

## EVALUATION AND COMPARISON OF AUTOMOBILE FUEL SYSTEMS, MOST APPROPRIATE TO SRI LANKAN AUTOMOBILE STANDARDS

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### ABSTRACT

Different kind of fuel systems available in motor vehicles used for private transportation in Sri Lanka. However the overall cost depends on several factors such as types of fuel available, fuel prices, efficiency ratings, emission control systems, primary investment & maintenance cost and the available infrastructure to provide continuous running support. This research paper is focused to determine the optimum fuel option for private transportation, which will be economical to use eco friendly. Test samples are limited with types of motor vehicles generally available in the local automobile sector. Test results noted have significant differences with above variables and research outcome may be influence towards the turning point for sustainable development of the Sri Lanka automotive sector.

Key words: *Automobile, Fuel, Emission, IC Engine, Environment*

### 1. Introduction

The Sri Lanka automobile market is categorized as brand new vehicles, reconditioned unregistered vehicles and used vehicles. Brand new vehicles are usually sold by the authorized dealer of the vehicle manufacturer. Vehicles used in other countries, which are relatively new are imported in to the country by traders as reconditioned vehicles. These are then registered as new vehicles in Sri Lanka. The final is the used vehicle which passes on hands within Sri Lanka. The local automobile market is dominated by Japanese brands. European brands are considered as luxury vehicle and has a confined market. The past 5-6 years have seen a demand for Indian passenger cars due to their reliability and their cheap running costs. However, it has to be noted that all Indian vehicles when first registered for use in Sri Lanka are imported brand new.

#### 1.1 Gasoline Engines

Conventionally known as a spark ignited internal combustion engine. Internal combustion achieved by igniting gasoline, injected (EFI) or blending air and gasoline by means of a spark plug. The efficiency of a gasoline engine is about 25-30%.

#### 1.2 Diesel Engines

Conventionally known as a compressed ignition internal combustion engine. Unlike gasoline engines, the diesel fuel is compressed by the moving piston and this heat of compression causes the fuel to ignite. Diesel engines are more efficient than gasoline engines with an efficiency of about 40%. Lower revving engines can exceed an efficiency value of 50%.

### 1.3 Bi-Fuel Engines:

The most common form of a bi-fuel engines in SL are the gasoline engines which are converted to run on LPG (Propane + Butane). The characteristics of the gasoline engine are not changed but an additional LPG fuel system is incorporated to the vehicles fuel system, making it possible for the driver to switch between gasoline and LPG. LPG is very much cheaper comparing to gasoline; hence savings on fuel bills can be made.

### 1.4 Hybrid Vehicles

Hybrid vehicles are vehicles which have two sources of power to drive the car, that is, two sources of fuel to power the car. In Sri Lanka the norm is for a car that utilizes a gasoline engine and an electric motor to provide drive to the wheels of the car. The gasoline engines used here run on an Atkinson Cycle rather than the conventional 4-stroke Otto Cycle. The motor is run by a special battery pack, which is developed to be charged on the run.

### 1.4 Electric Vehicles

As the name suggests, the car is fully electric and the drive is provided by a motor which is powered by a re-chargeable battery. These are classed as zero emission vehicles and very cheap and clean to run. The only expense will be the initial investment, minor running repairs and the electricity charges.

## 2. METHODOLOGY

Information regarding Diesel and Petrol vehicles were collected from the users of Toyota Corolla and Townace, customers of United Motors Lanka PLC and information on LPG converted vehicles, Hybrid Vehicles and the Nissan Leaf Electric car were collected from gas Auto Lanka Limited, Stafford Motor Company (Private) Limited and EV Lanka (Private) Limited.

The information collected were the average fuel consumption, basics of the existing technology, maintenance charges and frequency of services.

