Green eMotion

Development of a
European Framework for Electro-mobility

Deliverable 1.7

EV’s in Fleets
Interim Report

Prepared by:

Cork, Enel, Malmo, CPH, Cartif, Better Place, EDF, Barcelona, Endesa, Daimler
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Authors

	Name	Company
Key author	Mark Daly	ESB
Author	David Marc Gurewitsch	Better Place
Author	AnibalRenonnes	Cartif
Author	MetteBrinch Clausen	Copenhagen
Author	Ida Synnestvedt	Copenhagen
Author	Ian Winning	Cork
Author	Miguel Pardo	Endessa
Author	JitkaAndersson	Malmo
Author	Marcus Ljungqvist	Malmo
Reviewer	Luis Prada, Manuel Gonzalez& Javier Romo	Cidaut

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List of Abbreviations

BEV	Battery Electric Vehicle
CMS	Charge management system
DoW	Description of Work (Annex I of Grant Agreement)
DSO	Distribution system operator
ESB	Electricity Supply Board
EV	Electric vehicle
EVCC	Electric Vehicle Communication Controller
EVSE	Electric vehicle supply equipment
EVSP	Electric vehicle service provider
FBEV	Fixed Battery Electric Vehicle
GeM	Green eMotion
HMI	Human machine interface
ICT	Information Communication Technology
KPI	Key Performance Indicator
OEM	Original Equipment Manufacturer, i.e. Electric Vehicle manufacturer
PSV	Public Service Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
RES	Renewable energy source
RFID	Radio frequency identification
SBEV	Switchable Battery Electric Vehicle
SECC	Supply Equipment Communication Controller
TCO	Total Cost of Ownership
WP	Work Package
ZEV	Zero Emissions Vehicle

1 Executive Summary

This deliverable constitutes an interim report on the use of Electric Vehicles in fleets and as such is the preliminary step in a final report (D1.9) due towards the end of the Green eMotion project. It will describe the types of EV's and their uses in fleet scenarios.
Documenting real life scenarios the report shows successful use of EV technologies including any specific challenges encountered. These scenarios include office car pools, taxi services, urban bus routes and urban deliveries. The different types of electric transport are compared with alternative Internal Combustion Engine technologies.

The aim of the report is to provide detail of some of the existing fleets across Europe, for use by all actors in the EV industry to assist in further developing a sustainable EV fleet. Vehicle OEM's will gain a greater knowledge of the real life experiences, allowing more tuned response to customer demand. Policy makers both in member state countries and at European level can gain greater insight into the challenges of developing a cleaner transport infrastructure. Fleet managers will find the tools to better assess the appropriate introduction or expansion of an EV fleet, providing the main points to be considered.

Electric bicycles are seen to provide alternative means of transport over ICE vehicles where conventional bicycles are not always practical. The potential for wider exploitation of this method of transport is significant.

EV's as taxi's have been assessed in Dublin and are seen to provide a good alternative to ICE vehicles. The range limitations and speed of battery replenish are limiting but not excluding factors, allowing substantial opportunity in this area. A modest range increase combined with wider access to fast battery replenish would greatly increase the penetration levels.

The report assesses the success of an urban bus route in Copenhagen and highlights the opportunity for fixed route uses, while acknowledging the limitations in available bus technology at this point in time. This route is operated solely with EV's driving back to back journeys for full day shifts.

Urban deliveries are seen to offer great opportunities for use of EV's. The importance of route and use assessment is highlighted to ensure that the chosen technology is sufficient for the use case. Once the right fit has been achieved the benefits are wide, including fuel and maintenance costs as well as the noise, emissions and comfort factors.

The success of a car pool scheme at a large company in Dublin has been recorded, while the proven use has triggered steps to expand the scheme. The use case has been assessed for capital costs, running costs and emissions as against the alternative means of transport such as taxi's. The opportunities in this area are great particularly for medium to large companies where the employee base to sufficient to support the investment in EV's.

Fuel costs have been assessed, showing the trends over previous years, giving a clear indication of the future opportunity to control the cost of transport energy for fleet managers through the use of EV's. On top of this the cost of maintenance has been assessed, comparing ICE's with EV's. The expanding EV industry is acknowledged showing the trend towards further opportunities to reduce maintenance and repair costs due to the wide availability of EV service centres from an expanded number of suppliers.

The developing market and growing selection of vehicles is evident, providing confidence to the fleet purchaser in the commitment of policy makers, the auto industry and the other actors in the EV field. The growth in OEM built vehicles will also have a positive impact on the cost of running a 'stage' built EV, due to the wider availability of service expertise.

As the Green eMotion project continues, the data gathered is all the time increasing. In the final report this additional data will allow the project to describe in detail the overall EV fleet scenario in Europe, including the effect of climate on EV use in the demonstration regions. The indicators at this point in time show that the EV industry has reached a point where EV fleets are sustainable, while the identification of real life challenges trough this report will support the industry in developing a road map to further facilitate the exploitation of this clean transport solution.

2 Definition

A Fleet Vehicle as described in this report refers to any vehicle, two wheeler or above used in connection with commercial or public business by a private company, public body or institute. It excludes any vehicle used solely for private purposes. The quantity of vehicles included within a fleet is not discriminated against.

3 Technologies

With partners drawn from 12 countries and 10 demonstration regions, GeM is evaluating and demonstrating a comprehensive range and variety of types of Electric Vehicle. Every vehicle type from Pedelec to cars, buses and Trucks are represented in the fleets being evaluated by GeM partners in Denmark, France, Germany, Ireland, Italy, Spain and Sweden.

It is necessary to present a definition of the various terms and to describe examples of vehicle types to demonstrate the added value being delivered by Green eMotion.

3.1 Drive Types

The following section describes the main drive types commonly found in fleet vehicles. The intention is to give a clearer understanding of the inclusions within technology types and the boundaries between them as used in fleet scenarios.

Zero emission vehicle (ZEV): A vehicle that has no regulated emissions from the exhaust pipe or tailpipe.

ZEV is one of the most important definitions from the point of view of developing enabling measures and legislation to support the uptake of EV's. Both Climate Change strategies and the need to provide healthy cities for the future require reductions in CO2 and Noise. Measures to address noise in cities are now being regulated by European Directive which has been transposed into national legislation throughout the EU.

European cities have a variety of 'Toolkits' available when it comes to regulation and the implementation of control measures to support the economic development of city centers. However, the potential enhancement offered by more widespread deployment of EV's has yet to be exploited in support of declared objectives. The availability of a verity of Zero Emissions Vehicles across the range of vehicle types opens up a Virtuous Cycle as between the deployment of EV's in fleets and Climate Change Strategies especially for cities.

A **Battery Electric Vehicle** (BEV): The Battery Electric Vehicle is a vehicle which is powered by battery energy store only. The vehicle has no internal combustion engine, it is propelled by an electric motor, powered by a battery pack. The vehicle is recharged by connection to an external power supply and has no on board generation capacity.

Hybrid electric vehicle (HEV): The 1990s definition of IA-HEA Annex 1 was “a hybrid electric vehicle (HEV) is a hybrid road vehicle in which at least one of the energy stores, sources or converters delivers electric energy”. The International Society of Automotive Engineers (SAE) defines a hybrid as “a vehicle with two or more energy storage systems, both of which provide propulsion power, either together or independently”. Normally, the energy converters in a HEV are a battery pack, an electric machine or machines, and internal combustion engine, ICE. However, fuel cells may be used instead of an ICE. In a hybrid, only one fuel ultimately provides motive power. One final definition is from the UN, which defines a HEV as “a vehicle that, for the purpose of mechanical propulsion, draws energy from both of the following on-vehicle sources of stored energy/power: a consumable fuel, and an electrical energy/power storage device(e.g.: battery, capacitor, flywheel/generator, etc.).”

Hybrid Electric Vehicle (HEV): - *Parallel configuration*: A parallel hybrid is a HEV in which both an electric machine and engine can provide final propulsion power.

Hybrid Electric Vehicle (HEV): - *Series configuration*: A series hybrid is a HEV in which only the electric machine can provide final propulsion power.

Plug in Hybrid Electric Vehicle (PHEV): A HEV with a battery pack with a relatively large amount of kWh of storage capability, with the ability to charge the battery by plugging into the electricity grid. This allows two fuels to provide the propulsion energy giving the possibility of extended ranges where necessary and at the same time benefiting from cleaner more efficient electrical energy from the electricity network.

Internal Combustion Engine (ICE): Historically the most common means of converting fuel energy to mechanical power in conventional road vehicles. Air and fuel are compressed in cylinders and ignited intermittently. The resulting expansion of hot gasses in the cylinders creates a reciprocal motion that is transferred to the wheels via a driveshaft or shafts.

3.2 Categories

Electric Bike: With an Electric bike riding a bicycle is possible without pedalling. The motor output of an Electric bike is activated and controlled by using a throttle or button. Human power and the electric motor are independent systems. This means that the throttle and the pedals can be used at the same time or separately. This contrasts with the Pedelec which requires that the throttle and pedals must always be used at the same time. As a result, an Electric bike is more or less used in the same way as a scooter or motorcycle rather than a bicycle. UK, Swiss and Italian regulations define the maximum power that can be used for an Electric bike. More power makes it an electric scooter.

Pedelec: Pedelec stands for “pedal electric cycle”. While pedalling the cyclist gets additional power from the electric drive system. The control of the motor output of a pedelec is linked to the cyclist’s pedalling contribution by means of a movement or power sensor.

Electric Scooter or E-scooter: Small electric sit-down or stand-up vehicles ranging from motorised kick boards to electric mini motorcycles. Differences between the two types of small electric scooters are as follows: Stand-up scooters, instead of pushing the scooter forward with one leg, the rider simply turns the throttle on the handlebar and rides electrically. In contrast, sit-down scooters are small electric vehicles with a seat and are used much the same way as gasoline or petrol powered scooters. A throttle on the handlebar regulates the acceleration.

Car

Cars as described in this report are passenger vehicles up to 8 seats in addition to the driver, in accordance with European vehicle category M1. These can include ICE, or any of the electric drive configurations.

Van

Vans as described in this report are goods vehicles with a maximum weight not exceeding 3.5 Tonnes in accordance with European vehicle category N1. These can include ICE, or any of the electric drive configurations.

Truck

Trucks as described in this report will be larger goods vehicles greater in size than the category Van. This includes European vehicle category N2 and N3. These can include ICE, or any of the electric drive configurations.

Bus

Buses as described in this report refer to passenger vehicles described in European categories, M2 and M3. These can include ICE, or any of the electric drive configurations.

3.3 Pedigree

Year 2010 the Mitsubishi iMiev came on the European market which became the starting point for the new generation of affordable electric cars in EU. It was the first serious attempt to build an all-electric car based on the newest battery technology, Li-Ion. In year 2011 the Nissan Leaf and the Renault Fluence ZE came on sale. All three cars offered good range at a reasonable price. For the new generation of electric cars the consumer can now look forward to longer range and lower prices on all-electric cars. This new generation of electric cars offers a significantly higher standard for the building quality, compared to the previous made electric cars on the market. The change from small scale production series up to large scale OEM production is one of the key changes in the electric car industry the last three years (2010-2012), and the tendency is clear. More OEM built cars are on the way to the market and only a small amount of small scale producers of electric cars has survived.

The differences between the so called small scale production series or retrofit company cars and the OEM build cars are amongst other that the small scale cars[1]:are of poor quality– often with different types of malfunctions due to low quality management

low safety ratings – due to low investment and know-how

high maintenance costs- due to limited service network and high prices on simple failures

limited range – due to old battery technology and poor utilization of the battery capacity

long charging capabilities (mode 1 charging) – very few companies now offers mode 3 (the new OEM supported AC charging method)

For the retrofit versions the gearbox was often reused and replaced by a standard industrial motor, but similar to the small scale producers making fully designed electric cars, simple motor control units and battery management systems were widely used in the business. Often causing imprecise indications of the state of charge and with-it difficulties in knowing how far you could go. The battery itself was first up till 2011-12 often Lead-Acid or Nickel-Metal-Hydride batteries that did not have the range and reliability as the Li-Ion now has.[2]

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[1] http://www.ens.dk/DA-DK/KLIMAOGCO2/TRANSPORT/ELBILER/Sider/Forside.aspx

[2] http://www.tva.com/environment/technology/car_batteries.htm

The new generation of electric cars is seen to have overtaken the small production series, as the OEMs can offer significantly lower price, better quality, higher safety and longer range.

Strengths and weaknesses - OEM build electric cars

There are roughly four different OEM based electric cars. The all battery electric vehicle (BEV) which can either be with fixed (FBEV) or switchable battery (SBEV).The plug-in hybrid (PHEV) and the range extended electric vehicle (REEV) alternates between a conventional engine and a motor in different ways though.[3]

The technical set-up of the FBEV and the SBEV are very similar. One of the drawbacks for the FBEV has been and in some cases still is, that the car and battery is seen as one unit. Thereby the costumer takes over the risk of possible degeneration as well as the risk of another battery technology overtaking which can result in a price devaluation of the car at a faster rate than anticipated. Today some OEMs are therefore offering the customers to lease the battery which will thereby lower the economic exposure for the customer[4]. Still today the resale price for EV's is in general unknown.

Both types of all electric cars (when leasing the battery)have a higher price tag in most European countries than for comparable cars. In Denmark a 15 % saving in a total cost of ownership comparison is only possible due to a 180 % tax cut for electrical cars. The operations costs though are over a broad scale lower due to significantly higher energy efficiency of the all-electric car[5] and slightly lower price on electricity compared to gasoline.e

The technical set-up of the PHEV and REEV is very different from the FBEV and the SBEV.[6] In terms of range the biggest advantage for the PHEV/REEV is that they can be measured with the best diesel cars on the market, where the FBEV has a total range of avg. 80 to 160 KM on one charge. Due to the fact that both drive technologies are placed in the PHEV/REEV the price itself is significantly higher than for other competing technologies which also reflects the service costs being higher than for both BEVs and conventional cars.[7]

Please also see the different car technologies in the overview below in figure 3.1.

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[3] The PHEV (the first one was the Toyota Prius Plug-In) uses the motor for slow speed driving and for energy boosts of the conventional engine as well as with a recuperation of the braking energy. The battery gets recharged by charging the battery in Mode 2 or in Mode 3 (see paragraph X below). The REEV (the first one was the Opel/Vauxhall Ampera) uses the conventional engine as a generator for the battery which leads the current to the battery pack and then to the motor which exclusively runs the car (in emergency situations the car engine kicks in directly). Furthermore the REEV battery pack gets recharged also when charging the battery in Mode 2 or in Mode 3 (see paragraph X below). Both types of electric cars are regenerating the energy used for braking.

[4] Business model offered by Daimler, Renault and Better Place

[5] 14-20 % for gasoline, diesel 25-30 %, 75-85 % all-electric car

[6] http://www.afdc.energy.gov/vehicles/electric_basics_phev.html

[7] http://www.greencarreports.com/news/1018460_prius-repairs-cost-a-little-more-than-non-hybrids

Regarding the difference in charging methods (see figure 3.2) below and the next paragraph ‘Charging methods’).

	Micro-, mild & full hybrid	**PHEV** (Plug-in Hybrid Electric Vehicle)	**REEV** (Range Extended Electric Vehicle)	**SBEV** (Switchable Battery Electric Vehicle)	**FBEV** (Fixed Battery Electric Vehicle)
ICE	X	X	(X)		
Electric Drive Mode	(X)	X	X	X	X
Generator			X		
Recuperation	(X)	X	X	X	X
E-Boost Function	(X)	X			
Energy Source	⛽	⛽ 🔌	⛽ 🔌	🔌	🔄 🔌

Figure 3.1 Vehicle Technologies

3.4 Charging methods

There are (summer 2012) many charging scenarios for just a small amount of electric cars on the market such as;AC slow, AC fast, battery swap, CHAdeMO, combo (between AC and DC – not yet ready) and inductive charging (not yet ready).

