

**A FEASIBILITY STUDY INTO THE USE OF BATTERY-ELECTRIC VEHICLES FOR LAST
MILE DELIVERIES WITHIN AN IRISH URBAN ENVIRONMENT**

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1. Abstract

Climate change, a number of oil crises and the continually declining global reserves of crude oil, has persuaded an increasing number of governments, industries and societies around the world to reduce their dependence on imported fossil fuels. Domestically, the Irish government recognises its own challenges in relation to Ireland's dependence on a foreign energy source, and also the environmental implications of a fossil fuel powered transport sector. For instance, air pollution has become an increasing problem and the transportation sector is forecasted to contribute up to 21.3% of all Irish CO₂ emissions in 2011 [1]. This total figure has grown 131% since 1990 and road transport is a key contributor to this, especially as over 80% of all Irish freight is transported by fossil fuel powered road vehicles [2].

Ireland has a wider commitment to both the Kyoto protocol and EU emissions targets and Ireland will face heavy penalties if it does not reduce its emissions to 13% of 1990 baseline emission levels or 55.61 Mtonnes of CO₂eq per year by 2020 [1]. Currently the Environmental Protection Agency is projecting that Ireland will barely reach this target.

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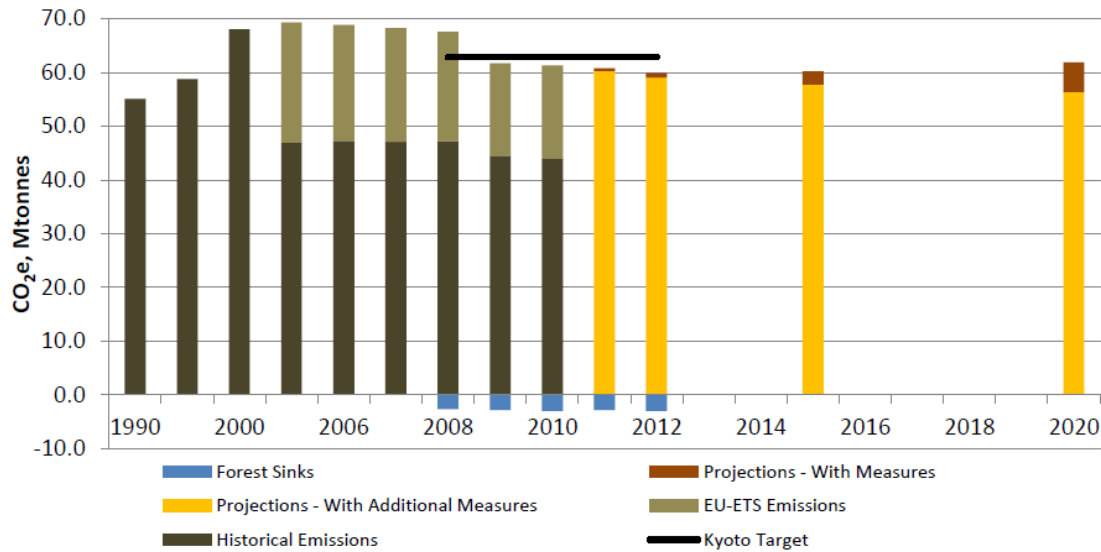


Figure 1 – Historical and Projected Greenhouse Gas Emissions (Including Forest Sinks for 2008-2012 period) for each scenario and the Kyoto protocol target

The environmental and health implications of burning fossil fuels, combined with a volatile supply, have forced freight and logistics service providers to look towards alternate fuel powered vehicles in order to shield and sustain their businesses. It is also in Ireland's national interest to reduce its dependence on imported fuel sources in order to provide for a more autonomous Irish society.

The aim of this research is to investigate the viability of the use of battery-electric commercial vehicles, specifically for last-mile deliveries in Ireland. These research findings will assist in tackling the aforementioned environmental challenges and contribute towards the Irish government's specific target of 10% of all vehicles in the Republic of Ireland car parc^[1] to be powered by renewable energy sources by 2020 [3].

