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## **Living Labs for Electric Vehicles in Flanders**

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### **Abstract**

In 2011 the Flemish government launched the Living Labs Electric Vehicles, consisting of 5 different platforms each differing in technology, scope, size and use patterns. For the build-up of these platforms, the Flemish government relies on private companies, local authorities and research institutes. These platforms serve as an environment in which platform members as well as other partners can carry out experimental research related to the roll-out of electric vehicles (EVs) and EV fleets. A total financial investment of ±30 million € was made, equally divided between the private sector and the government, and an introduction of 600 electric vehicles and 600 new electric charging points is aimed for. The addressed research topics within these living labs include the assessment of the driving range of the EVs, the assessment of the implemented drivetrain technologies and charging infrastructure, travel- and purchase behaviour, market potential analyses, the development of new business cases, the development of new services and products, total cost of ownership analyses, environmental impact analyses, and social acceptance. In addition, with respect to the charging infrastructure, standardization issues, interoperability of the charging systems, and billing and roaming procedures are studied. A wide variety of stakeholders related to electric mobility is involved in these living labs, ranging from knowledge centres, automotive manufacturers, electricity producers and distributors, service providers, public transport companies and local authorities, to fleet owners and end users. This paper gives an overview of the 5 launched platforms: EVA, iMOVE, Olympus, EV TecLab and Volt-Air.

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*Keywords:* demonstration, fleet, smart grid

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### **1 Introduction**

The upcoming oil shortage and global warming awareness push the automotive industry towards new and environmental friendly solutions. While hydrogen vehicles are foreseen to enter the market only after another decade, today's solutions are clearly focused on electric vehicles [1]. However,

in order to achieve an effective roll out of this technology, the involvement of various stakeholders is required and several challenges are to be met. In order to assess these challenges, as well as the requirements and consequences of such a roll-out in real-life conditions, limited EV fleets and charging infrastructure should be put in place, and used for daily routine transport and

mobility. Such an experimentation environment in which technologies are given shape in real life contexts and in which users are considered co-producers are called living labs [2].

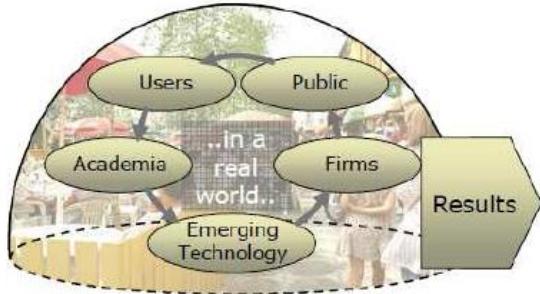


Figure 1: Basic living lab concepts

A key element in the living lab approach is the involvement from and open collaboration by all stakeholders: academia, (end) users, public sector and companies, as shown in figure 1. The living lab approach is also useful to close the so-called pre-commercial gap between the development of a technology or service and its commercialisation. In 2011, the Flemish government decided to catalyse the developments of such living labs by funding five EV platforms, each differing in technology, scope, size and use patterns. For the build-up of these platforms, the Flemish

government relies on private companies, local authorities and research institutes, which are partially funded for this effort. Secondly, these platforms serve as an environment in which platform members as well as other partners can carry out experiments related to the roll-out of EV's and EV fleets. A total financial investment of  $\pm 30$  million € is made, equally divided between the private sector and the government, and an introduction of 600 electric vehicles and 600 new electric charging points is aimed for. In addition the Flemish Institute for Science and Technology (IWT) will further invest 5 million € in projects focused on EVs, and the knowledge centre Flanders' DRIVE will invest 12.25 million € in projects which focus on the enhancement of EV technology.

## 2 The platforms of the living labs

The Flemish Living Labs Electric Vehicles address a variety of scientific research topics. Not only pure technological topics such as the assessments of the propulsion system of the vehicles, the charging infrastructure, the power consumption and driving range are considered,

Table 1: Overview of implemented hardware and test population in the Flemish living labs.