On the plug side AC charging seems ready. On the AC communication side there are still some interfaces to be joined between the partners involved (see the work in GeM WP3 and WP8). On the DC plug side three plugs are now relevant when charging a VW e-UP, Renault Zoe and a Nissan Leaf. There are still a lot of solutions to be standardized and many uncertainties to be answered.

Hereunder the different types of charging facilities will be give an overview of where the industry is at this moment.

AC charging

The most commonly used form for charging is the AC charging which can be facilitated in three modes.

Mode 1 charging: In this charging mode a 16A EC plug is used and mostly by the “first generation”(late 1980-2009) of electric cars, having a small battery density and short range. Mode 1 charging is still seen for retrofit cars and small scale production models but is not seen on the second generation OEM build cars - except from OEM build micro cars with a very limited battery density. This is partly due to the fact that a small battery can be charged relatively fast and that the power of a micro car battery is not exposing any overload to the current level where being charged. But for an average sized ‘Mode 1 car’ the charging can put stress on the current level pulling all the current the car can get. Where the current scenario is max 10-13A, often seen in for instance summer houses, charging up to 12 hours of max peak can potentially lead to dangerous hazards, especially since the typical Mode 1 charging set-up has no system to control the charging in the other end – the household plug!

Mode 2 charging: This mode is facilitated by a so called Mode 2 cable with an installed control box unit that limits the level of amps to be used for charging for the ‘Mode 3 car’. Some boxes can be adjusted to a certain amp level and some can’t. The typical max amp load is normally set at 8-12 A which at some point ought to prevent dangerous hazards as the box does not see what the limitations at the site are.
All Mode 3 supporting cars OEM build BEVs (FBEVs and SBEVs) and PHEV/REEVs – (figure 3.3 below) can use this type of control box in charging sites where an EC industrial inlet is accessible.
The Mode 2 charging limits the max amps and can be even slower than the Mode 1 charging mode.

Mode 3 charging: Facilitating Mode 3 is done by a ‘Mode 3 car’- all OEM built cars are supporting Mode 3 -and a charging station all of which supports the IEC standards IEC 61851-1, 61851-21+22 and the 62196-2.
1 Phased
This type of AC charging is and will be the most commonly used form for charging at home and at work as the car slowly, safe and controlled can charge up to 100 % state of charge.
The most commonly known plug on the car side for both types of BEVs and PHEV/REEVs is the Yazaki plug (SAE J1772/IEC 62196-2 type 1) facilitating 1 phased charging at 16A.On the charging station side the Mennekes (IEC 62196-2 type 2) is the most used plug on the market in Europe (see also 3 phased charging).
The Mode 3 1 phased charging is ideal for FBEV car fleet owners with very little need for recharging during the whole workday, which can either be set to charge approx. 5-6 hours (0-100 % at 16A) without being interrupted or with fixed charging during longer visits or breaks, depending on the frequency, but not less than 20 minutes. The charging time of the PHEV/REEVs is due to the significant smaller battery equivalent faster than the FBEVs using approx. 3-4 hours (0-100 % at 16A).

3 Phase Charging
To meet the requirements from the consumers to lower the charging time, when charging in the day time, a 3 phased solution will show up in 2012 (first by Mercedes and Renault). With the introduction of the 3 phased charging the plug on both the car

and the charging station side predominantly seems to be the Mennekes plug (IEC 62196-2 type 2) which facilitates charging at max 63A 500V[8] and an easy to use interface, but the standardization organizations in France are still in favour for the Schneider plug (IEC 62196-2 type 3) on the charging station side which has the same performance specs as the Mennekes plug. The EC is involved and wishes one plug type on the charging station side for the whole of Europe. The issue is not yet settled in the EC.

Some charge spot operators have set-up their charging infrastructure to support 3 phases as this set-up looks like to be competing with the DC fast charging system as the 3 phased infrastructure will be a lot cheaper[9]. It will also give the car driver a remarkably higher service degree as a 3 phased mode 3 charging of an average sized electric car (22kWh) can lower the charge time to only 1 hour (and to 30 minutes with 80 % SOC) compared to the present 1 phased mode 3 charging time from 5-6 hours. Thereby this charging mode could become ideal for fleet owners which use the vehicles for multiple shift drive events, with remarkably shorter charging time needed.

DC charging

DC charging is so far used by a few numbers of FBEV's, predominately Japanese cars (see figure 3.3 below). DC charging makes it possible for the driver to charge the car at approx. 25-30 minutes from 0-80 % state of charge. Initially the OEM's had included a limit of 1 DC fast charge a day in their warranties, however some of the OEM's have now removed this limitation, indicating better confidence in the battery performance. DC charging would tend to be seen as an ideal possibility for driving cycles with no more than a few DC charging events a day which makes it possible for longer KM range than for other FBEV's.

The original CHAdeMO solution for DC charging might become overtaken by a Combo version, which both SAE and IEC have standardized. Here in Europe the Combo 2 (IEC 62196) could take the lead as this plug is being supported by the German car industry. The idea behind this is to combine the DC fast charging with either the slow single phase AC charging scenario (for IEC 62196 combo 1) or the three phased AC charging scenario (for IEC 62196 combo 2) using the same plug for AC and DC charging (and thereby to increase the usability of the car.

As the combo plug is still not provided with any of the vehicles currently offered to fleet managers, the outcome is still uncertain, however it should be noted that this should have little impact on the driver as both options are capable of being offered at charging stations.

Battery Swap

The introduction of the battery swap (or switch) technology is now (summer 2012) available in Denmark and in Israel covering both countries nationwide. Hereby the possibility of driving an SBEV at the time being the Renault Fluence ZE (the Renault

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[8] The Smart ED has an onboard 22kW 400V charger

[9] And possibly increase the price of the car

Zoe ZE may come with switch technology) from one end of the country to another is possible – with a slightly lower average speed than in an average sized conventional gasoline car due to a few battery swaps on the way. An unofficial record set by Better Place Denmark (July 2012) demonstrated that thanks to the battery switch technology 2,399 KM could be driven in 24 hours (first attempt). This proves that the SBEV can act as a normal car when the battery switch infrastructure is in place in the area you operate.

The cost of the SBEV is without the battery and thereby the risk and battery up-date is done by the battery swap station operator. The battery swap station is able to handle multi battery pack sizes and can switch the battery in less than 5 minutes.

The battery cost for the fleet manager could be lowered by offering a battery pack which fits to the needs and which can be swapped to a higher density (same shape) at a higher price when needed. This could lead to that the SBEV in competition between the FBEV DC charged cars would be significantly cheaper to buy in a TCO calculation. Please see figure 3.4 below.

	AC Charging				**Inductive Charging**		**DC Charging**		**Fast Charge**
Charging Power	3,7 kW	11 kW	22 kW	44 kW	3,7 kW	11 kW	<20 kW	< 50 kW	60 kW
Voltage	230 V	400V	400 V	400V	230V	400V	450 V dc	<450 V dc	400V dc
Current	16 A	16 A	32 A	63 A	16 A	16 A	32 A	< 100 A	150 A
From SOC min.	30%	30%	30%	30%	30%	30%	30%	30%	30%
To SOC max.	100 %	100 %	100 %	80%	100 %	100 %	100 %	80%	80%
Charging time for 20 kWh	230 min	80 min	40 min	20 min	230 min	80 min	40 min	20 min	12 min

Figure 3.2 Charging Technology

List of electric cars available on 2012 sale in EU

In alphabetic order	CAR PEDIGREE				CHARGING METHOD				
	FBEV	SBEV	PHEV	Service network	AC Mode 1 charging	AC Mode 2& 3 charging	AC/DC combo charging	DC charging	Battery switch
Bellier	■			**1)**	■				
BlueCar	■			**1)**	■				
FIAT/MicroVett e500	■			**1)**	■	**2)**			
FIAT/MicroVettFiorino	■			**1)**	■	**2)**			
FIAT/MicroVettDoblò	■			**1)**	■			**2)**	
FIAT/MicroVettDucato	■			**1)**	■	**2)**			
Fisker Karma			**OEM**	**OEM**		■			
Garia	■			**1)**	■				
MitubishiiMiev/Citroën C Zero/Peugeot Ion	**OEM**			**OEM**		■		■	
Mega City	■			**1)**	■				
Mercedes Vito e-Cell	**OEM**			**OEM**		■			
MyCar	■			**1)**		■			
Nissan Leaf	**OEM**			**OEM**		■		■	
Opel/Vauxhall Ampera			**OEM**	**OEM**		■			
Renault Kangoo/Maxi ZE	**OEM**			**OEM**		■			
Renault Fluence ZE		**OEM**		**OEM**		■			■
Renault Zwizy	**OEM**			**OEM**	■				
Reva	■			**1)**	■				
Smart ForTwo ED	**OEM**			**OEM**		■			
Tesla Roadster	**OEM**			**OEM**		■			
Think City	■			**1)**	■				
Toyota Prius Plug-In			**OEM**	**OEM**		■			
1) Small service network - if any									
2) Additional choice									

List of electric cars coming on sale in EU by end 2013

The above list is of vehicles which are on sale or reasonably expected by end 2013.

In alphabetic order	PEDIGREE	CHARGING METHOD

	FBEV	SBEV	PHEV	Service network	AC Mode 1 charging	AC Mode 2 & 3 charging	AC/DC combo charging	DC charging	Battery switch
BMW i3 (both as BEV and PHEV)	OEM		OEM	OEM		🟩	4)		
BMW i8 / i8 Spider			OEM	OEM		🟩	4)		
Ford C Max			OEM	OEM		🟩			
Ford Transit Connect	OEM			OEM		🟩 3)			
Ford Focus Electric	OEM			OEM		🟩 3)			
Honda Jazz EV	OEM			OEM		🟩		🟥	
Hyundai i30 Plug-in			OEM	OEM		🟩			
Mercedes A Class E Cell	OEM			OEM		🟩	4)		
Peugeot 508 Hybrid4			OEM	OEM		🟩			
Renault Fluence ZE (2nd gen.)		OEM				🟩 7)			🟪
Renault Zoe ZE		OEM		OEM		🟩 7)			🟪
Smart ForTwo ED (3 phased as optional)	OEM			OEM		🟩			
Tesla Model S		OEM		OEM		🟩		🟥 5)	🟪 6)
Toyota Prius C			OEM	OEM		🟩			
Volvo C30 electric	OEM			OEM		🟩 3)			
Volvo V60 plug-in			OEM	OEM		🟩 3)			
VW e-UP	OEM			OEM		🟩	4)		
VW Golf Blue e-Motion (both as BEV and PHEV)	OEM		OEM	OEM		🟩	4)		
QBEAK	▨					🟩			

3) Three phase charging not confirmed
4) Combo charging not confirmed
5) Near future possibility for super charging +90kW station
6) No infrastructure solution yet mentioned
7) 3 phased

Figure 3.3 Vehicle Listings

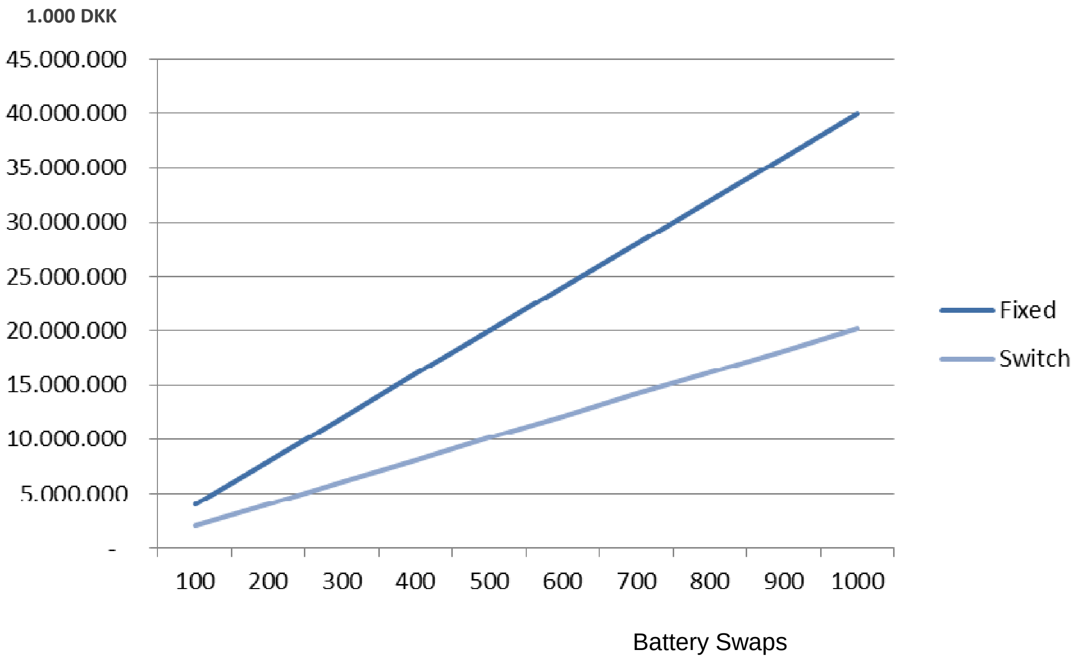


Figure 3.4 Total Cost of Ownership – FBEV v. SBEV
Source: Better Place Ltd., www.betterplace.com

4 Use cases

4.1 Electric Assisted Bicycles

Pedelec ‘Electric Assisted’ Bicycles CORK

Cork City Council has recently introduced a small fleet of bicycles for use by staff during the day. Members of staff apply to be users and they can get access to keys and the removable lights at the Reception Desk. In addition, the Transportation Division has been making use of a Pedelec ‘power assisted’ electric bike which was purchased at the end of 2011 by the Energy Agency Office. We are also going to consider the purchase another Pedelec for the fleet this year to support our promotion of the benefits of GeM.

About the use:

The electric bike is now being used on a regular basis by our Technician to undertake site visits that previously required the use of a car. In fact, the site visits necessitated the use of a vehicle from the car sharing club facility operated by GoCar. Trips of in excess of 12 Km are being undertaken by electric bike to visit and inspect the installation of the Real Time Passenger Information, RTPI system being implemented by the National Transport Authority, NTA. It has been noted by the user that in addition to extending the range of cycling, the enhanced ability to overcome the uphill gradients in Cork means this bike can be used were a standard bike would not be of interest. Details of the range and the battery capacity are provided with reference to the HERO eco Ultra Motor Hybrid A2B manufacturers brochure – http://a2b.ultramotor.com/en/a2b_hybrid_26 and Giant Cycles http://www.giant-bicycles.com/en-gb/bikes/model/twist.w/9359/55728/ also being considered for the cycle fleet by Cork City Council.

Electric Assisted Bicycles Malmö

Electric bicycles are now in use in Malmö and it is planned to start to track the bicycles in August 2012.

About the use:

City of Malmö has 30 electric assisted bicycles in its bicycle fleets. Those 30 bicycles are distributed at several departments of the city and used for various work related trips. The city is encouraging the employees to use the electric bicycles instead of cars for the trips within the city. In most of the cases the employee can make its own choice about what vehicle will be used for the trip. Malmö is a relatively small city with good bicycle roads and there is a good potential for increased use of electric bicycles for short / medium trips. Details of the range and the battery capacity are provided with reference to the Goodwheelmanufacturers’ brochure http://shop.goodwheel.se/se/grp/elcyklar.php

4.2 Bus Routes

The City of Copenhagen's e-buses run a fixed route, route 11A, which runs around the largest tourist attractions in the inner city zone 1. The fleet consists of 11 buses. The 11A route is 10.1 kilometres long and takes about half an hour. The buses run between 11-13 times per day. On average each bus thus runs 130 kilometres per 24 hours. The busses run 7 days a week during the following hours; on weekdays from 7am till midnight, on Saturdays 10am till midnight, and on Sundays 11am till midnight. The buses run every 10 minutes during the day and every 20 minutes in the evenings. There are no breaks in the day.

