Available online at www.academicpaper.org
Academic @ Paper
ISSN 2146-9067
International Journal of Automotive Engineering and Technologies
Vol. 2, Issue 2, pp. 64 – 69, 2013

International Journal of Automotive Engineering and Technologies
http://www.academicpaper.org/index.php/IJAET

Original Research Article

Possibility of Turkey to Transit Electric Vehicle-based Transportation

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Received 05 March 2013; Accepted 02 April 2013

Abstract

Electric vehicles (EV) are widely viewed as attractive rivals to internal combustion engines. However, to explore economic challenges of EVs is of crucial importance. This paper analyses the potential of Turkey to transit EV-based transportation. In order to succeed this, previous applications of the country about alternative fuels are introduced and cost effectiveness of electric vehicles against diesel engines is estimated. The analysis indicated that EV provides lower cost than diesel engine driven vehicle. Finally, proposal and recommendations are given to create an EV market in Turkey.

Key Words: Electric vehicles, vehicle choice, Turkey

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1. INTRODUCTION

Since their invention, internal combustion engines have widely been used as heart of transportation vehicles. However, environmental problems resulted from greenhouse gas (GHG) emission created by combustion of petroleum based fuels and the scarcity of known petroleum reserves force automotive engineers to develop new power sources. Dependence on imported energy sources, especially on oil, has become the most important issue in world energy supply security beginning with the oil crises period of 1970s. Since then, the concept of foreign oil has deeply affected energy policies, specifically of import dependent countries

Turkey which is located at the junction of Europe and Asia is one of the most rapidly developing countries. Because of social and economic development of the country, the energy demand is growing rapidly [1]. This fact increases dependency level of the country in terms of oil need. The deteriorated relations with the Middle-East countries which have approximately two-thirds of known petroleum reserves of the petroleum reserves of the world may possibly cause an economic chaos in the country which is strongly dependent to them due to oil reserves [2]. The issue of oil import dependency has regained importance, especially in developing countries, due to abrupt increases in oil prices during last decade. Consuming oil reserves in such countries causes inadequate energy sources against energy demand. The oil-exporting countries see this situation as an opportunity to exploit oil-dependent ones [3]. Therefore Turkey has to diversify its energy sources to be able continue its development.

Electric motors are the most probable candidates against the dominance of internal combustion engines due to their higher economic efficiency and environmental impact. Some authorities in Turkey consider EVs as reasonable alternative to petroleum-based fuels driven cars in order to ensure energy source requirement of the developing transportation sector. However, to be able to advance to this technology technical knowledge, tremendous investments and abundant infrastructure will be required. Although EVs are advantageous in terms of GHG emissions and fuel economy, to obtain electricity which is needed to drive electric motors from renewable energy sources has a crucial importance. In addition, limiting battery recycling market and high cost of batteries are two barriers which stand against EVs.

Consequently, the aim of this paper is to discuss the possibility of Turkey to pass EV transportation technology. In order to discuss the requirements for such a transition in Turkey, this article surveys the experience of other alternative fuel vehicle programs in Turkey in Section 2. In Section 3, the advantages of EVs are introduced. Finally, a comparative cost analysis of a commercial EV (Renault Fluence Z.E) is conducted and recommendations are given.

2. ALTERNATIVE FUEL POLICY of TURKEY

2.1 Biodiesel

In early 2000s, in order to meet the growing energy demand, the Turkish government initiated a reform program which regulates Turkey's energy market. Moreover, by enacting the Renewable Energy Law (Law No. 5346) in May 2005, the Turkish government provided a strong support towards increasing usage of renewable energy sources [4]. There were some successes as a result of this law. By 2005, there were 286 bio-diesel producers in Turkey but only about 60–70 of them, with a total capacity of 1.5 million tons, qualified for licensed production. Unfortunately, high private consumption tax rate was set for biodiesel by new legislation in April 2006 [5]. In addition, the cost of biodiesel has risen enormously with increasing oil and alcohol prices due to increasing demand. This decreased the number of biodiesel producing companies and production of biodiesel has ended almost completely by 2007.

2.2 Bioethanol

Bioethanol can be used as a 5% blend with petrol under European Union quality standard EN 228 [6]. Petroleum consumption in Turkey was 2,6 million tons in 2011, this amount is 3,6 billion liter gasoline-equivalent and bioethanol demand would be 180 million tons in case of using 5% mixture [7]. Petrol Ofisi (PO) is the only fuel oil company that uses the bioethanol in Turkey. Although, the legal rate is 5%, PO uses the rate just 2% because of the private consumption tax [8]. The country has 60 million liter production capacity in 2006 and is expected to reach 190 million liter/year capacity with recently founded manufacturers [9].

