CHAPTER 4
ECONOMIC IMPLICATIONS OF COMPRESSED NATURAL GAS

Mandatory conversion of commercial fleet to suit the use of CNG as an automotive fuel was implemented in Delhi with the objective of combating vehicular pollution. Together with the environmental benefits of CNG, economic viability was also publicized as one of the reasons why private vehicle owners might be interested in switching over to this fuel. Economics involved in the use of this gas however does not limit to its operational cost, when used as an automotive fuel. The economics also take into consideration of the cost at which the natural gas is obtained and transported to various sources of supply. Also we must not forget to impute the expenditure incurred on laying down infrastructure. Both the micro analysis (private benefit) and macro analysis (social benefit) are important in the given context. This chapter primarily aims at quantifying the benefits accrued to private vehicle owners by the use of CNG.

4.1 ECONOMIC BENEFITS OF COMPRESSED NATURAL GAS (CNG)

In the present scenario, the growth in the number of diesel vehicles has outstripped the ones that run on alternative fuels only because diesel is relatively cheaper as compared to petrol. Diesel cars are preferred over CNG cars despite being more expensive both in terms of purchase price and fuel cost. This could be attributed to the fact that there are very few ex-factory CNG vehicles which come with a guarantee of new diesel or petrol vehicles. Diesel being easily and widely available in all refueling stations across country makes it a preferred fuel over CNG. CNG users
usually have to face long queues for refueling because fewer filling stations are operational. This observed trend of increase in diesel vehicles in Delhi made it increasingly important to study the use of different automotive fuels in terms of the monetary benefits offered by them.

Petrol remains the costliest fuel in absolute monetary terms followed by diesel and then CNG. In the recent policy decision of the present government at the Centre, the subsidies on diesel were rolled back thereby increasing its prices, whereas the price of petrol had observed a slight decline in recent past. This reduction in prices as reasoned by Indian Oil Corporation (IOC) was a result of decline in International oil prices from $116.61 per barrel to $107 a barrel at the time of study (May, 2013) and also an improved Rupee-US dollar exchange rate. The benefit of the same had been passed on to customers and accordingly the aforesaid reduction in the retail selling price of petrol is being affected [1].

If the aforementioned trend continues, the analysts in the automobile industry believe that people's preference will relapse to petrol cars although diesel fuel would still be economical compared to petrol. However, CNG (as in the last week of May, 2013) was priced at Rs 39.9 per kg, Diesel was available at 49.69 per liter, while petrol was available at Rs 63.09 per liter.

This chapter estimated the private economic benefits available to the private vehicle owners on switching over to Compressed Natural Gas as an automotive fuel by using this fuel price differential wherever required. Vehicles considered for analysis were cars, buses and autos. Buses and autos that ply on Delhi roads already run on CNG. But the study had included these vehicles in order to provide a holistic viewpoint on economic viability of CNG for different vehicle types. Moreover, the
concept of economic viability holds for the buses and autos that run in other states of India. Though the price of fuels might still differ in time and across other regions, but it was safe to assume that mild changes would not be able to drastically affect the core economics that this chapter focuses on.

4.2 VARIABLES UNDER INVESTIGATION

4.2.1 Cost Differences

Vehicle purchase price, maintenance costs, and fuel costs were all included in lifecycle costs. The lifespan of the vehicles, as well as annual distance traveled in kms by the vehicle were also important factors, as they determine the amount of fuel cost savings. The discount rate was also an important factor in determining the economic viability as it helped in weighing the future cost differentials relative to upfront investment cost incurred on converting the vehicles to CNG. The study did not include cost of building or converting refueling infrastructure as it was safe to assume that these costs could be addressed in the price of CNG at fuel pumps or so to say the fuel price differential between CNG and other automotive fuels [2].

4.2.2 Fuel Costs

According to general observations and claim of several advocates of CNG throughout the world, CNG vehicles enjoy lower and more stable fuel prices than owners of petrol and diesel vehicles. The claim about the fuel cost as a component of lifecycle costs has received a lot of attention. As Indraprastha Gas Limited in one of its report maintained, that the price of CNG remains competitive vis-à-vis petrol and diesel, and the trend has carried forward [3]. Even if CNG prices which are administered by the government showed rise, there was a parallel rise in the petrol
and diesel price except a very recent price fall of petrol registered for the period between March to May 2013. However the prices of CNG have remained static over a period of time. The prices of fuels in Delhi during the primary investigation in (May 2013) were CNG (Rs.39.9 per kg), Petrol (Rs.63.09 per litre) and Diesel (Rs. 49.69 per litre).

