an EV, before and after the test period.

As someone is willing to pay more for an EV (35% after testing an EV), there is a chance they will buy it sooner, although this is not a significant difference (table 1).

Consumers who are willing to pay more (2500€ are 5000€ more) tend to buy an EV between now and 2 years. If someone indicated to purchase an EV at the same price as a conventional car, he/she tends to do this within 3 to 6 years.

Table 1: Has the willingness to pay more for an EV any effect on the purchase timeframe ( $p > 0.05$ )?

		Time frame wherein respondents shall buy an EV					Total
		0 to 2 years	3 to 4 years	5 to 6 years	7 to 10 years	More than 10 years	
Willingness to pay more for an EV	Same	16,7%	28,8%	28,8%	16,7%	9,1%	100%
	2500€ more	33,3%	29,6%	22,2%	14,8%	0%	100%
	5000€ more	29,4%	11,8%	35,3%	5,9%	17,6%	100%

The potential period of buying an EV, is also related ( $p < 0,05$ ) to the time when an EV will be considered as a full alternative (table 2). The sooner someone experiences an EV as a fully alternative for conventional cars, the sooner he will consider purchasing an EV.

Table 2: Relation between purchase intention and perception of EV as a full alternative

		Time frame wherein respondents shall buy an EV		
		0 to 4 years	5 to 6 years	More than 7 years
When will an EV by a full alternative	0 to 4 years	38%	1,4%	0,7%
	5 to 6 years	13,4%	17,6%	3,5%
	More than 7 years	4,9%	12%	8,5%

#### 4.6 Charging

The most important place for charging the batteries is home (figure 6). Striking after test driving an EV is the effect that people consider a classical fuel station as a potential loading point. It is possible that consumers want to keep their habits: going to a classical station. The working environment becomes the second important place.

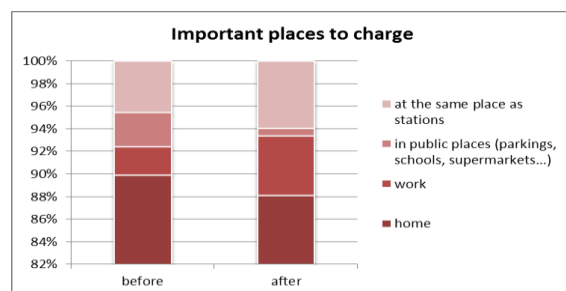


Figure 6: Important places to charge an EV, before and after the test period.

Figure 7 shows how much time a charging period can last at home versus on the road according to the test population. It is obvious that people have more time to charge at home, 57% is willing to wait between 6 and 8 hours for a fully reloaded battery. On the road, still 34% has the time to wait 30 minutes. Even 1 hour is acceptable for 17%.

Related to this, 90% wants the Belgian government to invest in public fast charging infrastructure.

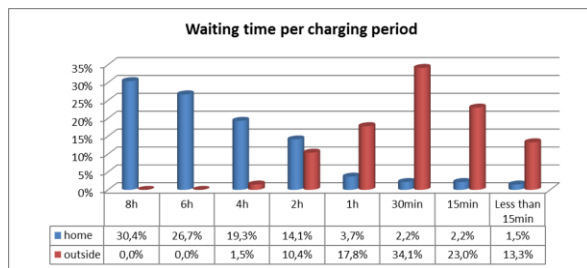


Figure 7: Willingness to wait per charging period.

## 5 Conclusions

In this paper, people, within a living lab environment, were asked to fill-in a questionnaire before and after testing an electric car. The questionnaire dealt with the experiences, appreciations for and attitude towards EVs and electric mobility.

Many people were interested to test an electric car, although their basic knowledge about EVs was poor. By actively getting in touch with electric mobility, their knowledge of it strongly increased.

Consumers confirm that the lower cost per kilometer is an important advantage, although it became less crucial after testing. Charging at home is perceived as an important advantage, which is logical as this is perceived as the most important place to charge. This advantage of electric mobility should be highlighted more as 76% of the Flemish housing units have a garage and therefore possible charging facility [11].

As expected, the limited electric range still remains the main disadvantage, followed by the high purchase price.

Consumers clearly underestimated the effect of a limited range. It takes time to get used to the limited capacity. This disadvantage can be eliminated by the government by investing in public (fast) chargers.

The willingness to purchase an EV within the future is related to the consumer's idea of when an EV will be a full alternative. The majority consider buying an electric car in the near future (within 4 years).

Related to this, one-third of the test population is willing to pay more for an electric car.

To conclude, slow charging at home and fast charging possibilities on public places are the incentives towards electric mobility. A reduction of the price is not necessary, but consumers want a higher driving range.

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