The buses have 9 seats and standing room for 12. They have been converted by an Italian manufacturer and are only charged by charging points. The buses do not require preheating in the winter. Only e-buses run on route 11A, and unfortunately it is rather difficult to give examples with fossil fuel buses on the same route. While details are available below on alternative ICE vehicles, it should be noted that the vehicles are of different specifications and direct replacements for the EV's. The traditional buses in the City of Copenhagen run on diesel, and below there is a chart with an overview of the differences between e-buses and traditional buses in terms of room, weight.

E-buses vs. diesel buses

	Seats	**Standing room (for)**	**All-up weight (kg)**	**Dead weight (kg)**	**Load capacity (kg)**	**Km to the litre (on average)**
E-buses	9	12	5,950	4,150	1,800	
12 m diesel bus	34	37	18,000	11,175	6,825	2,5
13,7 m diesel bus	43	61	2,0925	13,400	7,525	2,5
14,7 m diesel bus	47	63	22,700	14,700	80,000	2,5

Figure 4.1 General Bus Statistics

Maintenance costs

In this project, the operating costs of the e-buses have been more expensive than those of the diesel buses in all respects: The driving line cost per kilometre is higher, especially since the batteries are very expensive. There are 24 batteries in each bus, and the price of one battery currently amounts to 3,500 EUR. Up to now, three batteries packs (i.e. 72 batteries) have been replaced. Furthermore, the cost price of e-buses is higher than that of diesel buses, as the supply is smaller. Repair costs are also higher due to the special technology, which is rather time consuming. Additionally, there is a much larger risk of breakdowns and slow fault clearance with e-buses, since the

problems arising are not known. There is also a much larger residual risk when selling e-buses due to the fact that the e-technology is evolving rapidly, and therefore it is more difficult to sell an old e-bus compared to an old diesel bus.
Having mentioned the challenges above, it should be kept in mind that e-technology is constantly and rapidly evolving, which is why the price and product quality may do the same. E-buses should still be regarded and organised as the pilot project until sufficient experiences have been gained. However, this does not mean that there will not be an overall socio-economic benefit in the short term taking account of environmental pollution, noise etc.

Below there are two tables respectively indicating the e-buses' energy consumption per month and the distance travelled per month.

	Energy Consumption per month, all e-buses			**Since last reading**	
01-11-2009	**Electricity meter =**	**23,940**	kWh		
18-11-2009	**Electricity meter =**	**32,360**	kWh	**8,420**	
01-12-2009	**Electricity meter =**	**37,700**	kWh	**5,340**	kWh
01-01-2010	**Electricity meter =**	**51,680**	kWh	**13,980**	kWh
01-02-2010	**Electricity meter =**	**65,690**	kWh	**14,010**	kWh
01-03-2010	**Electricity meter =**	**77,740**	kWh	**12,050**	kWh
01-04-2010	**Electricity meter =**	**94,990**	kWh	**17,250**	kWh
01-05-2010	**Electricity meter =**	**109,480**	kWh	**14,490**	kWh
01-06-2010	**Electricity meter =**	**124,550**	kWh	**15,070**	kWh
01-07-2010	**Electricity meter =**	**140,710**	kWh	**16,160**	kWh
01-08-2010	**Electricity meter =**	**157,680**	kWh	**16,970**	kWh
01-09-2010	**Electricity meter =**	**174,600**	kWh	**16,920**	kWh
01-10-2010	**Electricity meter =**	**191,130**	kWh	**16,530**	kWh
01-11-2010	**Electricity meter =**	**209,060**	kWh	**17,930**	kWh
01-12-2010	**Electricity meter =**	**229,720**	kWh	**20,660**	kWh
01-01-2011	**Electricity meter =**	**250,300**	kWh	**20,580**	kWh
01-02-2011	**Electricity meter =**	**266,790**	kWh	**16,490**	kWh
01-03-2011	**Electricity meter =**	**283,100**	kWh	**16,310**	kWh

01-04-2011	**Electricity meter =**	**301,230**	kWh	**18,130**	kWh
01-05-2011	**Electricity meter =**	**325,210**	kWh	**23,980**	kWh
01-06-2011	**Electricity meter =**	**344,770**	kWh	**19,560**	kWh
01-07-2011	**Electricity meter =**	**363,510**	kWh	**18,740**	kWh
01-08-2011	**Electricity meter =**	**374,037**	kWh	**10,527**	kWh
01-09-2011	**Electricity meter =**	**384,280**	kWh	**10,243**	kWh
01-10-2011	**Electricity meter =**	**394,450**	kWh	**10,170**	kWh
01-11-2011	**Electricity meter =**	**406,300**	kWh	**11,850**	kWh
01-12-2011	**Electricity meter =**	**418,240**	kWh	**11,940**	kWh
01-01-2012	**Electricity meter =**	**431,060**	kWh	**12,820**	kWh
01-02-2012	**Electricity meter =**	**447,520**	kWh	**16,460**	kWh
01-03-2012	**Electricity meter =**	**461,070**	kWh	**13,550**	kWh
01-04-2012	**Electricity meter =**	**472,520**	kWh	**11,450**	kWh
01-05-2012	**Electricity meter =**	**482,560**	kWh	**10,040**	kWh
01-06-2012	**Electricity meter =**	**495,290**	kWh	**12,730**	kWh

Figure 4.2 e-Bus Energy Consumption

Kilometres per month

Dato:	**Bus 1**		**Bus 2**		**Bus 3**		**Bus 4**		**Bus 5**		**Bus 6**	
01-01-2012	64,709		82,410		98,891		88,442		61,969		62,592	
01-02-2012	64,709		85,276	**2,866**	98,891		92,196	**3,754**	61,969		66,605	**4,013**
01-03-2012	64,709		88,058	**2,782**	98,891		95,749	**3,553**	61,969		68,576	**1,971**
01-04-2012	64,709		90,910	**2,852**	98,891		98,680	**2,931**	61,969		71,662	**3,086**
01-05-2012	64,709		93,415	**2,505**	98,891		101,395	**2,715**	61,969		74,280	**2,618**
01-06-2012	64,709		94,782	**1,367**	98,891		104,324	**2,929**	61,969		77,955	**3,675**

01-07-2012		**-64,709**		**-94,782**		**-98,891**		**-104,324**		**-61,969**		**-77,955**

	Bus 7		**Bus 8**		**Bus 9**		**Bus 10**		**Bus11**	
01-01-2012	81,157		58,128		68,929	**2,254**	43,734		58,642	
01-02-2012	84,590	**3,433**	58,927	**799**	69,117	**188**	47,062	**3,328**	61,729	**3,087**
01-03-2012	87,529	**2,939**	62,167	**3,240**	69,984	**867**	50,089	**3,027**	63,641	**1,912**
01-04-2012	89,676	**2,147**	64,502	**2,335**	69,984		52,488	**2,399**	65,678	**2,037**
01-05-2012	91,234	**1,558**	66,688	**2,186**	69,984		54,720	**2,232**	67,757	**2,079**
01-06-2012	93,461	**2,227**	69,415	**2,727**	71,891	**1,907**	57,132	**2,412**	71,273	**3,516**
01-07-2012		**-93,461**		**-69,415**		**-71,891**		**-57,132**		**-71,273**
01-08-2012										

Figure 4.3 e-Bus Km Driven

From Figure 4.3 above we can see that the buses were heavily utilised with average monthly usage of over 2500km. While energy consumption figures are included in Figure 4.2 above, these figures represent only a short overlap period and therefore while they give an indication of kWh/km they are as yet immature. It is intended to revisit this topic in the final report to establish a fuller and representative picture of energy consumption and related seasonal effects

4.3 Taxis

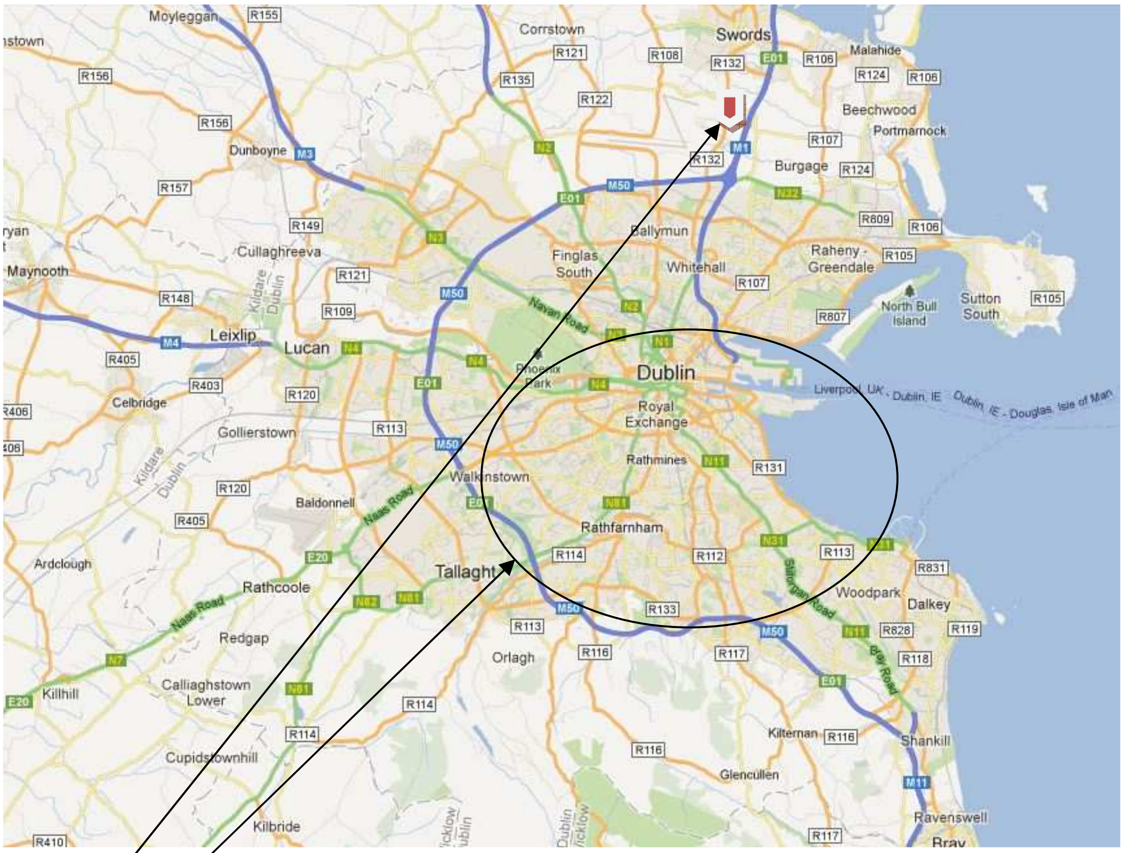
The Ireland demo region has monitored 2 Electric Taxi’s. The vehicle type and the charging technologies were different in order to assist in assessing challenges and opportunity in operating an electric taxi. Neither vehicle is shared by a second driver. The vehicles have been monitored over a 12 month period which has been supported by an interview of both drivers in order to ensure a greater understanding of the full experience.

Taxi Regulation

There are 11,028 taxi’s licensed in the Co. Dublin area at June 2012 of which 487 are wheel chair accessible. Taxi Regulation in Ireland specifies the load space required in the taxis. In the case of Taxi 1 special permission has been granted for use as a taxi, due to the undersized load space. A portion of taxi licences are granted for specific use as wheel chair accessible vehicles. These licences cannot be exchanged and must always include wheelchair accessibility.

Dublin Geographical overview

The Dublin area consists of approx. 920km^2. For both vehicles monitored the home area is south of the city however clients can wish to travel outside this area. The airport is located to the north of the city and is likely to be the most regular long journey a taxi driver based in the south of the city will encounter. (See Figure 4.4)



Airport
Home Area

Figure 4.4 Dublin Area View

Taxi 1

Taxi 1 is operated between 5 and 6 days a week. It has both AC charge (3.5kW) and DC ‘fast charge’ (50kW) capability. The primary place of residence has been fitted with an AC charge point. Taxi 1 is charged each night at the home charge point with occasional use of a DC charge at a city centre location. Friday’s and Saturday’s are the days where fast charging is most important due to the quantity (and distance) of trips undertaken. Approximately 20% of requests are declined due to range limitations, where the driver is uncomfortable about the return journey. At no time has the driver declined a fare due to luggage space. The driver experience has been very positive with particular notes made on responsiveness and comfort. The car is much preferred to the previous fossil fuel vehicle and attracts positive feedback from passengers. The driver is aware of the difference in fuel costs between both vehicles and this is a significant factor in considering the vehicle type. The driver believes a range of 250km to be suitable for taxi use in the Dublin area.

Taxi 2 is also operated between 5 and 6 days a week. It has 3 Phase AC charge capability only, with a charge time of approximately 8.5 hours. Charge outlets are installed at both home and taxi office locations. Due to the duration required to charge the only practical charging is overnight at the drivers home. Friday's and Saturday's are the days charging is the greatest problem due to the quantity (and distance) of trips undertaken. Approximately 40% of requests are declined due to range limitations, where the driver is uncomfortable about the expected distance. The driver experience has been generally positive with particular notes made on comfort and quietness, however charge times are a particular issue with this vehicle. The vehicle is more comfortable than the previous fossil fuel vehicle and attracts positive feedback from passengers. The driver is aware of the difference in fuel costs between both vehicles and this is a significant factor in considering the vehicle type. The driver believes a range of 300km to be suitable for taxi use in the Dublin area.

Vehicle ID	Taxi1	Taxi2	Comments
Type	Car, 5 Door	Van, Wheelchair Access	
Seating	5	6	
AC Charging	Yes	Yes	
DC Charging	Yes	No	
Charge Rate (AC)	3.5kW	5kW	
Charge Time (AC)	6.8 hrs	8.5 hrs	
Nominal Range	160km	160km	
Previous vehicle Engine Volume	Petrol, 2 Litre	Diesel, 2 Litre	
Average weekly km	900km	750km	
Weekly electricity Cost	€30	€35	Assuming €0.21 /kWh
Weekly fossil fuel cost	€140	€120	Assuming €1.60/l fuel
% Home Charge	85%	100%	
% Public AC Charging	0%	0%	
% Public DC Charging	15%	0%	

Savings per Annum	€5,280	€4,080	Assuming €0.21 /kWh and €1.60/l fuel, 48 weeks per year

Figure 4.5 Trial Taxi Comparison Chart

Findings

The ranges of the tested vehicle technologies are on the boundaries of practical use as taxi's in the Dublin area. Particular difficulties are experienced at peak times, while the vehicle operation is satisfactory at other days in the working week. The availability of DC fast charging significantly alleviates this obstacle and highlights the importance of fast energy replenish times by whatever method. The overall experiences of comfort and energy costs are very positive. Range extension and/or the accessibility of fast methods of charging or battery swapping are of particular interest to operators.

Future plans:

The number of taxis being monitored will increase and induction charging will be tested. More detailed analysis of usage patterns will be carried out, with particular attention to the indicators from this preliminary report. Alternative charging methods will be examined, particularly in the context of the demonstration of inductive charging in the Green eMotion project.

4.4 Courier & Urban delivery

As part of the Ireland demonstration region a total of 6 vehicles have been monitored over a period of 12 weeks in urban delivery and courier scenarios. These vehicles have all been ICE vehicles, with the intension of assessing usage patterns and analysing suitability for EV alternatives. In addition 3 fixed route courier post-delivery electric vehicles are monitored.

Drive patterns of the monitored vehicles show varying distances in a working day. The monitored vehicles show only one work shift per day, after which the vehicle is idle. The duration of breaks witnessed during the day is short with few lasting for more than 1 hour. The vehicles are all mainly used in day time applications. Due to the nature of the routes, (i.e. the majority is city centre) the vehicles are in the best environment to achieve the maximum ranges specified for EV's.

