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Carbon emissions of plug-in electric vehicles in Malta: A policy review

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ABSTRACT

Malta is committed to reaching 5000 Battery Electric Vehicles (BEVs) on the road by 2020 in line with its EU obligations. A scheme was recently announced aimed at encouraging ownership of electric vehicles, reducing the number of old motor vehicles from the road and thus reducing emissions. The scheme comprises a grant of €4000 to persons registering an electric vehicle, increasing to €5000 in the case of persons registering for an electric vehicle while at the same time de-registering their own vehicle, if it is at least 10 years old.

The unique problem in Malta is that as much as 98% of electricity generation is produced from combustion of fossil fuels, mainly heavy fuel oil and diesel oil. The combustion of fossil fuels results in significant environment impacts, particularly in emission of Carbon Dioxide (CO_2).

Against this background, the energy consumption of two locally available battery electric vehicles in the super-mini category is analyzed, taking into account the CO_2 generation characteristics of the Maltese electric power plants. Their performance is compared with that of vehicles in the same category, powered by different fuels.

This paper determines that the benefits of driving BEVs in Malta depend on the electricity mix at the point of charging, and with the existing electricity mix. Three scenarios are analyzed and in the case where the energy mix is dependent on natural gas, this study shows that the CO_2 emissions of BEVs are considerably less than for either hybrid or vehicle powered by conventional fuel.

1. Introduction

Mobility is essential for social interactions and economic reasons especially with rising populations and urbanization. Bi-lateral and multi-lateral trade agreements have given rise to the movement of people and goods across nations, generating increasing demand for transport infrastructure and systems. Transport and its range of services have become vital for everyday life. There is of course a downside to all this.

The different modes of transport people use to travel or send goods have huge environmental implications in terms of fuels, emissions, and land use given that transport modes rely heavily on fossil fuels. Burning fossil fuels release carbon dioxide (CO_2) and in turn CO_2 is present within the atmosphere, at sea, and on land. It is both produced and absorbed by micro-organisms, plants, and animals. However, human activities including transport produce huge quantities of CO_2 and thereby causing climate change. These effects have been costed in various studies including a recent study (von Brockdorff et al., 2015) which estimates the annual cost of climate change caused by transportation in the Maltese Islands at €46.8 million. The same study recommends increased use of electro-mobility as one of a number of policy options to reduce CO_2 emissions.

In our modern world, use of the electric vehicle (EV) is on the rise. Electric vehicles have potentially several benefits when compared with conventional internal combustion engine vehicles (ICEV). They are said to have lower operating and maintenance costs, and produce little or no local air pollution. They reduce dependence on fossil fuels and help reduce greenhouse gas emissions from the on-board source of power. However, this depends heavily on the fuel and technology used for electricity generation in charging the batteries. The environmental impact of electro-mobility therefore varies from one location to another and it can be said that an electric vehicle is only as effective in reducing CO_2 emissions as the electricity used to generate its power. The UK Government's King Review (King, 2007) concluded that electric passenger vehicles could achieve CO_2 emissions as low as 30 g/km by 2030 but this would require reduced dependence on fossil fuel for electricity generation.

EVs are not a new phenomenon as these types of vehicles have been tested for many years going back as far as the mid-19th century and especially the early 20th century, when electricity was the preferred propulsion method. The EV is generally regarded as silent, clean, and simple to operate.

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However, its range is limited by the charge of its batteries. This means that such vehicles are restricted to areas where they can easily return home to re-charge or where re-charging facilities are made available. Early EVs were slow compared to steam or petrol-powered vehicles, with the normal cruising speed being less than 30 km per hour and having a range of around 35–50 km. The performance of EVs has since improved since and their popularity has increased as a result.

Based on three scenarios, the objective of this paper is to understand the potential environmental benefits or impacts of EVs in terms of CO_2 emissions in the Maltese Islands, and to compare the performance (emissions, acceleration and top speed) of EVs with hybrid and internal combustion engine vehicles.

2. Material and methods

2.1. Literature review

In its environmental reports, the European Commission puts road transport as the second largest source of greenhouse gas emissions (GHG) in the European Union (EU), after power generation and is responsible for over one-fifth of the EU's total emissions of CO_2 (European Environmental Agency (2014)). Road transport is one of the few sectors where emissions have been rising rapidly over the last 20 years, with the exception of the period 2008 to 2010, when lower transport activity owing to the economic slowdown brought about a drop in CO_2 emissions. Between, 1990–2010 emissions from road transport increased by 22.6%. This increase slowed down efforts by the EU to further reduce overall emissions of greenhouse gases (they fell by 15.4%).

Worldwide, the biggest threat to reducing emissions is the expected increase in the number of vehicles. According to Dargay et al. (2007) and Meyer et al. (2007), the number of motor vehicles is expected to more than double before 2050.