Table 1: Fuel Cost

Products	Price per liter (Rs)
Lanka Petrol 90 Octane	162.00

Lanka Petrol 95 Octane	170.00
Lanka Auto Diesel	121.00
Lanka Super Diesel	145.00
Auto Gas	100.00

Table2: Field Data

Data Collection Of Vehicles	Diesel	Petrol	Gas
Vehicle no. 1	13	12	11
Vehicle no. 2	11	10	12
Vehicle no. 3	14	13	13
Vehicle no. 4	15	14	10.5
Vehicle no. 5	13	12	10
Vehicle no. 6	13	12	9.5
Vehicle no. 7	12.5	11.5	10.5
Vehicle no. 8	11.5	10.5	11
Vehicle no. 9	13.5	12.5	11.5
Vehicle no.10	13.5	12.5	12
Average	13	12	11.1

## 3. CALCULATION AND DISCUSSION

### 3.1 Petrol Vehicles:

The Mitsubishi Lancer is a popular sedan marketed in Sri Lanka by United Motors Lanka PLC, authorized dealer for Mitsubishi Motors in Sri Lanka. The car is marketed with three choices of engines; a 1300cc, 1500cc and 1600cc petrol engines.

Most of the users use Octane 90 petrol for their vehicles, and the average fuel economy is at 10-11kms per liter at city limits.

Considering Mitsubishi Lancer cars that are run an average of 20,000 km annually on Octane 90 petrol we can calculate the fuel cost as follows:

- Litres of Petrol used per annum  
: 20,000/12 = 1666 l.
- Amount spent on Petrol per annum  
: 1666l \* 162 = 270,000

### 3.2 Diesel Vehicles

Car chosen Toyota Corolla/ Townace Mini van

Source –owners of said vehicles.

The Toyota Corolla and the Toyota Townace Mini Van are two of the most popular diesel powered passenger vehicles in Sri Lanka. These two vehicles are equipped with a 2000cc conventional diesel engine which is capable of providing a fuel consumption of 13km/l within city limits.

On average, the motorist travel approximately 20,000km per year and the vehicles average fuel consumption is 13km/l.

- Litres of Diesel used per annum : 20,000/13 = 1538 l.
- Amount spent on Diesel per annum : 1538l \* 145= 223,076

### 3.3Bi-Fuel Vehicles:

Source: Mr. H. Pathmasiri, Manager Conversions, Gas Auto Lanka Limited.

As mentioned in the introduction, the gasoline engine of the car is converted to run on Liquid Petroleum Gas (LPG). That is, an alternative fuel system consisting of LPG is used. This is achieved by adding another fuel system simultaneously with the existing petrol injection or carburetion system of the vehicle.

However, as the Octane value of LPG is higher than petrol, a much richer air + fuel mixture is needed to provide performance equal to that of petrol. This means that the fuel consumption of the vehicle will be slightly poorer (5-10%) when running on LPG when compared to petrol. But, as there is a large difference in the unit prices of LPG and petrol, the motorist will benefit larger savings on his/her fuel bill.

Let us assume that the fuel consumption of the car when running on LPG is 7.5% higher than that on petrol.

- Litres of petrol used per annum : 20,000/12 = 1666.67l
- Amount spent on petrol per annum : 1666.67\*162 = 270,000.54
- Fuel consumption when running on LPG : 12\*92.5/100 = 11.1 km/ l
- Litres of LPG used per annum

- : 20,000/11.1 = 1801.80 l
- Amount spent on LPG per annum : 1801.80\*100 = 180,180.00
- Added LPG conversion charge : 75,000.00
- Total amount spent on LPG : (180,180.00+75,000.00)=255,180.00
- Savings during the first year of LPG Conversion : (270,000.00– 255,180.00)= 14,820.00
- Table2: Field data
- Saving made each consecutive years : (270,000.00- 180,180.00)=89,820.00

The above calculations have been made purely without considering other running maintenance of the car.

Basically, there are no other differences in the maintenance schedule of the petrol engine car and a LPG converted car. The EGI system has to be serviced every 20,000km or 12 months. This is made easy as the system comprises of an ECU which has the entire history of the engine.

### 3.4 Hybrid Vehicles

The two main brands monopolizing the hybrid car market in Sri Lanka are Honda with their Insight Hybrid models and Toyota with their Prius Hybrid Synergy Drive models. When considered the Sri Lankan car market, the most popular method is to have a motor assisting a petrol engine. Both cars are equipped with an intelligent Motor coupled with a petrol engine. However, both these cars use different technology and methods of the implementation of the electric motor assist to provide drive.