For vehicles which are on fixed routes, AC (3.5kW) charging may be sufficient, once the distances travelled are within the practically achievable range of the vehicle. Due to the short breaks and relatively long distances covered by many vehicles, particularly those on variable distance routes, it would be necessary to consider the charging methods for EV urban delivery. Vehicles will often require fast charge or battery swap technologies to facilitate extensions in range during the short intervals between usages. This would be particularly important where vehicles are to be used in 'back to back' shift scenarios, that is, where a driver finishes a work shift and another driver takes the same vehicle for the next shift. Increased range capabilities would address the needs of single shift vehicles where they can be charged over longer periods of time, however the multi-shift vehicles will still require a fast replenish facility.

The nature of usage experienced across the vehicles monitored, would suggest that, if uncontrolled, the charging would take place mainly at the time of peak electricity demand. To best optimise this and to control energy prices for the user, there is opportunity to exploit scheduled charging, thus making use of night time or other variable electricity rates. While this timing could be undertaken in the vehicle, it would be advantageous to consider centralised scheduling for larger fleets as this would alleviate, stresses to the electricity supply at a depot from large scale simultaneous charging.

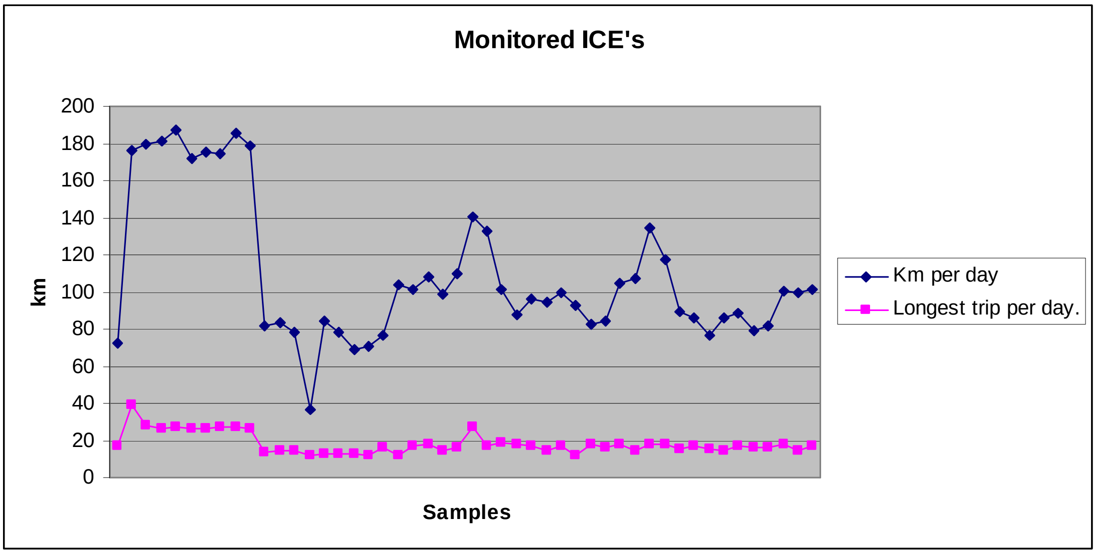


Figure 4.6 Urban Delivery Vehicle Usage

4.5 Car Pool

Transport is a particularly significant overhead for many businesses, however it is not goods delivery alone that creates this drain on resources, in many cases it is transit of employees. Company vehicles can be utilised where particular members of staff such as sales or service engineers are regularly travelling on behalf of the business, however in cases where travel patterns are more sporadic, then taxi's or car mileage allowances are typically favoured. The use of personal vehicles is still a financial drain on the business however it has the added disadvantage of requiring the employee to commute to work in their personal car, where they might otherwise be able to utilise public transport. This situation clearly doesn't support the sustainable targets of modern business. A solution to the challenge may be found in a 'car pool' system, however migration to an ICE car pool holds none of the fuel saving benefits, nor does it benefit the sustainable targets of companies.

A fleet of 4 EV's were used in a car pool located at the head office of a Dublin based company. The office is the main workplace of approximately 800 employees from a variety of business units.

As the company has multiple offices within the region and conducts business with other industry partners, employees would regularly be required to travel to other locations as part of their work. This travel may require employees to walk, cycle, use their own vehicle or take a taxi.

The car pool has not yet been advertised throughout the company but relies solely on word of mouth, with the number currently using the car pool standing at 40 users and is provided free of charge. Following this pilot, it is hoped to supplement the number of vehicles available and advertise the service to a wider audience under a 'business shared service' scheme.

Users of the car pool can make bookings by contacting a member of staff responsible for vehicle management who can then view availability and enter bookings on behalf of the user. It is anticipated that the software would be made available to all staff once a wider deployment of the system commences. It is also anticipated that key management is upgraded to allow more automated access control.

Data was gathered from records of the company taxi account and the receipted taxi expenses of employees. The total combined value of receipted expenses from taxi usage and the invoices to the taxi account can be seen in Table 4.8 below.

Taxi Invoices 2011	
01 Jan 2011 - 31 Dec 2011	**Totals**
€ Total	€61,672
No of Trips	4,224
€ Average	€17.17
Av. Distance Km	2.98

Taxi Receipts (Personal Expenses)	
Total spend	€43,473
Total no of trips	2,058

Regulated Taxi Fair Structure	**Rates €**
Standing charge	€4.10
Charge / km	€1.03

Combined Taxi Costs	
Total Spend	€105,145
Total no of trips	6,282
Average Distance Km	12.27

Table 4.8 Taxi Invoices & Expenses

A cost comparison of owning 4 electric vehicles for 5 years against the cost of taxis over 5 years reveals that the taxi's would cost €525,724, while the cost of owning and maintaining the electric vehicles would cost approximately €132,213. See Table 4.9 below.

The TCO for the fleet of 4 EV's has been calculated using the parameters set out below. The distance travelled over the taxi journeys is calculated using the number of journeys and the regulated taxi fairs listed in Table 4.8 above. Currently in Ireland, the cost of a Nissan 'Leaf' is €25,500 with an electricity consumption of €1094 for 77,077km. Energy costs are calculated based on night time charging at a rate of 10.18 cent/kWh. Data acquired from the Nissan 'Carwings' monitoring system calculated energy consumption of 0.14kWh/km, (based on 900km of typical travel) therefore the calculation of fuel for the vehicles is:

0.14kWh x 10.18 cent x 77077km = €1098.50 per year.

The insurance for the four vehicles is estimated at €4000 per year, however for many fleet insurance policies this would be considered high. Vehicle road tax is €120 per vehicle per year and the maintenance costs have been consistent for 3 existing vehicles over 2 years at €105 per vehicle each year. A National Car Test applies to vehicles which are 4 years old, this test is only repeated after a further 3 years and therefore will only apply once during the evaluation period at a cost of €55 per vehicle.

	1 Year (€)	5 Years (€)
Cost of Taxi's	105,145	525,725
EV Ownership x 4		
Capex	20400	102,000
Fuel	1098.50	5492.50

Insurance	4000	20,000
Tax	480	2400
Maintenance	420	2100
National Car Test NCT (Required in Yr 4)		220
TCO	26,398.50	132,212.50

Table 4.9 Comparison Overview

A comparison of emissions showed that for the taxis journey total distance of 77,077Km the taxis emitted 11.56 million grams of carbon, while the same journeys in an electric car would reduce it to 5.32 million grams (based on Ireland's electricity mix). This promotes sustainable travel and a reduction in their carbon footprint. These figures show that there is an opportunity to improve sustainable travel in the office. The replacement of taxi journeys with low emission electric vehicles not only reduces the companies carbon footprint, but also it's spend on staff transport. See Table 4.10 below.

Emissions		
Taxi carbon g / Km	150	
EV carbon g / Km		69
Taxi carbon g / total Km	11561621	
Millions grams of carbon	11.56	
EV carbon g / total Km		5318345.83
Millions grams of carbon		5.32

Table 4.10 Emissions comparison Taxi v. EV

Tables 4.11 and 4.12 give summary details and assumptions used in the pilot.

Summary Data	
Total number of bookings	1,074
Total distance driven (kms)	29,250
Average distance	27.2
No of bookings per car	358
Avg distance per car	9,750
Number of cars available	4
Working days in month	21

Table 4.11 Summary Data

Comparable monthly costs	
Equivalent cost in a taxi	€4,793.16
Cost to pay for fuel:	**Euro**

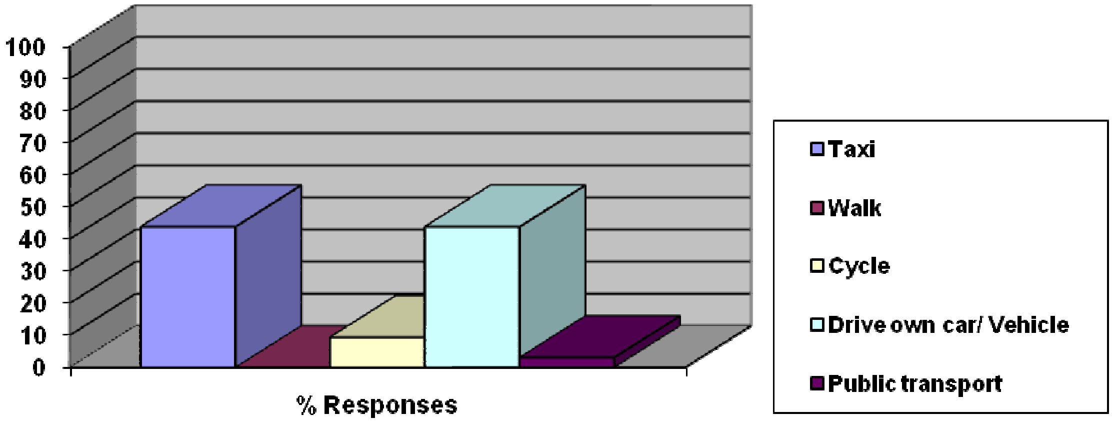
- petrol	514
- diesel	310
- electricity	56
Assumptions	
Cost of fuel per km (cent)	
- petrol	12.5
- diesel	7.5
- electricity - Night Rate	1.42
EV Purchase Cost	€25,500
Taxi costs	
Standing charge	€4.10
Charge / km	€1.03
Total distance km Taxi	4,177
No of Standing charges	-160
Total km remaining	4,017
Total cost of standing charges	€656
Total cost of remaining charges	€4,137
	€4,793
Emmissions	
Total distance for trips Km	4,118
EV carbon g / Km	69
Taxi carbon g / Km	150
Taxi carbon g / total Km	617,687
EV carbon g / total Km	284,136

Table 4.12 Monthly equivalents

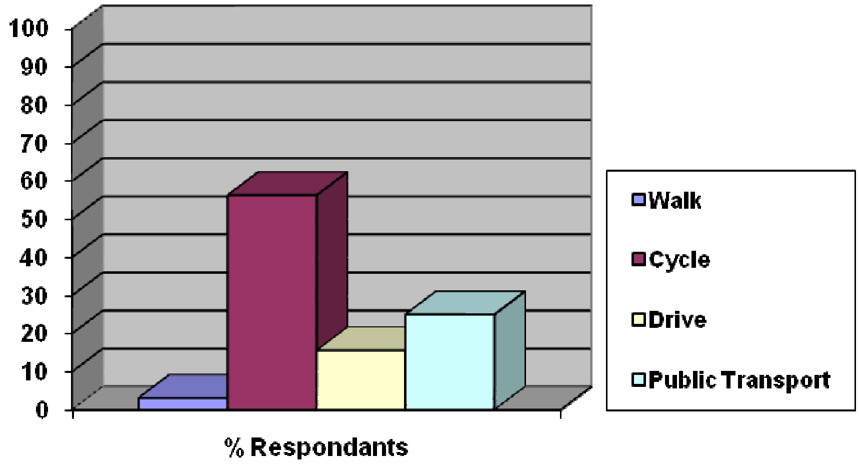
From the data gathered in this use case and validation with equivalent taxi usage, there is a clear benefit both financially and environmentally for the use of an EV car pool. The average return journey the cars were used for was 26Km and the cars were used on average, twice a day. This high number of uses of the vehicles and the high average distances augurs well for the cost benefit of using this type of car pool system in place of a taxi service or indeed a mileage system for personal vehicle usage.

In addition to this data a survey was carried out of registered users of the car pool in which questions were presented relevant to user acceptance. From the responses received it can be clearly seen that the EV carpool was mainly replacing ICE vehicles.
The high level of respondents who use either cycling or public transport to commute to work combined with the high number of users who would have used own transport as an alternative means of travelling to meetings indicates that there is a greater benefit to having EV car pools other than that simply calculated on the business journeys.
While the percentage of work related journeys which were possible with an electric vehicle was high, the main limitation was the range limitation of 70km available with the preproduction vehicles used in the pilot. It should be noted that the ranges available on many of the vehicles currently available is significantly higher, thus allowing almost all trips to be within the capabilities of the EV.

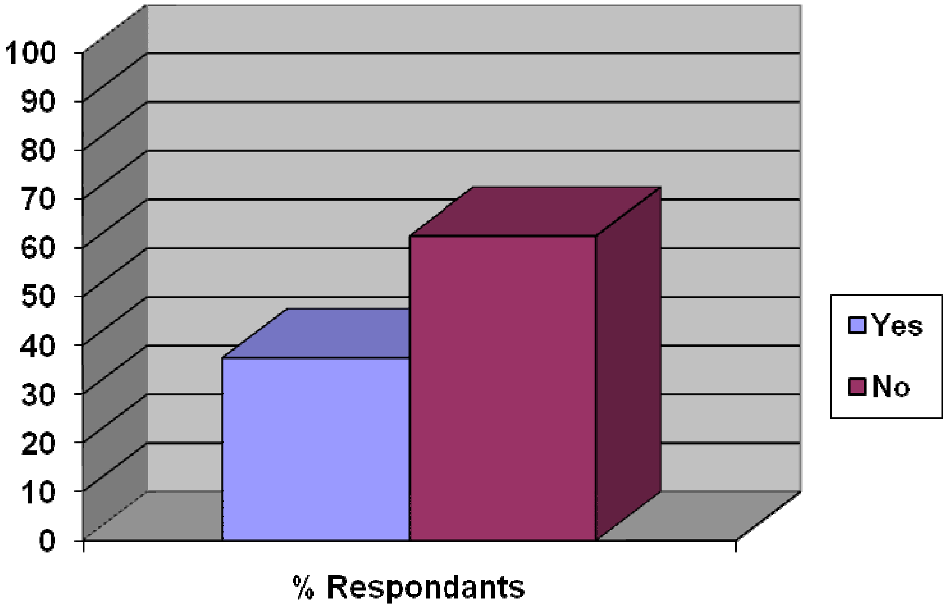
1. If the electric car was unavailable, what method of transport would you choose?



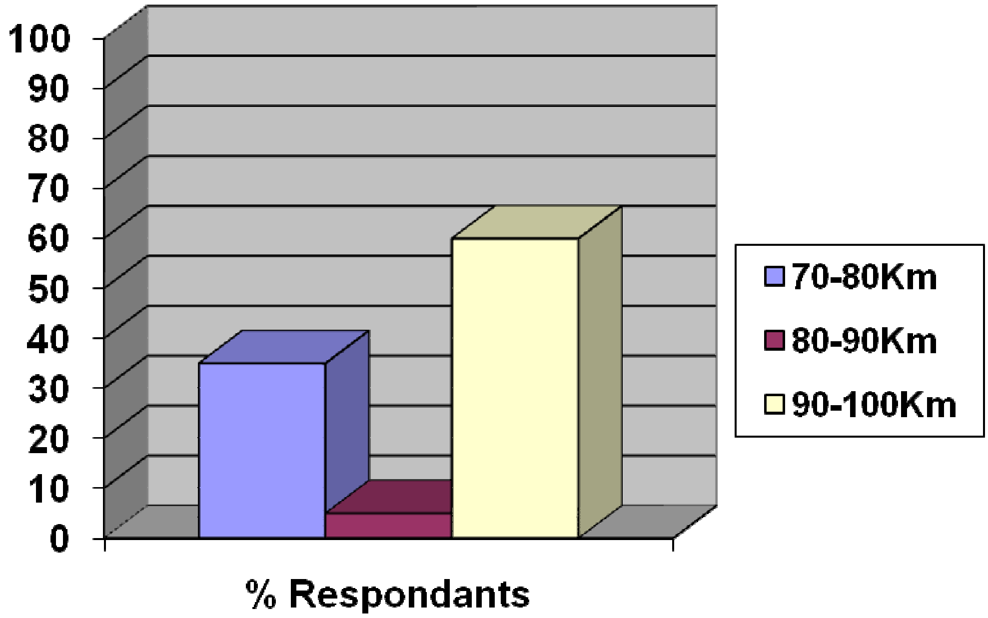
2. How do you usually commute to work?