2.3 LPG (liquefied petroleum gas)

LPG-powered vehicles have been using approximately for 50 years in Turkey. Legally the application of auto-gas in Turkey started in 1995. Regular and legal conversion of vehicle fuel systems to LPG systems were attempted at the end of 1980s. But they abdicated this idea due to lack of formal approval of LPG as a motor vehicle fuel and tiresome official formalities. Mid-1990s, Turkish engineers in Bursa studied on formal procedures insistently. And their efforts availed in order to approve LPG as a motor vehicle fuel on June 29, 1995. Fortunately, Ministry of Industry and Commerce allowed conversion of fuel systems to LPG systems [10]. Between 1996 and 1998, number of LPG-fueled cars reached peak value and increased dramatically [5]. The consumption quantity of LPG has reached 174,398 tons in 2011 [11].

3. IMPORTANCE OF ELECTRIC VEHICLE IN TRANSPORTATION SECTOR

Tendency to EVs began with crude oil scarcity and increasing public awareness of the environmental results of combustion of fossil fuels. Energy requirement which is triggered by industrialization of developing and developed countries increases dependency level of these countries on foreign oil. This forces foreign oil-dependent countries to spend important share of their national income to oil import. For example Turkey's annual crude oil production can meet only 10 % of national demand and the remainder is imported from other countries. Therefore to secure energy policies, countries have to diversify their energy sources. In order to succeed this, the major automobile manufacturers have devoted an increasing budget to develop competitive EVs in recent years. There are many merits of using EVs for urban transportation. Due to quiet electric motor, the noise emitted by EVs is lower than carbon-based driven vehicle. In addition, EV's higher efficiency at lower engine loads makes them advantageous in heavy traffic conditions where it is impossible to operate the vehicle at higher speeds. Another advantage of EV is quicker and more accurate torque generation of electric motor. This lowers response time of electric motors to several milliseconds (10–100 times as fast as that of the internal combustion engine). Finally, the driving and braking force of an electric motor between tire and road surface can easily be measured from motor current. This advantage will contribute greatly to application of new control strategies based on road condition estimation [12].

4. AN ECONOMIC EVALUATION OF EVS

In order to understand cost effectiveness of EVs, a commercial electric vehicle (Renault Fluence Z.E.) is compared to diesel fueled (Renault Fluence dCi 105 hp) internal combustion engine since Renault Fluence dCi 105 hp is the most suitable vehicle with its comparable characteristics. The complex structure and expensive batteries increase the initial cost of Fluence Z.E. However, the difference is eliminated by Turkish government with PCT discount applied to EVs. At a diesel price of US$2 per liter, Renault Fluence dCi 105 hp would use US$11 more fuel per 100 km compared to Renault Fluence Z.E.(The difference

between fuel prices can be changed according to the period of charging time, Table 1) When these prices are calculated for 4 years period of time, fuel cost gain for Renault Fluence Z.E will reach to US$5449 compared to Renault Fluence dCi 105 hp.(All these values are calculated based on 15,000 km per year travel distance) In addition, Renault Fluence Z.E is exempted from motor-vehicle tax (MVT) due to zero emission and this situation makes it more attractive to purchase. Since electric motors do not require periodic service maintenance, expenditures spend to maintenance is also minimized for the EVs. Detailed maintenance expenditures for both vehicles are provided in Table 2. Despite its advantages, rent cost of batteries would create and extra expense for Renault Fluence Z.E. To sum up, the combination of tax discount, fuel cost advantage and reduction of the maintenance expenditures of Fluence Z.E. compensate initial manufacturing cost and rent cost of batteries.