	Scope	Hardware	Vehicle Type	Driver Test Population
<b>EV TecLab</b>	<ul style="list-style-type: none"> <li>Technically oriented</li> <li>Prototypes/pre-release for heavy duty</li> </ul>	<ul style="list-style-type: none"> <li>EV: 36</li> <li>Infrastructure: 30 on-board charging stations, 2 conductive charging points, 3 inductive chargers</li> <li>36 data logging systems</li> </ul>	<ul style="list-style-type: none"> <li>30 e-Vans</li> <li>2 e-Trucks</li> <li>1 Fuel cell bus</li> <li>3 e-Busses</li> </ul>	<ul style="list-style-type: none"> <li>Professional drivers (City buses and logistics)</li> </ul>
<b>iMOVE</b>	<ul style="list-style-type: none"> <li>Large scale EV platform</li> <li>Batteries</li> <li>Smart grids</li> </ul>	<ul style="list-style-type: none"> <li>EV: 175</li> <li>Infrastructure: 300 charging points</li> <li>&gt; 100 Data logging systems; 70 smart phones</li> </ul>	<ul style="list-style-type: none"> <li>e-Cars</li> <li>e-Vans</li> </ul>	<ul style="list-style-type: none"> <li>EV's to private during 1 year</li> <li>Companies</li> </ul>
<b>EVA</b>	<ul style="list-style-type: none"> <li>Large scale public charging infrastructure</li> <li>Large differentiation in EV's</li> <li>Overall geographical coverage</li> <li>Smart grid</li> </ul>	<ul style="list-style-type: none"> <li>EV: 161</li> <li>Infrastructure: 220 charging stations (2 plugs each) in 71 charging islands</li> <li>+/- 160 Data logging systems (smart phones + vehicle loggers)</li> <li>71 smart meters</li> </ul>	<ul style="list-style-type: none"> <li>59 e-Cars</li> <li>52 e-Vans</li> <li>3 e-Busses</li> <li>25 e-Scooters</li> <li>15 e-Bikes</li> <li>7 e-Quads</li> </ul>	<ul style="list-style-type: none"> <li>Private</li> <li>Authorities</li> <li>Professional</li> </ul>
<b>Olympus</b>	<ul style="list-style-type: none"> <li>Multimodality</li> <li>ICT Services</li> <li>Car sharing</li> </ul>	<ul style="list-style-type: none"> <li>EV: 187</li> <li>Charging infrastructure installed at 34 train stations (&gt; 800 plugs)</li> <li>230 Data logging systems</li> </ul>	<ul style="list-style-type: none"> <li>21 e-Cars</li> <li>16 GUMs</li> <li>20 e-Scooters</li> <li>130 e-Bikes</li> </ul>	<ul style="list-style-type: none"> <li>Customers rental cars</li> <li>Authorities</li> <li>Companies</li> </ul>
<b>Volt-Air</b>	EV in microgrid of companies	<ul style="list-style-type: none"> <li>EV: &gt; 66</li> <li>Infrastructure: 42-72 charging points</li> <li>30 Data logging systems for vehicles and 20 for energy supply</li> </ul>	<ul style="list-style-type: none"> <li>e-Cars</li> </ul>	<ul style="list-style-type: none"> <li>Lease-customer</li> <li>EV at Volvo + Siemens</li> </ul>

but also socio-economic aspects are addressed. These include topics such as market potential analyses, travel and purchase behaviour, the development of new business models, the development of new services and products, total cost of ownership analyses and social acceptance. With respect to the charging infrastructure, special attention is paid to standardization issues, interoperability of the charging systems, and billing and roaming procedures. Last but not least, there is a strong focus on the environmental impact of electric mobility.

The living labs are organised in 5 platforms differing in scope and scale: EVA, iMOVE, Olympus, EV TecLab and Volt-Air. An overview of the implemented hardware as well as the involved test driver population is given in table 1. The living labs are running over a period of 3 years. More information can be found in [5,6].

## 2.1 The EVA platform

This platform is lead by Eandis (Energy distributor) and aims for a large scale introduction of charging points in order to obtain an acceptable geographical spread over the whole Flemish region [7]. This platform aims to achieve the

critical mass for the development of public charging infrastructure in Flanders. The EVA platforms aims to install 220 charging stations, each containing 2 sockets. The charging stations are grouped in 71 charging islands, spread over 51 cities and municipalities. By maintaining a well-considered geographical spread while rolling out the charging infrastructure, the platform aims to offer a charging point to every EV-user within 20km or 20 minutes for 80% of the Flemish region. The charging islands are placed on public places as well as semi-public places such parking sites at supermarkets and shopping centres. In addition to the charging infrastructure 161 electric vehicles from more than 20 different brands are involved, including e-cars, e-vans, e-busses, e-scooters, e-bikes and e-quads. In order to monitor the behaviour of the EVs, 160 data logging systems are put in place (smart phones + vehicle loggers). The charging stations are grouped in so called charging islands which encompass charging possibilities and parking sites for e-cars and e-vans as well as e-bikes and e-scooters (figure 2). These islands are connected to a back office by means of a broadband internet connection. This communication system will allow to develop new applications for the EV