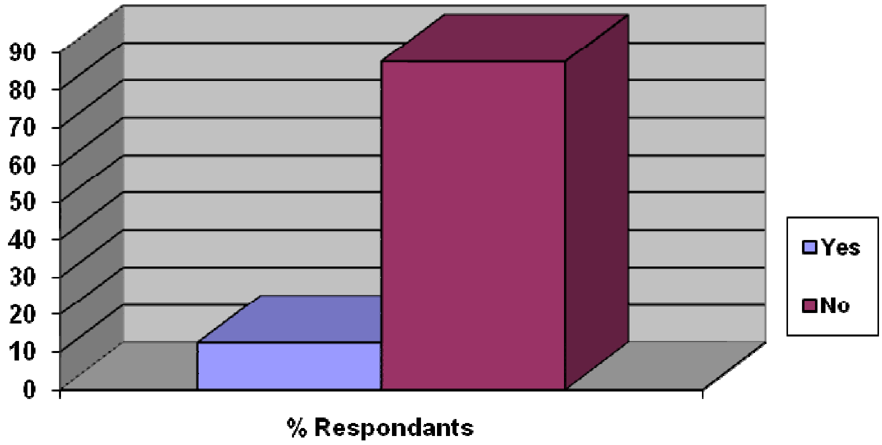
3. **Have there been many work related journeys that the electric car could not facilitate?**



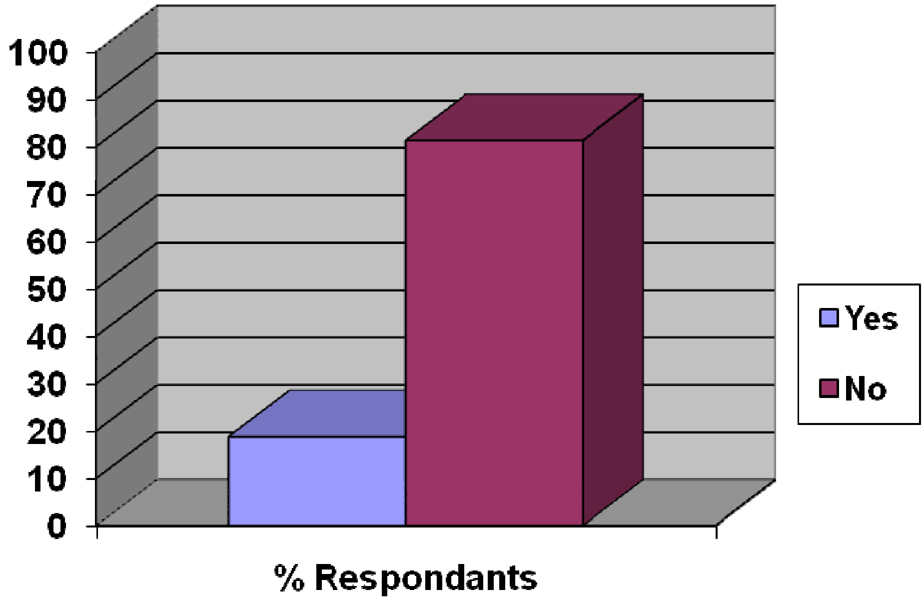
4. **If yes, what distances were they, on average?**



5. **Are there any instances where you have recharged the car while using it away from head office during working hours?**



6. **Are there any journeys where you would choose a taxi over an electric car, given that the electric car was available?**



The above data shows that a car pool system using Electric Vehicles is an acceptable and workable solution to the majority of the respondents. The main limitation of range which was experienced with the preproduction vehicles would not be a factor for many of the vehicles commercially available at this point in time.

5 Fleet EV Usage Patterns

The data from all vehicles registered under the category ‘fleet’ in each of the demo regions of Green eMotion has been correlated to provide some useful information on usage times and charge start times.

Figure 5.1 below shows the distribution of ‘Plug in’ times for the monitored vehicles. The chart shows the times of plug in predominantly across the standard day to evening time after a work shift. The data indicates that while there are significant plug in events arising during the typical evening energy electricity consumption peak, the number of events during the daytime is still very high. This differs significantly from the private vehicle household charge events monitored in GeM WP 1, which showed a much higher level of charge events started at or during the evening peak. This indicates that the effect on the electricity system could be significantly lower on fleet vehicles than an equivalent number of private use vehicles.

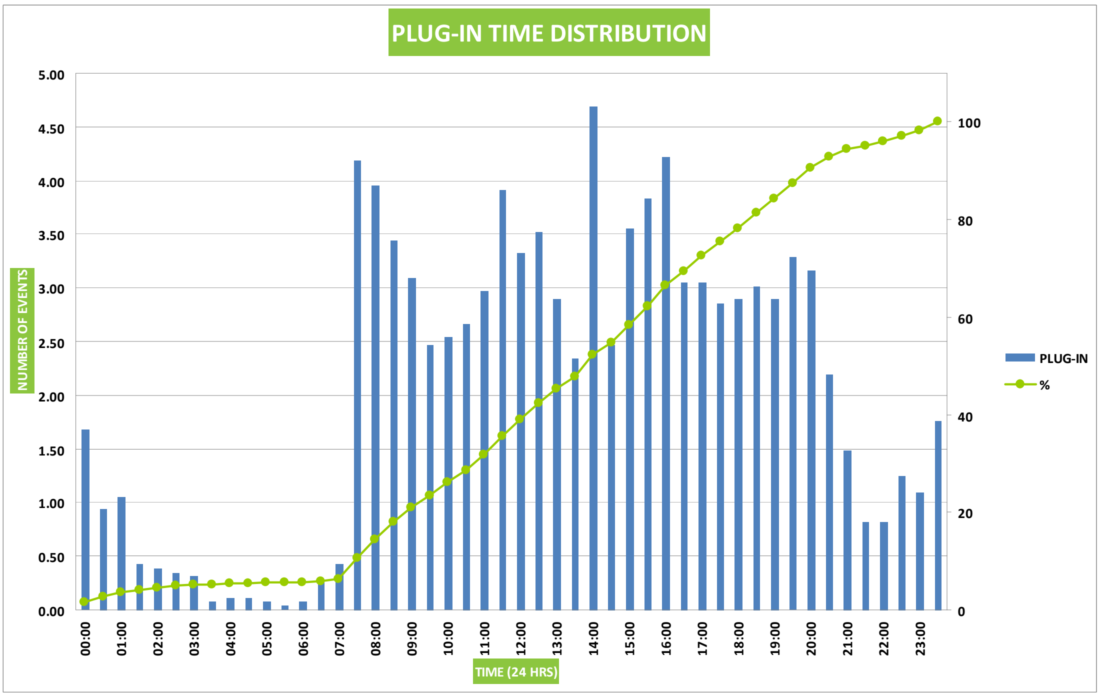


Figure 5.1

The distribution of start and finish times of fleets are shown in Figure 5.2 and Figure 5.3 respectively. These charts show that the distribution overlap is very close indicating that the journey times are generally short. The monitored vehicles started their daily activity at approx. 6.30 am. Last journey activity tapering off from 6pm with almost no activity after 11pm.

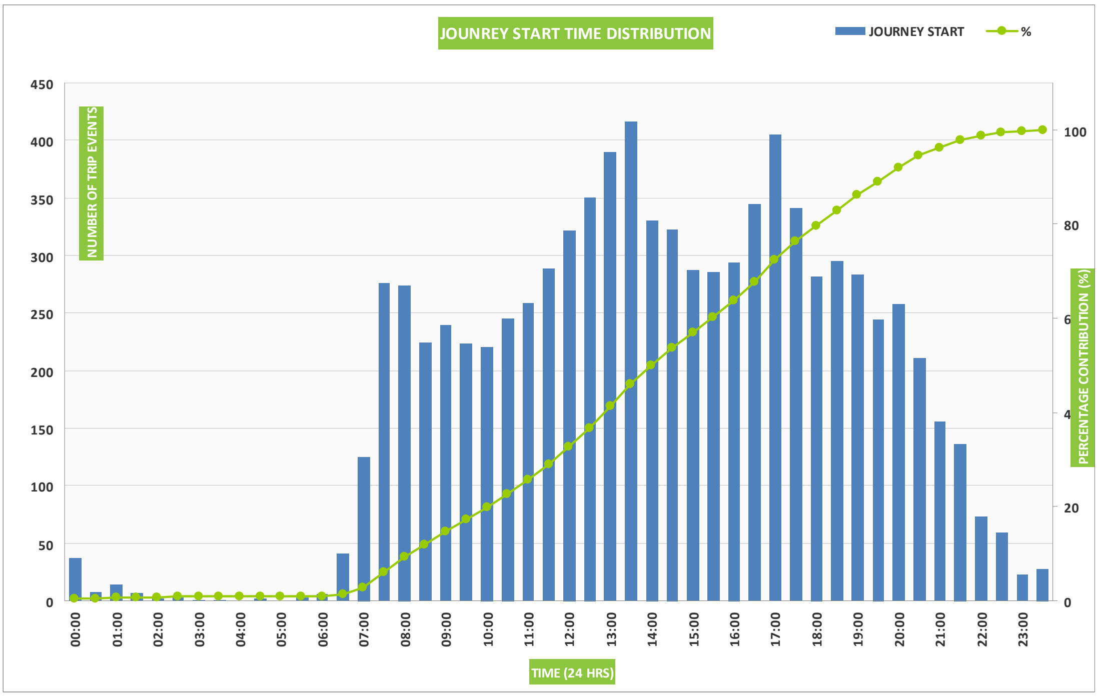


Figure 5.2

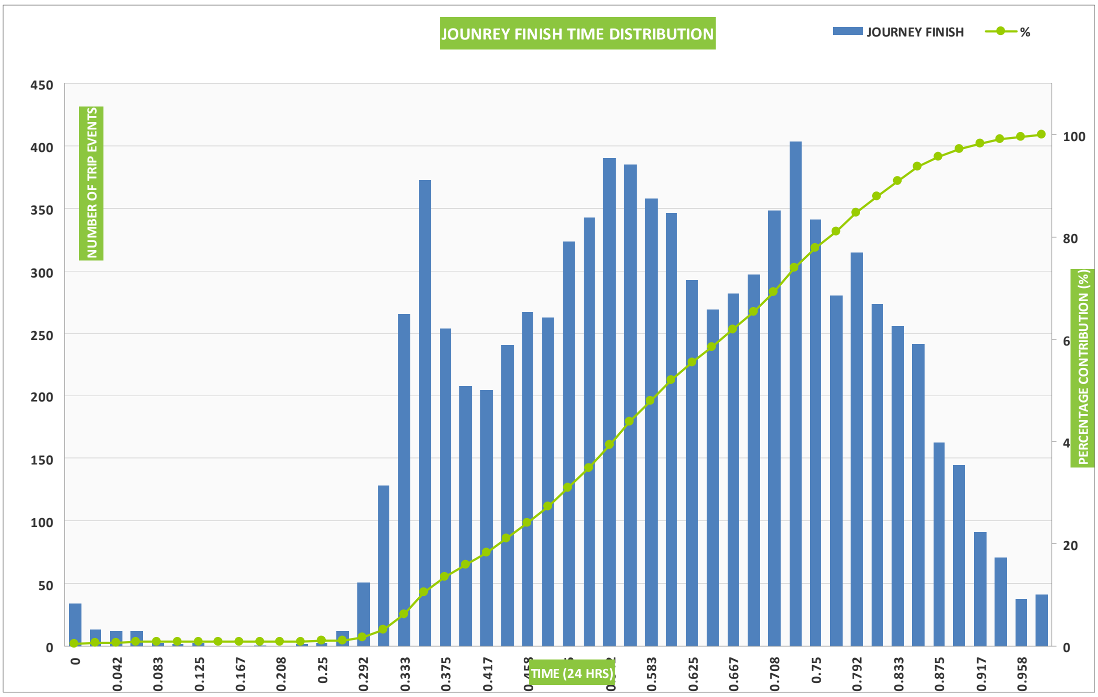


Figure 5.3

The combination of the chart event plug in times as well as the journey start and finish times show that fleet vehicles tend to use available opportunities for top up charging. This charging is spread out over a wide section of the day.

5.1 Vehicle Costs

Vehicle costs of EV's have reduced significantly over the last number of years. In many cases the initial investment is the same or little more than an ICE equivalent. This has been brought around by larger production quantities and the entrance of the vehicle OEM's to the EV market. It is now much simpler for a fleet manager to assess the costs of migrating some or all of a fleet to EV. Purchase /lease costs, fuel and maintenance are now straight forward to calculate. The reduced cost has made the proposal of EV's far more cost effective for potential customers in general, however due to the vehicles being offered this is particularly true when it comes to fleets.

5.2 Lease/Purchase models

There are two main models by which EV's are sold into the European market. These are Battery lease and outright purchase.

Battery lease is where the vehicle is sold to the customer however the battery is leased thereafter. This removes any perceived risk the customer may foresee regarding battery life or battery technology improvements. In the case of battery degradation vehicle supplier would be responsible for changing the battery. In a scenario where there was a significant advance in battery technology or efficiency, the supplier may offer an upgrade lease for the vehicle.

Outright sale is where the vehicle is sold to the customer including the battery. This leaves the customer responsible (after warranty) for the vehicle battery. Customers who do not perceive the risk to battery life or customers, who do not want a continuous payment scheme, may find this more attractive.

Currently the models offered after exclusive by manufacturer; however the changing arena may prompt manufacturers to offer multiple purchase models. Furthermore there is no reason why manufacturers or leasing companies would not offer other alternatives.

5.3 Fuel Economy

The fuel economy of a conventional vehicle is evaluated as the amount of fuel consumption per 100 Km traveling distance (litres/100km). The operating fuel economy of a vehicle depends on a number of factors, including fuel consumption of the engine, gear number and ratios, vehicle resistance, speed and operating conditions [Eshani 2005].

Example table (also from Figure 5.4). There is also an optimal operating region in which fuel consumption is minimal. This region is usually located at the middle of the speed range, corresponding to the maximum torque where the losses in induction and exhaust strokes are minimized.

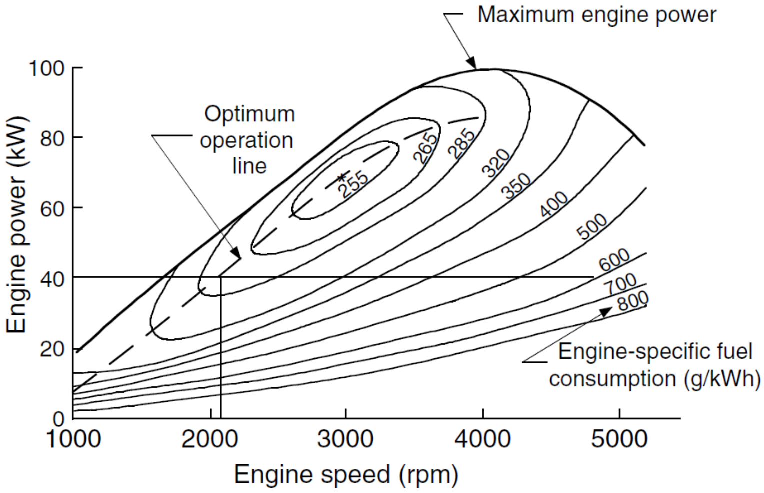


Figure 5.4 Fuel economy characteristics of a typical gasoline engine [Eshani 2005]

Due to this complexity, various drive cycles have been developed to simulate real driving conditions and measure emission and fuel economy. In figure 5.5 is shown the European ARTEMIS driving cycles for urban, rural and motorway roads [Artemis 2004]. These driving cycles are represented trough the variation of speed during a certain amount of time. Several tests are conducted for a given motor or vehicle and then an average value of fuel consumption is calculated.