Specimen : Honda Insight

Source : Stafford Motor Company (Private) Limited.

### 3.5 Electric Vehicles:

Specimen: Nissan LEAF

Source: Mr. A. Wijegunasekara – Director, EV Lanka (Private) Limited.

	Petrol	Diesel	Gas	Hybrid
Average Fuel Consumption (Km/L)	12	13	11.1	15
Price Per Liter	162	145	100	162
Total Fuel Used Per Annum (20,000km)	270,000	223,076	180,180	216,000
Maintenance Cost Per Annum	22,000	30,000	25,000	22,000
Total Cost Per Annum (Without Conversion Cost)	292,000	253,076	205,180	238,000
Conversion Cost	0	0	75,000	0
Total (Including Conversion Cost)	292,000	253,076	280,180	238,000
Fuel Cost Per Km	13.50	11.15	9.01	10.80
Cost Per Km (Considering Maintenance)	14.60	12.65	10.26	11.90

The Nissan LEAF is the first ever fully electric car to be sold in Sri Lanka. The car is driven by a 140BHP

Table 3: Costs Evaluation For Different Fuel

induction motor and is powered by a 300V Li-ion Battery. The battery input to the motor is 600V and is achieved by the use of an inverter. A fully charged battery can give a range of 150 - 180km but this depends mostly on the driving habits of the driver. The average range is about 150km Normal charging cycle on a 230V 15A conventional socket takes about 4-6 hours and the rapid charging method takes around 15-30 minutes and can only be performed by a special charger plugged to a 3-Phase current system. Total electricity needed to charge the battery is 23KWh

As per EV Lanka (Private) Limited, operations are ongoing to create and develop the necessary

Infrastructure in Sri Lanka to support of users of the electric car. The company is planning on opening 46 charging centers, island wide and further charging

points at certain restaurants, supermarkets and popular stops.

Cost of running and maintaining an electric car is calculated differently from the above. This is in accordance to the electricity tariff imposed by the Ceylon Electricity Board (CEB).

When taking into consideration the cost of running the electric car, we will have to understand that the costs will include the annual usage of electricity units of running a household as well.

Taking into consideration that an average household uses 150 units of electricity per month and that the electric car needs 11 charging cycles per month to run 20,000 km per year the following was computed:

The website of the CEB website provides a calculator which helps in calculating the used electricity bill.

Total Cost of electricity per year: 221,874

- Total cost for vehicle charging: 173,594
- Maintenance cost per annum: 1,0000
- Total cost to run per year: 183,594
- Electricity cost per km: 8.9
- Cost per km (considering maintenance): 9.1

#### 4. RESULTS & CONCLUSION.

According to calculation can see that the most economical options are the electric car, the LPG converted car and then the Honda Hybrid, all in descending order. However, infrastructure to support the running of the electric car is presently not available in the country, although, the source at the dealer of the electric car has confirmed that these facilities will be made available this year (2014).

Table 4: Cost Comparison Per km

Rs/Km	Petrol	Diesel	Gas	Hybrid	Electric
Petrol	0	-2.3	-4.5	-2.7	-4.9
Diesel	2.3	0	-2.1	-0.4	-2.5
Gas	4.5	2.1	0	1.8	-0.4
Hybrid	2.7	0.4	-1.8	0	-2.2
Electric	4.9	2.5	0.4	2.2	0
Savings Percentage (w.r.t)	NA	17.4	33.3	20.0	36.3

Petrol)					
Total Savings Percentage (w.r.t Petrol)	NA	13.3	29.7	18.5	37.7

Hence, taking this into consideration, the most economic vehicle to run at present will be the LPG converted Bi -fuel car.

## 5. REFERENCES

[1]Mr. H.B.H Pathmasiri, Manager, Gas Conversions, Gas Auto Lanka Limited. (Petrol-LPG conversions)

[2]Mr. A.G Wijegunasekarara, Director, EV Lanka (Private) Limited. (Nissan LEAF)

[3]Stafford Motor Company (Private) Limited. (Honda Insight Hybrid)

[4]United Motors Lanka PLC (Conventional Petrol engines.)

[5]Owners/users of Toyota Corolla & Townace Diesel vehicles.