This research contributes to both ESB's "ecars" subsidiary and an EU INTERREG IV-B project called "ENEVATE" which aims to facilitate and support the accelerated introduction of electric mobility in the North West Europe region. "ENEVATE" also intends to rapidly boost innovation and competitiveness of the domestic electric vehicle sector within North West Europe and contribute to the environmental challenge of reducing CO₂ emissions. This research will involve engaging with industry to undertake a pilot in Dublin City Centre to assess the viability of using electric commercial vehicles in a last mile delivery scenario. The pilot will focus specifically on the use of battery electric commercial vehicles, while investigating, for example, the savings in running and maintenance costs in comparison to internal combustion engine vehicle counterparts.

[Figure 1 - Environmental Protection Agency, 2012. Ireland's Greenhouse Gas Emissions Projections 2011-2020. Environmental Protection Agency, Wexford, Ireland]

^[1] "Vehicle parc" is defined as the entire fleet of vehicles on the road

^[2] "ENEVATE" – European Network of Electric Vehicles and Transferring Expertise

1. Historical Context

With the newly founded ESB investing in the electrification of Ireland during the 1930's, access to a reliable electricity source allowed battery electric vehicles to gain strong support from commercial vehicle operators of the time. Vehicle manufacturers based in the United Kingdom, such as "*Morrison Electricar*" and "*Smiths*", were producing machines that had both minimal running costs and high reliability. These vehicles were perfectly suited to both UK and Irish businesses' needs, and so they virtually monopolised the Irish urban commercial vehicle market and over 600 of these types of vehicles operated on Dublin's streets in the 1970's [4]. Laundries, bakeries, dairies, and even the infamous Guinness factory used battery electric vehicles for their routes and they were a common and popular sight on the streets of Irish towns, especially Dublin. The oldest example of a BEV used in Ireland that exists today, for instance, is a Morrison Electricar (Vehicle registration: ZD 5957), which was originally bought by the now defunct Kiely's Bakery that was based in Hanover Street, Dublin in 1946. Eventually the vehicle was sold to the Dartry Laundry Company in 1950 and it was finally retired in 1986, standing testament to the reliability of battery electric vehicle technology, operating locally for more than 40 years.



Figure 2 - Dartry's Morrison Electricar leaving the company for the last time (1982)

Popularisation of the household washing machine, consumers preferring to visit supermarkets instead of having their groceries such as milk and bread delivered, the businesses that offered last-mile or door to door deliveries soon diminished and Ireland's substantial fleet of battery electric commercial vehicles was retired. This research aims to match current technology to local logistic service provider needs in order to trial the state of the art technology that is currently available to the Irish market so that modern fleets can benefit from the advantages of operating battery electric vehicles.

2. Research Methodology

Research into the viability of using commercial electric vehicles within an Irish urban environment commenced in August 2011.

From research to date, it can be shown that work in this field is of paramount importance to reducing the pollution levels within urban environments and that the use of electric vehicles within fleets, provided they are assigned the correct routes and consignments, can deliver substantial savings on life-cycle costs to fleet owners. The collection of data in order to assess the use of electric vehicles will differ between the various companies, though through the use of appropriate key performance indicators a solid and comprehensive study can be made.

In addition, in order for this research to be conducted, a mixed methods approach has been used, allowing as much relevant and unique information as possible to be obtained. This information has and will ensure a comprehensive understanding of the current electric vehicle market in Ireland and yet provide an insight into the many differing aspects of such a wide subject matter.

The research undertaken for this research to date can be divided into the following two categories:

❖ Qualitative Research:

During the course of this research vehicle operators in the logistics and service provider sectors have been interviewed and data has been gathered on their fleets in order to match their vehicle requirements with currently available battery electric vehicle technology. These surveys are on-going and consist of a mix of open and closed ended questions in order to keep the surveys interesting for the interviewee, also, in order to glean as much information as possible; time is given for an unstructured interview at the end. These unstructured interviews were invaluable as they gave insight to the general opinions and concerns of Irish fleet operators on the use of BEV's for last mile deliveries. Information taken from Irish and international conferences accompanied by correspondence with stakeholders of both the Irish and European battery electric vehicle market also contribute a large amount of qualitative research to date.

❖ Quantitative Research:

The obtainable quantitative research will come from data trackers that are fitted to the vehicles that will be running in the pilots which are due to start mid-2012. Initial screening interviews with potential stakeholders allowed the gathering of information

On local fleets and correspondence with industry has allowed preliminary statistics in relation to running costs of both internal combustion engine and battery electric vehicles to be obtained.