The highest growth rates are expected in developing countries where growth rates of car ownership are expected to stabilize in the EU. The European Commission (2007) identified cars as being responsible for around 12% of EU CO_2 emissions. In recent years significant improvements in vehicle technology, particularly in fuel efficiency, have helped to reduce CO_2 emissions. However, the increase in traffic and number of vehicles on European roads have neutralized the positive effect of new technology.

Mandatory emission reduction targets have since been set for new vehicles. The fleet average set for all new vehicles is 130 g of CO_2 per kilometer (g/km) by end 2015–with the target having been phased in from 2012 falling to 95 g/km by 2021, phased in from 2020 (Fig. 1).

The 2015 and 2021 targets represent reductions of 18% and 40% respectively compared to the 2007 fleet average of 158.7 g/km.

In terms of fuel consumption, the 2015 target is approximately equivalent to 5.6 l per 100 km of petrol or 4.9 l/100 km of diesel. The 2021 target equates to approximately 4.1 l/100 km of petrol or 3.6 l/100 km of diesel (European Commission, 2014). The European Commission also declared that while good progress was being made towards meeting its climate and energy targets for 2020, an integrated policy framework for the period up to 2030 was necessary to ensure regulatory certainty for investors and a coordinated approach among Member States. EU leaders, in fact, agreed to a greenhouse gas reduction target of at least 40% by 2030 as compared to 1990 (Guardian, 2014).

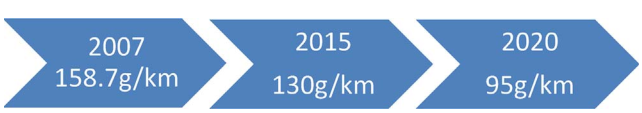

Fig. 1. EU emission reduction targets.

In line with this target and across the EU, measures were put in place to help buyers to choose new vehicles with low fuel consumption and emissions. This included information providing fuel efficiency and CO_2 emissions. Directive 1999/94/EC relating to the availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger vehicles specifically requires:

- A label showing fuel economy and CO_2 emissions to be attached to all new cars or displayed nearby at the point of sale;
- A poster or display to be exhibited showing prominently the official fuel consumption and CO_2 emissions data of all new car models displayed or offered for sale or lease at or through the respective point of sale;
- A guide on fuel economy and CO_2 emissions from new cars to be produced in consultation with manufacturers at least annually. The guide should be available free of charge at the point of sale and from a designated body within each Member State; and
- All promotional literature is to contain the official fuel consumption and specific CO_2 emissions data for the passenger car model to which it refers.

A further initiative is the New European Driving Cycle (NEDC). This is meant to represent the typical usage of a car in Europe. It consists of four repeated ECE-15 urban driving cycles (UDC) and one Extra-Urban driving cycle (EUDC) (UNECE, 2014). The NEDC, categorizes electric vehicles as “ZEV (zero emission vehicles) and not according to the CO_2 footprint of their energy sources or the primary source for creating the electricity used to power EVs (Varga, 2012).

A recent study has in fact attempted to estimate the impact of charging electric vehicles using existing electric infrastructure (van Vliet et al., 2011). Other studies including Thomas (2012) and Doucette and McCullouch (2011) highlight the CO_2 emissions impacts for various countries on the basis of the primary source of energy used. Such studies provide evidence that electric vehicles generate CO_2. Depending on the primary energy source, the CO_2 emitted by EVs can reach levels generally associated with conventional vehicles.

The carbon emissions of grid powered electric vehicles vary from country to country according to the power source, and are four times greater in countries with coal dominated power generation than in those with low-carbon electricity (Wilson, 2013). The national electricity grid in Malta is as yet not connected to any other electrical network, and all the electrical energy that is required is generated locally. There is currently one power station (at Delimara) operated by Enemalta with a nominal installed capacity of around 570 Megawatt. Malta has no indigenous primary energy resources and Enemalta relies entirely on imported fuels, mainly heavy fuel oil (HFO) and light distillate (Enemalta, 2014). In 2013, the fossil fuel mix for the electricity generation in Malta was mainly composed of heavy fuel oil accounting for 89% of the electricity generated with the remaining 11% from gas oil (Malta Resources Authority, 2013a,b). Interestingly, the National Statistics Office (2014) reports that out of 2,216,101 Megawatt hours (MW h) generated in 2013, only 36,692 (or 1.66%) were generated by renewable sources.

An important value for this study is the amount CO_2 generated due to fuel combustion at the power station. According to Enemalta the overall specific carbon emission factor for the year ended 2013 is 0.766346 kg CO_2/kW h (equivalent to 766.346 g CO_2/kW h) (Enemalta, 2014). This value can be compared to 0.45 kg CO_2/kW h for the United Kingdom, 0.071 kg CO_2/kW h for France and 0.406 kg CO_2/kW h for Italy, calculated for the period 2009–2011 (International Energy Agency, 2013). France has an extremely low level of CO_2 emissions per kWh since over 90% of its electricity is generated by nuclear or hydro energy.

Figures published by the International Energy Agency shows that Malta recorded comparatively high CO_2 emissions per kW h from electricity generation when compared to both European and other