4.2.3 New Vehicle Costs

According to the prices of ex-factory CNG vehicles by Maruti Suzuki Ltd. in four of its cars namely WAGON R, Estillo, Alto 800 and SX4, the price differential ranged from Rs. 54000/- to Rs 62000/- approximately. The retrofit conversions of vehicles for CNG use were assumed to cost between Rs.18000/- to Rs 50000/- depending upon the quality of the CNG kit provided by the dealer [4]

4.2.4 Maintenance Costs

As mentioned earlier in chapter 3 (section 3.2.3), it is difficult to draw comparisons for maintenance costs between ex-factory CNG and petrol/diesel cars. The maintenance costs depend upon several factors like general upkeep, use of the vehicle etc. These factors differ from car to car. So the present study assumed that maintenance costs for both CNG and petrol/diesel vehicle were equivalent[5].

4.2.5 Fuel Economy

The fuel economy is inferred using mileage figures published for ex-factory vehicles on the brochure of the cars under investigation namely Wagon R, Estillo, Alto 800 and SX4. Fuel economy of petrol and diesel cars was taken as 19.6 kmpl and 21.7 kmpl respectively. Fuel Economy for CNG car was taken as 26.3 km per kg.
Fuel Economy for autos that run on petrol is 25 kmpl and CNG is 40 km/kg. Buses plying on city roads run 4 kmpl on diesel and 5 km/kg on CNG [6].

Car manufacturers did try to tap the price differential between alternate automotive fuels and hence came up with ex-factory vehicles in CNG. Maruti Suzuki had launched its four cars in CNG (Green) variant namely Alto 800, Estillo, Wagon R and SX4. CNG kits are preinstalled in these cars and they can run on dual mode i.e. both petrol and CNG. The only car to have the ex-factory models in all three variants (petrol/diesel/CNG) is SX4. These ex-factory CNG vehicles are expected to boost public confidence and trust as they come with same guarantees as of new car on petrol/diesel.

As, these ex-factory cars are there in market, it has become simpler to arrive at the economic benefits that CNG cars offer when compared to petrol. So while the present study compared operational costs of petrol and CNG, all the quantitative variables like mileage and prices were taken as stated by the manufacturers in their respective official brochures.

As a part of thesis, collected data was analyzed to arrive at the operational costs of vehicles running on various alternate fuels namely CNG, petrol and diesel.

<table>
<thead>
<tr>
<th>Automotive Fuels</th>
<th>Cars</th>
<th>Auto</th>
<th>Buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETROL</td>
<td>3.2</td>
<td>2.50</td>
<td>NA</td>
</tr>
<tr>
<td>DIESEL</td>
<td>2.28</td>
<td>NA</td>
<td>12.4</td>
</tr>
<tr>
<td>CNG</td>
<td>1.50</td>
<td>0.99</td>
<td>7.98</td>
</tr>
</tbody>
</table>

Source: Primary Probe
The cars included in the primary probe (table 4.1) were all private ex-factory vehicles. Study of the operational cost of vehicles running on alternate fuel showed that given the prices of each fuel and the computed average of mileage as stated by the manufacturers, the vehicle operational cost is least in the case of CNG. There was a reduction in an operational cost of using a car on CNG by 55 % when compared to petrol driven cars, while percent reduction in the operational costs is 35 % when a CNG driven car is compared to diesel. An auto if driven on CNG registers approximately 60 percent reduction when compared to petrol, the only alternative fuel it can be driven on. Whereas, for the buses which were driven on diesel before the Supreme Court orders for complete conversion to CNG came into effect, there is 35 percent reduction in operational costs. The results of primary study are graphically presented in fig 4.1. Vehicles are taken on the x-axis and the running cost is taken on the y-axis. The graph illustrates the cost effectiveness of CNG as compared to petrol and diesel.