In order to complete this research, the following tasks must be completed and the outcomes suitably analysed and documented:

- i. Investigation of the types of delivery vehicles currently used within Dublin City Centre,
- ii. Investigation of current uses of ICE vehicles within Dublin City Centre, through interviews with local logistics and service providers,
- iii. Collection and analysis of real-time data in relation to vehicle uses and requirements, e.g.
 - a. Route and route length in relation to range,
 - b. Time of travel,
 - c. Fuel usage,
 - d. Dwell times,
 - e. Payload and consignment type,
 - f. Infrastructural requirements of the user,
 - g. Maintenance costs,
- iv. Collaboration with local vehicle suppliers, such as:
 - a. Renault Ireland,
 - b. Electric Vehicles Ireland,
- v. To interview potential stakeholders, such as:
 - a. Local retailers,
 - b. Local logistic service providers,
 - c. Local service providers,
- vi. To promote the use of electric vehicles within the logistic service provider industry,
- vii. Identification of potential barriers to entry and consideration of possible solutions.

Cost Benefit Analysis:

The running costing information for some of the most popular battery-electric light commercial vehicles^[3] available to the Irish market have been obtained to date. This has allowed insight into the life-cycle costs of running a typical electric vehicle over various durations, making it possible to create a theoretical study of BEV's in relation to their ICE counterparts which will be compared and verified with real data once vehicle trials commence during the proposed pilots.

In order to show an example of costing for these vehicles the Ford Transit and Smith Edison battery electric vehicle counterpart will be compared with the following assumptions:

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- i. A fuel price inflation of 15% per year throughout the course of both vehicle's working lives,
- ii. That the starting price for electricity is €8c per Kilowatt-hour,
- iii. That the starting price for fuel will be €1.40 per litre, which is 10c per litre cheaper than the average diesel price for March 2012 [6] in order to take daily price fluctuations into consideration,
- iv. That the route lengths will be 100kms per day, for both diesel and battery electric vehicles, which equates to 35,000kms annually, taking into account a 7 day week and a 50 week year due to their continual deliveries to retailers throughout the weekend,
- v. Maintenance over the first 5 years is €1,313 for the Smith Edison BEV, not covered under 3 year body warranty and 5 year battery warranty. Any proceeding work is calculated at 25% of the diesel vehicle's maintenance costs,
- vi. The diesel powered Transit van has a fuel consumption rate of 17mpg,
- vii. The Smith Edison will travel a distance of 2.06 miles per Kwh,
- viii. As the second hand market values for commercial electric vehicles is unknown as of yet, the depreciation will render both vehicles valueless at the end of each time period.

Taking these assumptions into consideration, it can be seen that the theoretical breakeven point for the battery electric vehicle is at 5 years, even with an initial cost of more than double its diesel counterpart. Once this point has been reached, the savings are particularly noticeable, once again proving the business case for battery electric vehicles. Once the sales volumes of electric vehicles reaches critical mass, the initial cost of these vehicles will decrease which will continue to make them a more attractive and viable solution for businesses which operate in the logistics provider sector.

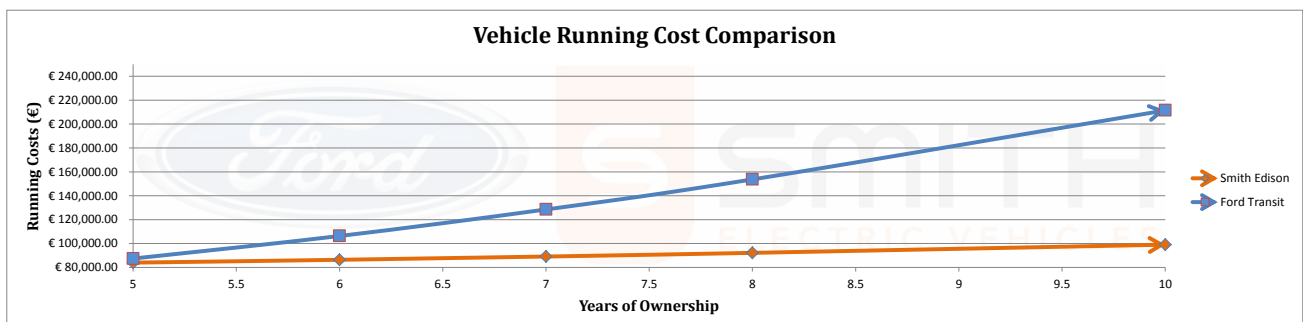


Figure 3 – Vehicle running cost comparison after reaching break-even point [5]