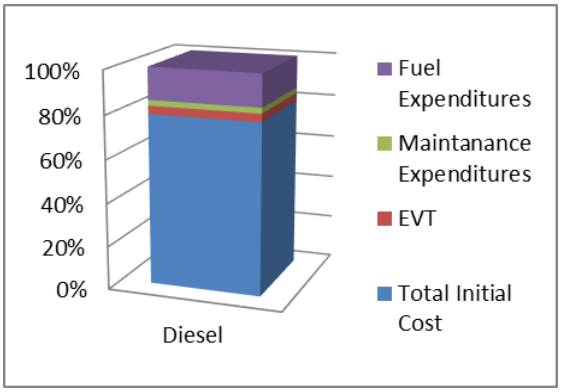

Figure 1. Expenditures of Renault Fluence 1.5 dCi 105 hp over 4 years

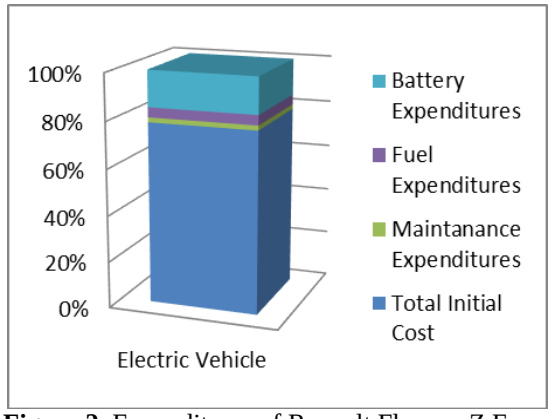

Figure 2. Expenditures of Renault Fluence Z.E. 95 hp over 4 years

Table 1. Comparative cost analysis of Renault Fluence Z.E with Fluence 1.5 dCi 105 HP

		Vehicle	
		Fluence 1.5 dCi 105 HP	***Fluence Z.E. 95 bg***
Cost	**Initial Cost**	US$21,867*	US$26,684
	PCT	US$9547	US$944
	VAT	US$3936	US$4803
Total Cost		US$35,351	US$32,432
Maintenance Expenditures		US$590	US$224
Wear and Tear Parts		US$548	US$631
Fuel Consumption per 100 km		5,3 liter	22 kW
Fuel Cost		US$2/liter	Day: 13 ¢/kWh**
			Puant: 21 ¢/kWh
			Night: 8 ¢/kWh
MVT		US$1661	US$0
Fuel Expenditures per 100 km		US$11	Day: US$2,9
			Puant: US$4.51
			Night: US$1.94
Fuel Expenditures per 60000 km		US$6616	Day: US$1751
			Puant: US$2711
			Night: US$1167
Battery Expenditures		US$0	US$6468
Total		US$44767	Day: US$41,508
			Puant: US$42,468
			Night: US$40,924

*US$: US dollar **¢:US cent

Table 2. Maintenance expenditures

Maintanace Expenditures*	**Labor**	US$138	US$55
	Engine Oil	US$203	US$0
	Air Filter**	US$76	US$92
	Oil Filter	US$19	US$0
	Cabin Filter	US$91	US$78
	Oil Bung Gasket	US$1	US$0
	Fuel Filter	US$63	US$0
Wear and Tear Parts*	**Front Brake Pads**	US$162	US$162
	Front Brake Disc and Pads	US$214	US$286
	Rear Brake Pads	US$77	US$87
	Windscreen Wipers	US$96	US$96

***for 4 years (15,000 km/year) ****Battery Air Filter**

5. RECOMMENDATIONS for TURKEY'S TRANSITION TO EV

Turkish automotive sector is directed to search new energy sources because of limited oil reservoir and environmental problems. Automotive engineers consider EVs as promising alternative to internal combustion engines. However, there are many prerequisites that Turkey should provide before passing to EV technology. Most important handicap of EVs is their manufacturing cost. This high cost creates a drawback for vehicle customer, therefore governments attitude play a key role in deployment of EVs. Today Turkish government support EVs by applying Private Consumption Tax (PCT) reduction, EVs are also exempted from MVT. However, to make EVs more competitive the government should provide subsidies for EV research and development.

The limited number of charging stations has been a barrier to development of EVs. Whereas refueling stations for gasoline and diesel are uniformly and extensively distributed throughout Turkey, there are only 37 battery charging stations for EVs most of which are located in western part of the country. Increasing number of EV customer will encourage fuel providers to make investments to battery charging stations.

In order to increase people awareness about the negative effects of internal combustion engine and convince customer to purchase EVs, universities should provide educational and technical seminars about the benefits of EVs.

6. CONCLUSIONS

This study discusses the chance of Turkey to transit EV technology. The early studies about alternative fuels in Turkey are introduced and advantages of EVs over internal combustion engine driven vehicles are also provided. A comparative cost analysis is conducted to explore cost effectiveness of EVs and it is found that EVs are more advantageous despite of their battery expenditures. Finally future recommendations are given to spread EV technology.

A deliberate national policy is required to spread EV technology to broader markets. Since the security of energy supply plays an important in the way of development, the transition to EV will be a milestone for the country.

Acknowledgement

We would like to thank Turkey EV Project Coordinator of Renault-Mais Company Mr. Ümit Çevik for providing data and technical support.

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