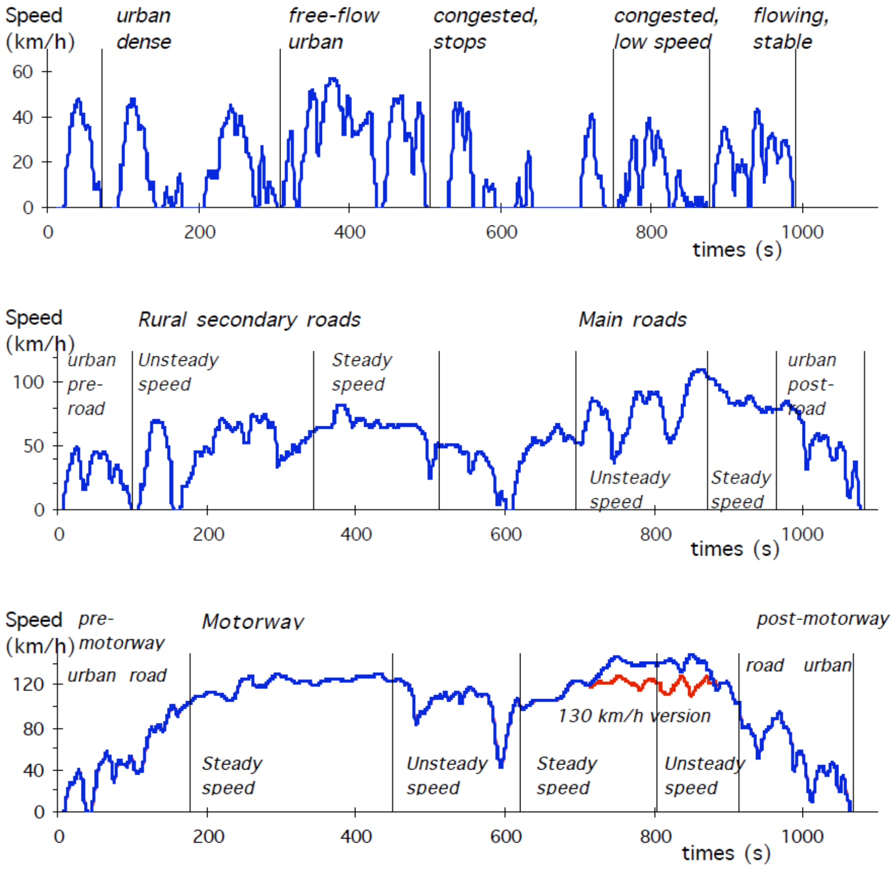


Figure 5.5 European ARTEMIS Driving cycles [Artemis 2004]

In the case of electrical vehicles, the energy consumption is expressed through the capacity of the battery expressed in kWh measured at its terminals and the driving range per battery charge. The energy consumption per unit distance in kWh/km is generally used to evaluate the vehicle energy consumption.

The objective here is to compare the differences in the fuel economy for both conventional and electric vehicles used in fleets.

Once the fuel consumption (l/100km) and energy consumption (kWh/km) is known the price of the corresponding energy source will let to compare side by side the cost (€/km) of conventional and EVs.

For example, in Table 5.7 the fuel consumption for a Van and its counterpart EV version are presented.

Conventional Van (90 C.V., Diesel)	Electric Van	
5,9 l/100km	22kWh	170km

Table 5.6 Example of Van fuel economy

Taking an estimated price of 1,4 € and 0,17 €/kWh [10], the cost for the corresponding vehicles are:

Conventional Van (90 C.V., Diesel)	Electric Van
8,26 € / 100km	3,74 € / 170km 2,2 € / 100km

Table 5.7 Comparison of fuel costs

There is an increase of more than 3 times between the fuel costs for conventional vehicle compared, or more than 6€ in fuel costs saved every 100km.
The savings of EV electricity costs against the cost of running fuel can be accurately calculated as:

$$S_{EV-F} = \left(1 - \frac{C_E \frac{P_{EV}}{R_{EV}}}{C_F \frac{F_E}{100}} \right) \times 100$$

Where:

Parameter	Meaning	Units	Example
C_F	Fuel cost	€/l	1,4
F_E	Fuel efficiency	l/100km	5,9
C_E	Electricity	€/kWh	0,17
P_{EV}	Capacity of the battery	kWh	22
R_{EV}	Range of EV	km	170

With the example mentioned above (Diesel vs EV) the obtained savings of EV fuel are more than 73%.

The equation shown above can be split in two quotients the first one shows the relationship between the prices of diesel and electricity (demand, market, taxes, etc.) and the second quotient is the comparison in the efficiency of conventional and electric vehicles (technology trends).

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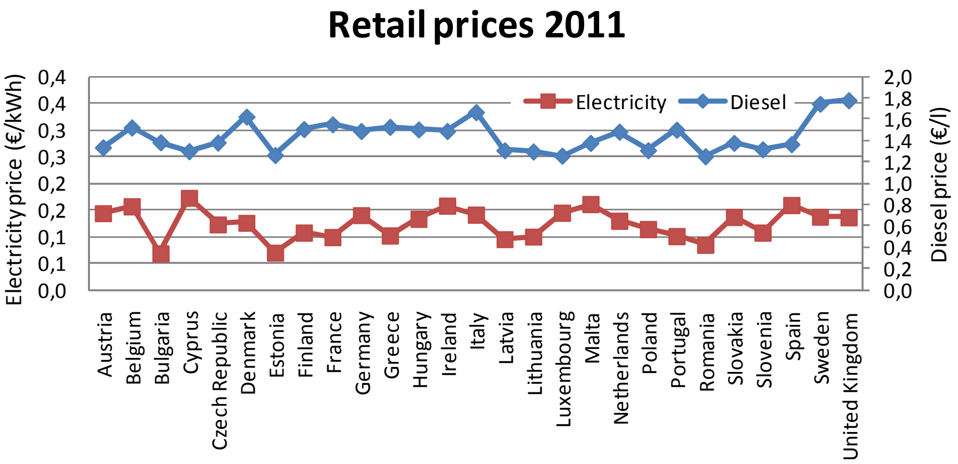
[10] Average prices in Spain as of 2012-07

To assess the potential of this improvement it is necessary to analyse the fuel and energy costs in the different regions. On the other hand it will be necessary to forecast the evolution of the fuel and energy prices and the evolution in the different technologies for both conventional and EVs.

Based on different sources of information [EnergyEU 2012, Eurostat 2012] it can be calculated the savings in different European countries for the selected van vehicles. In Figure 5.5 is shown an example of savings calculation for the van vehicle mentioned above. There is a high percentage (80% in average) of potential savings in the different countries, when switching ICE vehicles to EV ones.



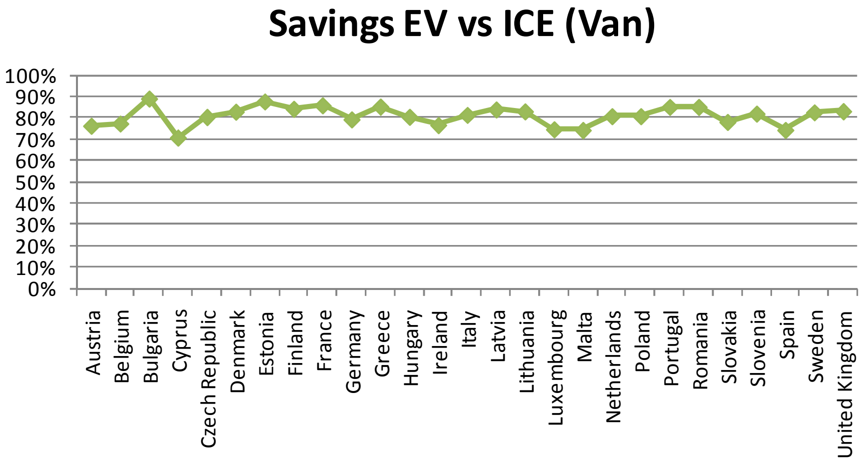


Figure 5.8 Savings of EV Van vs. ICE Van in Europe countries (average 2011)

Wholesale Prices

The usage and pricing of gasoline (or petrol) results from factors such as crude oil prices, processing and distribution costs, local demand, the strength of local currencies, local taxation, and the availability of local sources of gasoline (supply). Since fuels are traded worldwide the trade prices are similar, the price paid by consumers largely reflects national pricing policy: some regions, such as Europe, impose high taxes on gasoline (petrol).

There are different principles that govern fuel pricing in countries [GTZ 2009]:

The level of fuel prices should allow for full cost recovery of producers/importers, refiners and distributers including the costs the adequate maintenance of facilities and other assets.

Fuel taxes are good instrument for making road users pay for road use.

Internalisation of external costs and incentives for energy-efficient transport. Besides its economic benefits, the transport sector causes numerous externalities such as air pollution, soil degradation and accidents.

Fuel taxes are a means of generating revenues for the public budget.

In Figure 5.9 we present a conceptual map that shows the main factors affecting the fuel and energy costs.

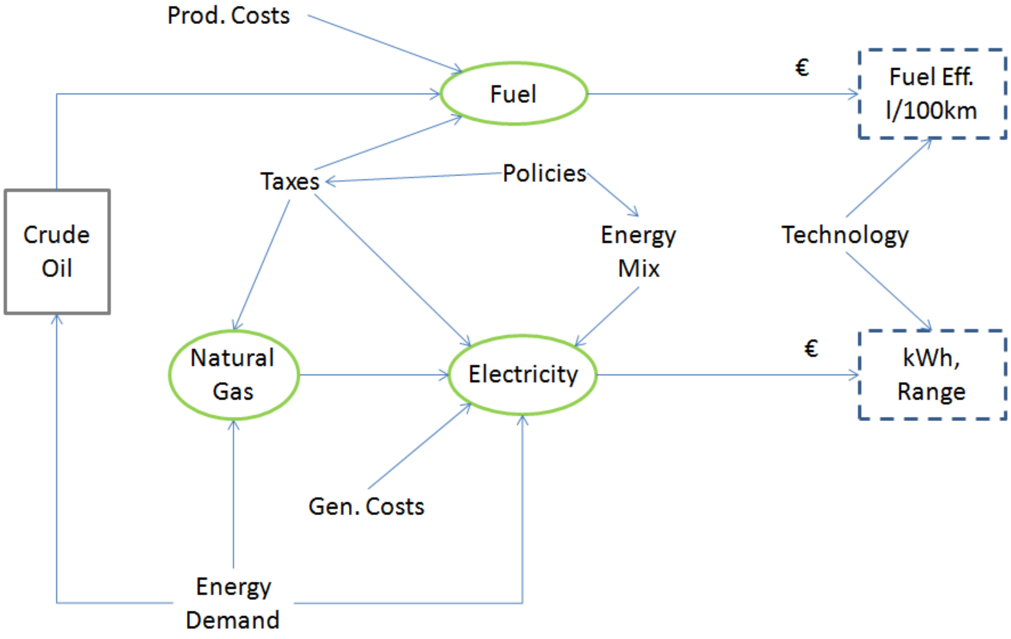


Figure 5.9 Influence on the fuel and electricity costs

Regarding the availability of fuel prices, in numerous countries especially those with ad hoc pricing mechanisms, decisions on fuel prices are made sometimes behind closed doors; the wider public is subsequently informed of new price levels but is kept in the dark about the price composition, the rationale for the price increases and the purpose of imposed taxes and levies [GTZ 2009].

Following a review of different sources of fuel prices is presented.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH [GTZ 2011]
A German body on behalf of the Federal Ministry for Economic Cooperation and Development who conducts a study about international fuel prices. In their more recent report (International Fuel Prices 2009), reviews the fuel prices by continent and the taxation mechanisms. The report provides comprehensive graphs with the prices for Diesel and Gasoline in the different countries as shown in Figure 5.10 and 5.11.