References:

- [1] Environmental Protection Agency, 2012. *Ireland's Greenhouse Gas Emissions Projections 2011-2020*. Environmental Protection Agency, Wexford, Ireland.
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- [3] Department of Communications, Energy and Natural Resources, 2010. *National Renewable Energy Action Plan, Ireland – Submitted under Article 4 of Directive 2009/28/EC*. DCENR, Dublin, Ireland.
- [4] Corcoran, M., 1999. Electric Survivors, *Fleet Management Magazine*. March 1999, p.18.
- [5] Electric Vehicles Ireland, 2012. Vehicle Comparison Data. EVI, Tullamore, Ireland.
- [6] CSO Stat Bank, 2012. National Average Price by Consumer Item and Month. Central Statistics Office, Dublin.

Appendix:

Theoretical savings over life of vehicle (Smith Edison vs. Ford Transit):

5 Years:

5 year ownership					
Smith Edison 3.5t LWB HR			Transit Diesel 350		
Indicative Cost	€	77,022.00			€ 27,350.00
Depreciation	€	77,022.00			€ 27,350.00
Term (yrs)		5			5
Sub Total	€	77,022.00			€ 27,350.00
MP/Kwh		2.06	MPG		17
Current Fuel Costs	Kwh / cent	8	Litre / Cent	140	Cost per gallon € 6.36
Miles PA		21747			21747
Fuel Costs todays price	€	4,222.72			€ 40,707.83
% Projected Fuel Increase		15			15
Fuel Inflation	€	1,469.51			€ 14,166.32
Total Fuel Costs	€	5,692.22			€ 54,874.15
Maintenance Costs	€	1,312.50			€ 5,250.00
TOTAL LIFE COST	€	84,026.72			€ 87,474.15
Total Life Savings	€	3,447.42			

* Source: Electric Vehicles Ireland (E&OE April 2012)

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8 Years:

8 year ownership					
Smith Edison 3.5t LWB HR			Transit Diesel 350		
Indicative Cost	€	77,022.00			€ 27,350.00
Depreciation	€	77,022.00			€ 27,350.00
Term (yrs)		8			8
Sub Total	€	77,022.00			€ 27,350.00
MP/Kwh		2.06	MPG		17
Current Fuel Costs	Kwh / cent	8	Litre / Cent	140	Cost per gallon € 6.36
Miles PA		21747			21747
Fuel Costs todays price	€	6,756.35			€ 65,132.52
% Projected Fuel Increase		15			15
Fuel Inflation	€	4,797.01			€ 46,582.78
Total Fuel Costs	€	11,553.36			€ 111,715.30
Maintenance Costs	€	3,687.50			€ 14,750.00
TOTAL LIFE COST	€	92,262.86			€ 153,815.30
Total Life Savings	€	61,552.44			

* Source: Electric Vehicles Ireland (E&OE April 2012)

10 Years:

10 year ownership					
Smith Edison 3.5t LWB HR			Transit Diesel 350		
Indicative Cost	€	77,022.00			€ 27,350.00
Depreciation	€	77,022.00			€ 27,350.00
Term (yrs)		10			10
Sub Total	€	77,022.00			€ 27,350.00
MP/Kwh		2.06	MPG		17
Current Fuel Costs	Kwh / cent	8	Litre / Cent	140	Cost per gallon € 6.36
Miles PA		21747			21747
Fuel Costs todays price	€	8,445.44			€ 81,415.65
% Projected Fuel Increase		15			15
Fuel Inflation	€	8,698.80			€ 83,043.96
Total Fuel Costs	€	17,144.24			€ 164,459.62
Maintenance & Servicing Costs	€	4,937.50			€ 19,750.00
TOTAL LIFE COST	€	99,103.74			€ 211,559.62
Total Life Savings	€	112,455.88			

* Source: Electric Vehicles Ireland (E&OE April 2012)