## Charging islands: a unique concept

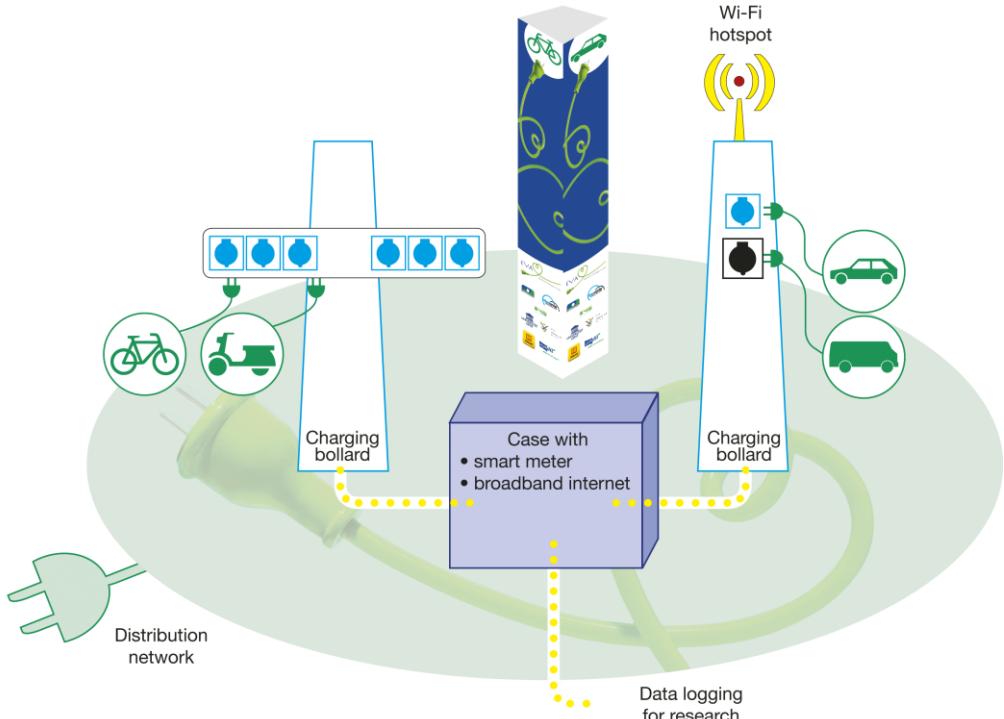


Figure 2: Smart EV charging island in the EVA platform

users such as the monitoring of the state of charge of one's battery through smartphone. Already the charging island provide a Wi-Fi hotspot to the EV-user. 200 Of the charging stations are placed on public domain. In addition 3 fast chargers are placed at different petrol stations (Total). The smart metering at charging level in combination with the vehicle logging allows monitoring adequately the behaviour of the vehicles and the impact of the vehicles on the grid. In addition, part of the test drivers of the e-cars and e-vans are carefully selected in order to obtain a statistically relevant test group, which is subsequently monitored and questioned by means of surveys. In this way, not only the travel and charging behaviour of the drivers is studied, but the personal impressions and experiences of the EV users are assessed as well. Moreover, the EVA platform interacts with Flemish cities and municipalities for the placement of the charging infrastructure, and hence the impact of the roll out of this infrastructure on the public domain is thoroughly assessed.