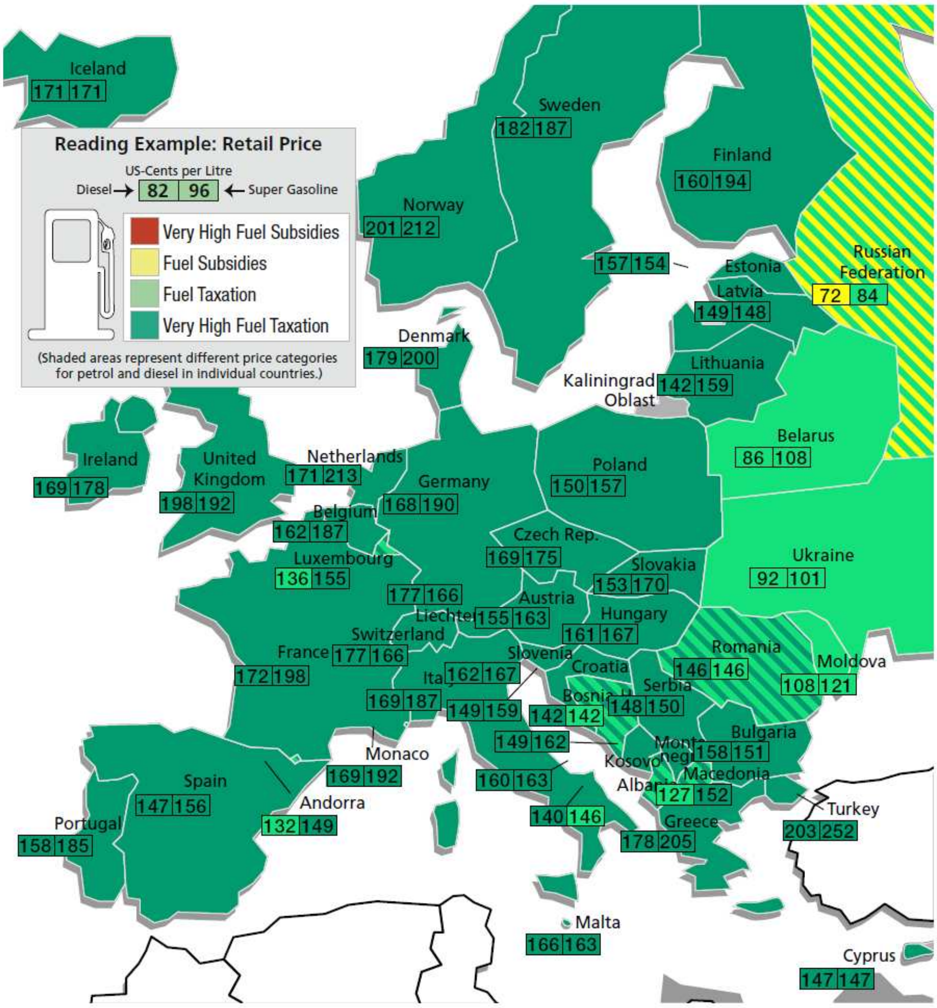


Figure 5.10 Diesel and gasoline prices in 2009

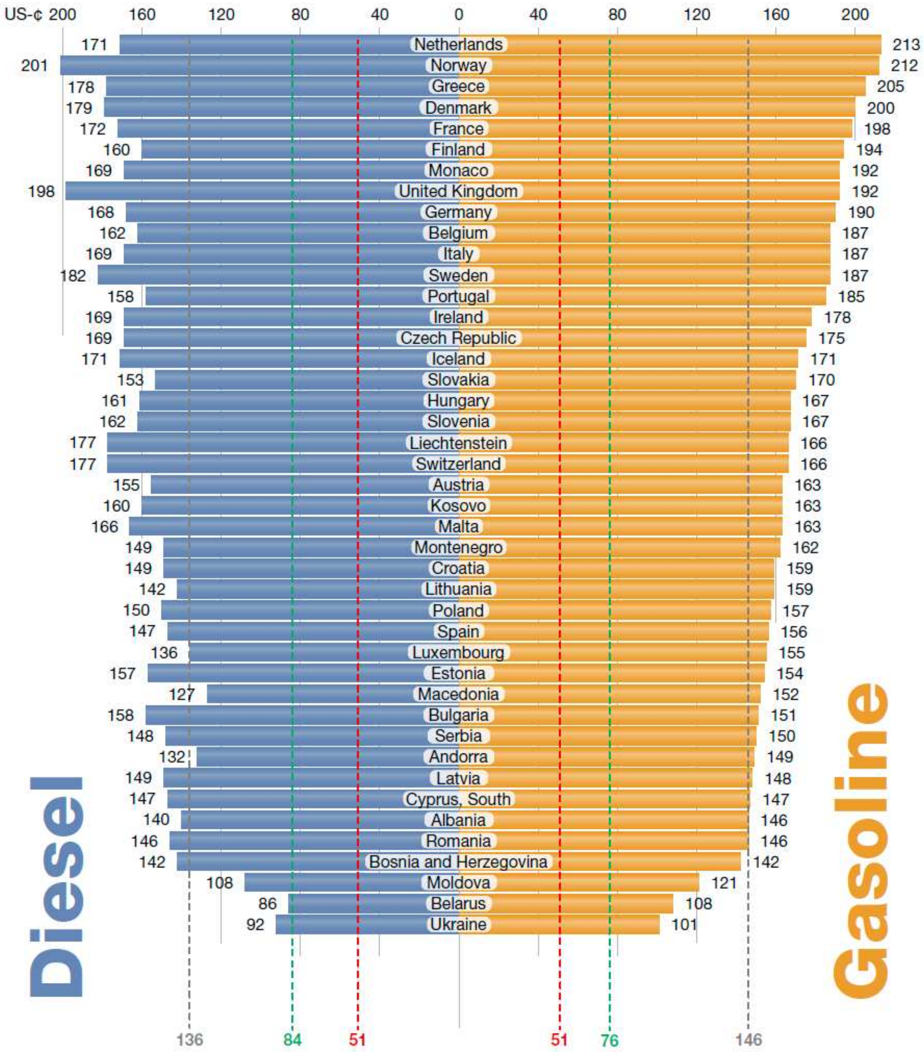
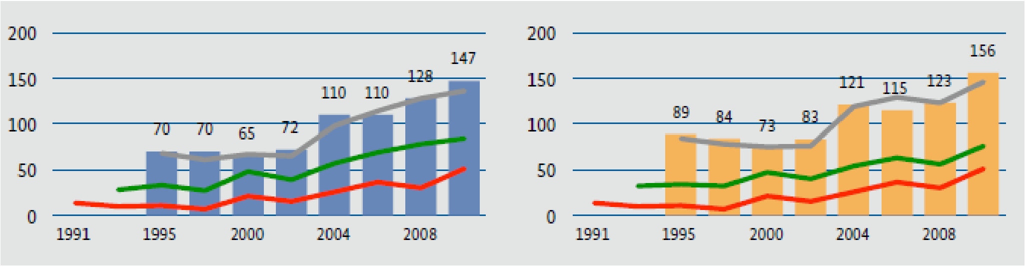
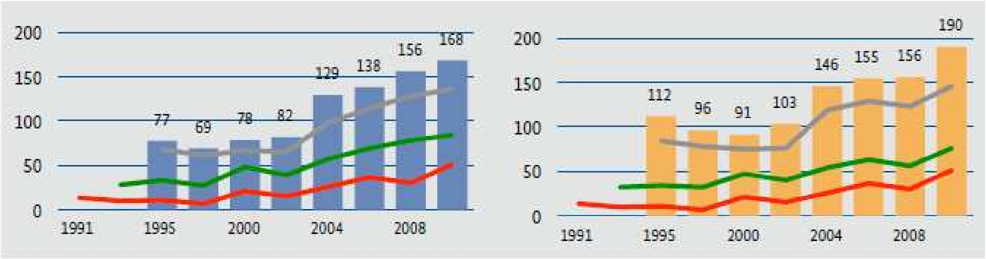


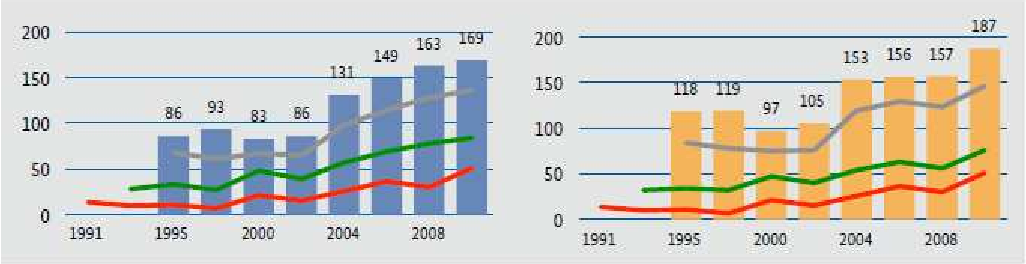
Figure 5.11 Diesel and gasoline prices in 2009



Spain



Germany



Italy

Figure 5.12 Trend in some countries of Diesel (blue) and Gasoline (orange) prices (in US cents), compared with the lowest in 2010 (Romania, grey line), prices in US (green) and crude oil (red).

Europe’s Energy portal [EnergEU 2012]
Europe's Energy Portal is a commercial organization, within the EU, but run independently from the European Commission. The Portal was founded in 2005 and is specialized in price data for fuels, gas and electricity. The end-user of energy, both the domestic and the industrial, is the prime source of input to their data analysis.They also depend on government bodies for their data input.

In its website is possible to find the following free data:
Fuel prices recently updated (Gasoline and Diesel).
Retail (end-user) energy prices for households and Industry: Natural Gas, Electricity. Less than one year older.
LPG and Heating Oil
Feed-in tariffs
Fuel taxes
Energy dependency (imports) per country (3 years old).
Emissions (CO2 and NO2)

The historical time series can be purchased at the website.

Eurostat [Eurostat 2012]
Eurostat is the statistical office of the European Union situated in Luxembourg. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions. There is a huge range of statistics that can

reviewed at the website. For example it’s possible to extract the electricity prices for households consumers as shown in Figure 5.13. On the other hand Eurostat since 1st January 2011, has stopped collecting and publishing monthly petroleum product prices. There is also an Oil bulletin [Eu_Oil 2012] that depends on Energy department and provides consumer prices and net prices (excluding duties and taxes) of petroleum products in the EU member states each week.

In Figure 5.14 is presented the trend of gasoline and diesel prices since 03/01/2005 in Spain and Belgium while Figure 5.15 shows the consumption levels for the same region. Clearly the main difference for the two countries can be seen in the price of Euro super 95 that it’s in general a 18% higher in Belgium than in Spain. This bulletin provides more interesting figures like the annual consumption of the different fuels, as presented in Figure 5.12.

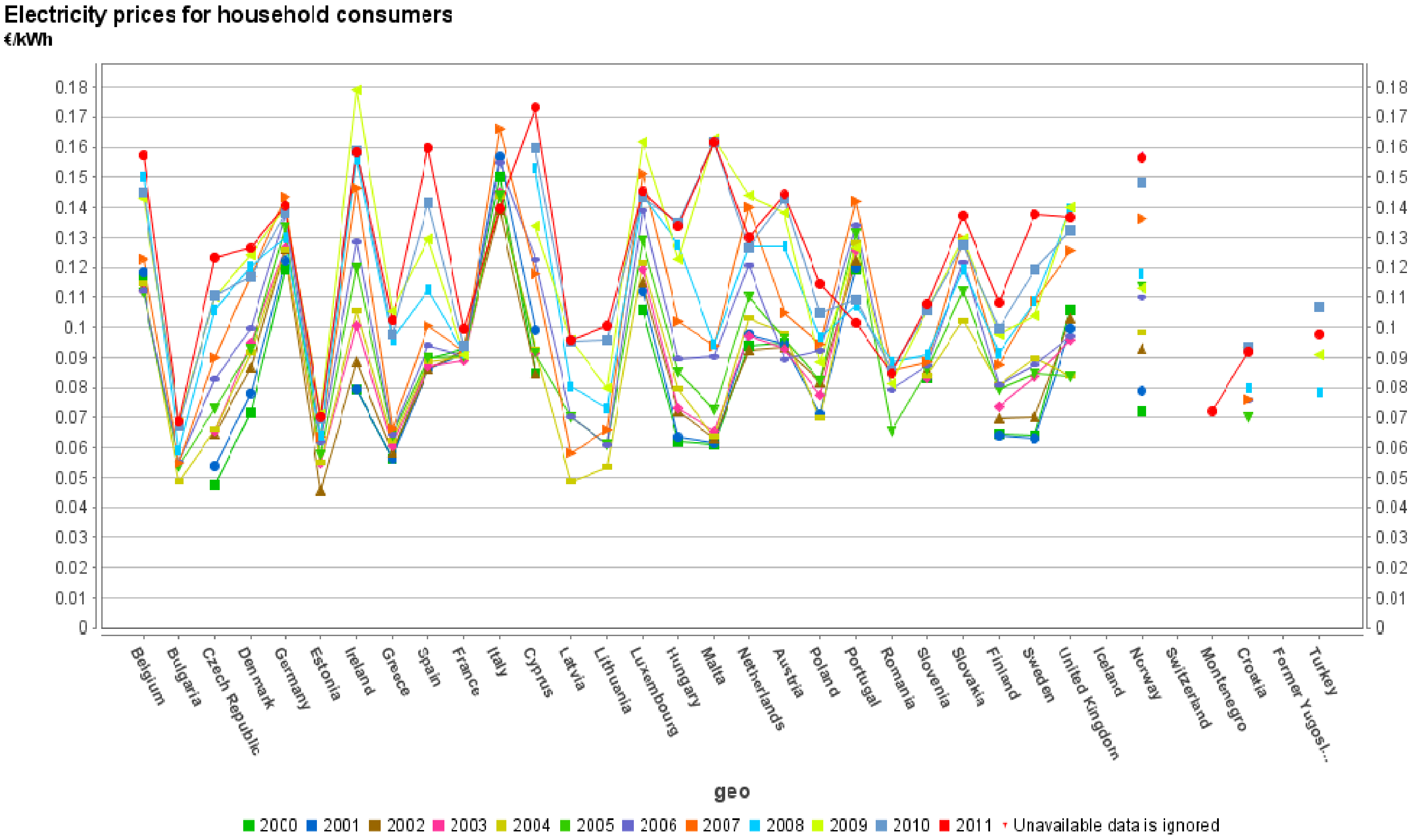


Figure 5.13 Electricity prices for households consumers €/kWh.

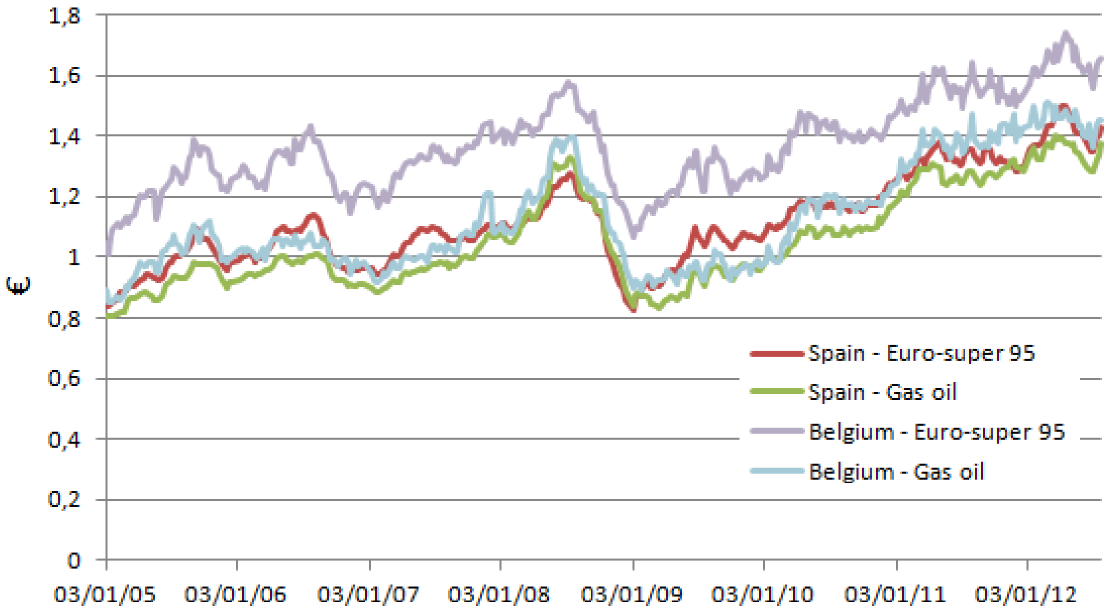


Figure 5.14 Price trend for Euro-super 95 and Gas oil for Spain and Belgium.

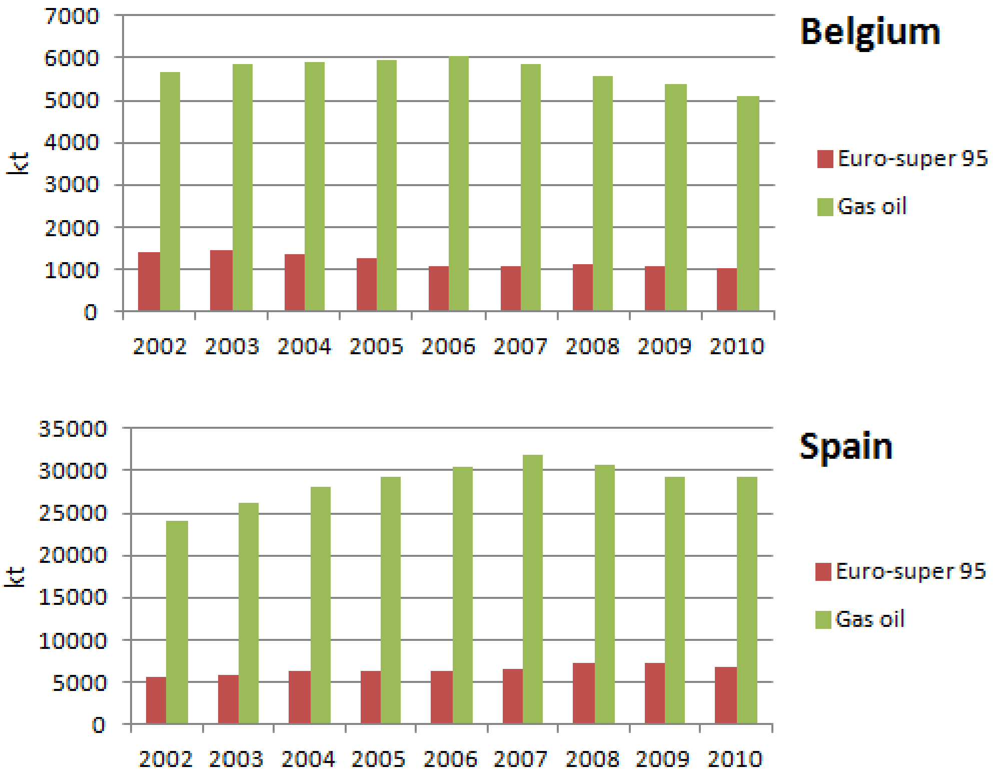


Figure 5.15 Annual consumption of fuel in Spain and Belgium

5.4 Maintenance costs

At this point in the project, the Electric Vehicles monitored have not been in service for a sufficient amount of time to provide an accurate and meaningful reflection of maintenance costs. Early indications support the commonly held view that maintenance costs of Electric Vehicles are lower than the ICE equivalent, mainly due to the lack of oil in the vehicle and the reduced ware on the braking systems as a result of the use of the motors in slowing the vehicle. While example data is provided below, the final report on EV's in fleets, planned later in the project will further examine a more substantial data set. The table below shows maintenance costs from a range of ICE vehicles and corresponding costs from an EV. It can be seen that the EV is significantly cheaper than any of the ICE vehicles listed.

5.4.1.1 ICE

(Source: http://www.coches.net/servicios/costes-mantenimiento/)

Prius III		A3		Clio		Kia cee'd	
Km revisión	€	Km revisión	€	Km revisión	€	Km revisión	€
15000	85,92	15000	224,92	20000	**261,54**	15000	**105,28**
30000	192,39	30000	249	30000	5.4.2	30000	**148,11**
45000	92,17	45000		40000	**341,5**	45000	**210,22**
60000	192,39	60000	**356,83**	60000	**296,12**	60000	**166,32**
75000	148,61	75000		80000	**488,31**	75000	**136,55**
90000	278,86	90000	**336,67**	90000	5.4.3	90000	**301,68**
105000	222,57	105000		100000	**261,54**	105000	**186,04**
120000	260,1	120000	**312,96**	120000	**929,47**	120000	**261,2**
135000	92,17	135000		140000	**261,54**	135000	**154,77**
150000	240,13	150000	**249**	150000	5.4.4	150000	**150,49**
165000	85,92	165000		160000	**929,47**	165000	**241,5**
180000	278,86	180000	**400,62**	180000	**296,12**	180000	**238,08**
195000	190,1	195000		195000	5.4.5	195000	**138,92**
210000	192,39	210000	**292,88**	200000	**341,5**	210000	**283,47**
225000	228,83	225000		220000	261,54	225000	**186,04**
240000	353,42	240000	**312,96**	240000	**929,47**	240000	**261,2**
255000	85,92	255000		260000	**261,54**	255000	**136,56**
270000	278,86	270000	**292,79**	270000	5.4.6	270000	**197,6**
285000	85,92	285000		280000	**341,5**	285000	**241,5**
300000	233,88	300000	**356,83**	300000	**296,12**	300000	**266,99**
	3819,41		3385,46		6497,28		4012,52
€/km	0,012731367	€/km	0,0112848 7		0,0216576	€/km	0,013375067
Tyres	1500		1500		1000		1500
	5319,41		4885,46		7497,28		5512,52
€/km	0,017731367		0,01628487		0,02499093		0,018375067

Audi (A3 3p/Sportback (8P desde 07/2008)) A3 1595 cc (1.6 Ltr) 102CV/75kW [T53/MW6]

Renault (Clio II Campus (BB desde 06/2009)) Clio II Campus 1461 cc (1.5 Ltr) 65CV/47kW B/CB3M K9K740

Kia (Cee´d (desde 10/2006)) Cee´d Emotion 1591 cc (1.6 Ltr) 122CV/90kW

5.4.6.1 Electric

Example table (also from http://www.coches.net/servicios/costes-mantenimiento/) with the maintenance routines and costs. We will have to compare them with the ICE.

Nissan Leaf	
Km review	€
15000	
30000	**205,2**
45000	
60000	**217,24**
75000	
90000	**157,06**
105000	
120000	**283,44**
135000	
150000	**229,27**
165000	
180000	**235,29**
195000	
210000	**139**
225000	
240000	**289,45**
255000	
270000	**217,24**
285000	
300000	**235,29**
	2208,48
€/km	0,0073616
	1500
	3708,48
	0,0123616
Nissan (Leaf (ZE0 desde 10/2010)) Leaf Eléctrico 80kW	

Figure 5.16 Example Maintenance Costs

5.5 Emissions

Electric vehicles are often dismissed as not being zero emissions due to the requirement to fuel electricity generation by fossil fuel resources. Sweeping statements are never an accurate reflection of the true state of the sector. Equivalent CO2 emissions on EV's will vary from country to country and from minute to minute. We can see from the table below that the energy mix across these sample countries varies substantially. Many of the fuel sources contained in the generation mix offer lower CO2 when it reaches the wheel than an equivalent ICE vehicle. With renewable sources offering close to zero CO2, there is advantage in most member states in the utilization of EV's. Green eMotion Deliverable D9.5 will further evaluable the environmental impact of widespread shifting towards electricity based mobility.

% Generation Mix examples from across Europe.

Country	Coal	Natural Gas	Oil	Nuclear	Hydro	Renewables	Diverse
Denmark	9	21	2	0	0	25	43
Spain	7.9	23.8	0	22.1	13.8	27.1	5.3
Germany	42.7	13.7	1.2	22.8	3.2	12.5	3.8
Sweden	4.8	0	0	38.3	45.6	11.3	0
Italy	12.8	43.1	1.7	1.2	0	35.2	6
Ireland	14.3	61.4	2.1	0	2.1	9.7	10.4

Figure 5.17 Green eMotion external Stakeholder Report

EC member state targets for generation by renewable sources are high agenda items and are steadily increasing the renewable generation. This increase in sustainable energy goes further to driving down the equivalent CO2 emissions of EV's. Furthermore development of smart charging systems which will allow increased preference of renewable sources while charging your vehicle can further facilitate renewable sources by allowing load balancing at times of renewable instability.

Fleet usage of EV's can assist substantially in the renewable goal. Particularly where there are a number of vehicles used at a single depot, charge management systems can be utilized to gain greater reductions in energy prices. This utilization of charge management can be very beneficial to electricity system control.

5.6 Noise

Noise pollution - a way out through an electrified transportation fleet?

Noise has always been an environmental challenge to mankind. In many cities throughout Medieval Europe, it was not allowed to go by horse or in horse carriages during night hours because of the disturbance of sleep. Even in ancient Rome restrictions was made to prevent iron wheeled wagons to disturb to nightly sleep.

In modern society, ambient noise, and traffic noise in particular, is louder and wider spread than ever before. It has huge effects on humans and wildlife alike and today it is a well-known fact that noise affects health and has a large impact on people's life and the wellbeing of the society in whole. Quiet areas are scarce and continuously grow smaller. Noise disrupts communication, disturb sleep, concentration and rest and generally affect our quality of life. There are also indications that prolonged exposure to traffic noise can cause effects on the cardiovascular system and create stress. These effects on health not only affect the individual citizen, but also infer large social and economic costs.

How many are effected, who are most vulnerable and what does it cost.
Today, about 40 percent of the population in the European Union, about 200 million people, suffers from noise levels exceeding 55 dB, a level potentially dangerous to health. Additionally, 30 percent of the population, about 150 million people, is exposed to levels above 55 dB at night. One should then bear in mind that the recommendations from World Health Organization (WHO) is 33 dB during nighttime[1].
Some groups are more vulnerable to noise than others. Children are highly affected since they spend more time in bed than adults. To mention some examples, noise has an effect on learning, motivation and potentially blood pressure. Other groups that are more sensitive to noise are chronically ill, elderly, shift workers and less affluent citizens.[2]
Except from the severe costs of health and convenience of people, traffic noise also has a tremendous economic cost for society. In Europe, the social cost of traffic noise is estimated to be about 40 billion Euro each year, or about 0.4% of the Gross Domestic Product (GDP). In those estimates, 90 % o the noise comes from passenger cars and trucks. [3]

Studies calculate vehicle noise as the sum of noise produced by a number of factors, such as tire contact to surface, aerodynamics, engine sound, horns and braking. At low speed, engine sound and drive train are the dominating factors, while aerodynamics and tire noise are dominant in higher speeds[4]. This makes the relatively silent electrical motor interesting to have a real potential to reduce noise levels in our cities. In urban traffic, electric vehicles (EV) are less noisy than vehicles with combustion engines at slow speeds. However, when the speed exceeds about 20 kilometres per hour, an electric car is noisy as a car with an internal combustion engine[2] since the tire and aerodynamic noise factors take over.

In an urban environment, electrical vehicles may be one piece of the puzzle solving the traffic noise challenge. EV's together with technical advancements and efforts in areas such as more silent tires, silent pavement and speed reductions, could challenge traffic noise in Europe in near future. In urban areas a commercial EV fleet could have large impact. This has been investigated and demonstrated before and the impacts of noise reduction are large [5, 6]. Exchanging heavy duty vehicles such as trucks and busses into low-noise electric alternatives could potentially reduce the noise pollution in urban environments, especially in noise sensitive situation such as in residential areas or deliveries in noise restricted areas.

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[1] Hurtley, C., Bengs, D. ed., 2009, *Night noise guidelines for Europe*, World Health Organization, Regional Office for Europe, Denmark.

[2] Genuit, K., Fiebig, A., 2010, *Psychoacoustics for the creation of acoustically green city areas*, 23-27 August. Sydney, Australia, ICA 2010.

[3] den Boer, L.C, Schroten, A., 2007, *Traffic noise reduction in Europe.* CE Delft, March 2007.

[4] Victoria Transport Policy Institute, 2009, *Transportation cost and benefit analysis – Techniques, estimates and implications, sec. ed.* [pdf] Victoria, Canada. Available at: http://www.vtpi.org/tca/tca0511.pdf [Accessed 25 June 2012].

[5] McMorrin, F., Anderson, R., Featherstone, I., Watsoi, C. ed., *Plugged-in fleets – A guide to deploying electric vehicles in fleets*, EV20. Available at: http://www.theclimategroup.org/_assets/files/EV_report_final_hi-res.pdf [Accessed 1 august 2012].

[6] Douglas, C., *Quit deliveries demonstration scheme (QDDS), Final Project Report*, Department for transport, London. Available at: http://assets.dft.gov.uk/publications/quiet-deliveries-demonstration-scheme/quiet-deliveries-demo-scheme-final-project-report.pdf [Accessed 1 August 2012].

5.7 Other factors

Fleet Manager's and the Benefit of EV's

From a vehicle fleet point of view the GeM Project is focused on the deployment and use of Plug-in Hybrid and Battery Electric Vehicles, collectively referred to as EV's, across the full range of types or vehicle classes. The use of Hybrid Electric Vehicles that do not cater for plug-in charging from the grid do not form part of the GeM fleet as these vehicles do not require electrification of the transport infrastructure and more crucially would not contribute the quanta of energy savings being sought by 2020. Typically, ICE powered vehicles consume between three and five times more energy based on the full life cycle when manufacture, fuel consumption and disposal of the vehicle are calculated as compared to Plug-in hybrid and Battery EV's.

The energy savings associated with the full life cycle of EV's are not as yet fully reflected in projected cost of ownership as is always the case with an emerging technology and the associated market conditions. However, the incentives and benefits on offer to the purchasers of EV's seek to offset the initial capital cost for the early adopter.

EV's for Goods Deliveries in Cities & Urban Areas

The use of EV's as for goods delivery in city centres and urban areas is one of the most attractive options from a fleet manager's point of view. Firstly, given the duty cycle and range associated with goods deliveries EV's are inherently more efficient in dealing with traffic congestion, stopping and starting and with the parking associated with loading and unloading. As with private users of EV's a capital grant or a refund is available to the purchaser of a new vehicle. However, in many jurisdictions an Accelerated Capital Allowance or write off in one is available to the business investing in the purchase of an EV or EV's for the vehicle fleet.

Accelerated Capital Allowances for Electric Vehicles

Capital Allowances allow a business to gain relief from Corporation Tax on money spent on capital equipment purchases such as vehicles. The relief is received by allowing the company to reduce its taxable income by an amount equal to the pre-tax value of the asset. The company therefore "writes down" the asset against profits. They normally must do this over an 8 year period so 1/8th or 12.5% of the capital value of the asset is written down each year until 100% write down has been achieved at the end of year 8.
The total value of the relief to the business is therefore equal to 12.5% of the pre-tax value of the asset. Under normal Capital Allowances, this total benefit accrues over an 8 year period so. 1/8th of the relief is received each year.
Under Accelerated Capital Allowance (ACA) schemes, 100% asset write down is permitted in year 1 allowing the full value of the tax relief benefit to be received in year 1 thus helping to stimulate a greater cash flow for the business. ACA is intended to stimulate businesses to buy more energy efficient products which include Electric Vehicles and their associated charging infrastructure.
GeM Project & Fleet Managers
Fleet Manager's need to be appraised of the savings and benefits of a transition to EV's in the vehicle fleet and vehicle dealers and energy agencies within the regions should consider special marketing and promotional initiatives to highlight the potential savings and benefits with reference to actual Case Studies on Goods Deliveries with EV's such as:
Virtuous Sustainable EV Cycle for Cities: Climate Change Strategies – Reduction in CO2 emissions & Noise - EV's in fleets –Liveable Urban Centres– Healthy Cities initiative – The benefit of a transition to widespread deployment of EV's in fleets needs to be highlighted as a Virtuous Cycle for Cities

GeM is demonstrating the viability and economic costs associated with the deployment of EVs in fleets which can be seen to support the viability of City centre strategies based on Pedestrian Priority Zones, Restricted Access, Zero Emissions Zones, Low Emissions Zone, Clean Zones, Quiet Night-time Deliveries and Clean Air strategies as implemented throughout European cities. The need to extend these measures both in terms of range and impact requires a comprehensive deployment of EV's in both public and private fleets. A strategy of undertaking commitments by cities on CO2 emissions and Noise reduction would contribute to the uptake and deployment of EV's to a very significant extent.

The more sustainable modes of transport comprising walking, cycling, Public Transport and EV’s are essential to secure liveable and healthy cities for the future. If cities begin to commit to Climate Change reductions in CO2 combined with reductions in Noise, the deployment and uptake of EV’s will increase in the manner envisaged by policy makers to deliver reduced unit costs for vehicle fleets.

The widespread deployment of EV’s in vehicle fleets is an essential prerequisite to the establishment and maintenance of healthy cities for the future in Europe and globally. The electrification of transport infrastructure as reflected in the term ’electro-mobility’ is a key to a sustainable future in Europe as demonstrated by partners on GeM.

There is a clear advantage in terms of fuel economy for the EV vehicles versus the conventional vehicles. In terms of savings it is expected an average of 80% if we compare, for example, an EV van and a conventional van. In order to the assess the total impact in Europe economy it will be needed a deeper study that will take in to account the available EV technology capacities and ranges to be compared against their counterparts conventional vehicle. To estimate the total potential savings in fuel economy it will be needed to estimate the figures of vehicles devoted to fleet operation, and their spending in fuel.

6 Conclusion

The EV has made large strides in technology, availability of infrastructure and price points over the last number of years. Many member states have made significant steps to facilitate and even encourage the use of EV's. All of these factors combined with rising fuel prices have made EV's more attractive to fleets than ever before. The use cases assessed also identified clear advantages of EV's in fleet while many of the obstacles encountered are being addressed already. The use cases provide a good basis to assist the fleet manager in making an informed choice as to suitability of the technology.

Each of the use cases will be assessed further between this and the final report to give further information on specific cases and challenges. Furthermore the volume of data gathered from the wider EV fleet across the demo regions will be substantial enough to establish real and quantifiable patterns of use to assist the wider industry in servicing the EV sector.

At this point, the application of fixed route buses shows high potential, however the cost of operation and maintenance is still an obstacle, posing a challenge to bus operators when considering migration to electric technologies. Cars and small vans have reached a point where the fleet manager can easily assess the suitability of the application and identify the clear benefits of adopting the EV technology.

EV's are not answer to all fleet applications, however they provide an immediate, viable solution to a large portion of fleet applications, particularly in urban use scenarios.