## 2.2 The iMOVE platform

This platform is lead by Umicore and involves 18 Flemish companies and knowledge centres [8]. A large scale EV fleet is set up. The aim is to obtain a thorough insight in parameters related to large on-road EV fleets (with a special focus on batteries), combined with the effect of such fleets on the electricity grid. The platform involves 175 EVs (e-cars and e-vans) and 300 charging points in Flanders. The charging points are placed in (semi) public places as well as on company park sites. In order to assess the private use of EVs, 70 vehicles are made available to 4 batches of 70 volunteering test drivers during a period of 10 weeks. These test drivers are selected and recruited within the general public taking into account several factors such as daily mileage, urban/non-urban home address, availability of private parking space and charging possibilities, family situation, age, gender, profession and education. For test drivers who have the possibility to charge the EV at home, a smart charger is installed in order to investigate the private charging behaviour. In addition the EVs

are equipped with data loggers and hence the travel and charging behaviour of these test drivers is followed closely. Further on, the personal findings of the users are monitored by means of surveys, both prior and after the trial period. The EVs are provided by Infrax (electricity distribution company) and the selection and follow-up of the test population is carried out by the Vrije Universiteit Brussel with the support of IBBT. Next to the 70 EVs for the private users, 105 vehicles are being used in a professional environment by the various partners involved in the platform. The platform implements more than 100 vehicle data loggers and 70 smartphones for the monitoring of the EVs.

## 2.3 The Volt-Air platform

Lead by Siemens, this platform focuses on the integration of EVs in car fleets and the microgrid of companies. The platform consists of 3 sub-labs connected by means of a common platform for data exchange. The first sub-lab is the Siemens microgrid containing 10.000 m<sup>2</sup> of solar panels, a combined heat and power system and 6 electric vehicles. Secondly, there is the lab of Volvo Cars containing electric Volvo C-30s equipped with monitoring devices. Finally the third sub-lab is created by a leasing company (Westlease) which renders 60 electric vehicles available at low price to local companies based in and around the city of Kortrijk. In addition, this city will install 3 charging stations. The aim is to lease the EVs to a wide range of the companies on long term. Complementary to the vehicles, the leasing company provides charging infrastructure at the customers' premises. In parallel, 6 vehicles are tested by the Siemens personnel. Besides developing new (multimodal) mobility concepts, locally-based services and new energy management systems, the Volt-Air platforms aims to assess the influence of smart grids on the user profile of companies with respect to energy consumption, which can eventually lead to new and efficient billing methods. In addition, the Volt-Air platform explores the possibilities for companies to produce their own electricity for the EV fleet.

## 2.4 The Olympus platform

Lead by NMBS (Belgian Railways), this platform focuses on multimodality for which mobility infrastructure is combined with the ICT business platform. The focus of this platform lays on the sharing of EVs with the integration of different means of transport such as trains, electric cars and electric bicycles. Four large train stations will have e-bikes, e-scooters and e-cars available for rent. In addition, 34 train stations will be equipped with charging stations for EVs, counting for more than 800 plugs.

Car sharing and its integration in the mobility chain is one of the main foci of the platform. At the stations where car sharing based on classical ICE vehicles was already available, the customer can now choose for the electric version. For stations with possibilities to rent classical bikes, the electric version can now be taken as well.

Olympus involves a total of 187 EVs and 230 data logging devices. Olympus will develop an open service platform containing data related to EVs, charging stations, billing, traffic and energy balancing, and on which new charging stations, vehicles, services and players can be plugged in. This will form the base for the development of a range of new networked mobility services such as multimodal route planning and reservations. In this way added value in a B2B as well as a B2C environment will be created.

## 2.5 The EV TecLab platform

Lead by Punch Power Train, EV TecLab is a technical platform focusing on heavy duty vehicles for which the power train is developed by Flemish companies. 30 E-vans, 2 e-trucks, 3 battery electric busses and 1 fuel cell bus are made available on the platform. Next to the assessment and optimisation of the vehicle propulsion technologies, EV TecLab will investigate how the involved vehicles will meet the requirements with respect to several transport and logistics applications. In addition, the opportunities for the production of the implemented drive trains in Flanders will be assessed. Special attention is given to a variety of charging technologies: the 30 e-vans will have on-board charging possibilities and 2 conductive, but

also 3 inductive charging systems will be implemented. 36 Data logging systems will monitor the driving behaviour of the vehicles.

In contrast with the other platforms, the test drivers are almost all professional drivers, for example the electric busses will be driven by professional bus drivers from the Flemish public transport company (De Lijn).

## 3 Conclusions

The Flemish region has now started to fully explore the opportunities given by electric vehicles. In order to catalyse an effective roll-out of this technology, the government joined forces with a wide range of stakeholders to form living labs in which the introduction of electric vehicles is carefully monitored and a broad range of research topics is addressed.

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