**Fig 4.1**

Operating Costs in Rs/Km

![Comparisons of Operating Costs](image)

Source: Primary Probe
The missing bars indicate vehicles not operating on a given fuel. The autos usually run on either CNG or petrol and buses usually on diesel or CNG. However in Delhi all the autos and buses operate only on CNG after orders from Supreme Court in 2001 were duly implemented by Delhi Government [7].

**Table 4.2**

*Savings in Rs/Km by CNG w.r.t Petrol and Diesel*

<table>
<thead>
<tr>
<th>Automotive fuels</th>
<th>Cars</th>
<th>Auto</th>
<th>Buses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol</td>
<td>1.7</td>
<td>1.51</td>
<td>NA</td>
</tr>
<tr>
<td>Diesel</td>
<td>0.78</td>
<td>NA</td>
<td>4.42</td>
</tr>
</tbody>
</table>

Source: Primary Probe

After comprehensively establishing the running cost of vehicles in Delhi, when running on alternate automotive fuels namely CNG, Petrol and diesel, the next step was to confirm the financial edge of using CNG over the other two automotive fuels. This was done by computing the amount of savings made effective by the use of CNG in place of other two automotive fuels that is Petrol & Diesel (see table 4.2).

**Fig 4.2**

*Savings in Rs/Km by use of CNG w.r.t Petrol and Diesel*

Source: Primary Probe
It must be noted that the saving made by car owner using CNG as against petrol is of Rs 1.7/- per kilometer and as against diesel is Rs 0.78/- per kilometer. Likewise table shows savings for both autos and buses.

The analysis of savings made effective by using CNG is illustrated graphically in fig 4.2. Vehicles are taken on the x-axis and the savings taken on the y-axis. The study shown here indicates that CNG is more economical and cost-effective.

4.3  BREAK EVEN ANALYSIS

Though CNG use resulted in low operating cost per km due to its lower price, but in order to comprehensively establish economic viability of CNG as an automotive fuel, the study incorporated into the quantitative analysis, the cost of investment resulting from switching over to CNG mode. The CNG variants of cars are approximately on an average Rs 55000/- more expensive that the petrol version. Retrofit conversions cost between Rs. 18000/- to Rs. 50,000/-[8].The study assumed an intermediate value of Rs. 40,000/- for retrofit conversions. It is this additional cost that must be repaid to the vehicle owner through fuel cost savings. In order to proceed with the break even analysis, the study used the method of discounted payback period approach.

4.3.1  Discounted Payback Periods

In the context just discussed above, the study drew a parallel with the capital budgeting concept of discounted payback periods. The method of discounted payback period was used to calculate the length of time to recover the costs of investment based on the investment's discounted cash flows.
As contrary to simple payback period which determines the length of time by simply dividing the initial outlay with cash flow each year, discounted payback period discounts each individual cash flow by taking into consideration the time value of money.

Table 4.3 and Table 4.4 (see next section) depicted payback periods for various assumptions that were within the limits of existing analysis and literature review. The focus was mainly on the following parameters:

- Information on vehicle price differential and vehicle life time of \textit{ex-factory} vehicles were used wherever the comparisons were drawn between petrol and CNG as an automotive fuel.

- Information on vehicle price differential and vehicle life time of \textit{retrofitted} vehicles was used wherever the comparisons are drawn between diesel and CNG as an automotive fuel.

- Ex-factory CNG vehicles were assumed to sell for an average of Rs 55000/- more than petrol vehicles. As stated earlier this was the average price differential between ex-factory models of four cars mentioned earlier. The service life of these vehicles was assumed to be 10 years.

- As stated earlier the retrofit conversions of vehicles for CNG use was assumed to cost between Rs 18,000 to Rs 50,000. The best guess was taken to be Rs 40,000/-. The service life of such retrofitted vehicles was taken as 5 years in the analysis.

- Fuel economy of petrol and diesel cars was taken as 19.6 kmpl and 21.7 kmpl, respectively. Fuel Economy for CNG car was taken as 26.3 km/kg.
• Interest rates were taken at the “social rate” of 5 percent. Rate of 10 percent that assumed partial market failure was also applicable to fuel savings.

• The fuel price differential was the difference between prices that prevailed in the last week of May, 2013.

• Finally, the annual distance travelled by the vehicle was taken between the range of 7500 kms to 50000 kms per year.

4.3.2 Sensitivity of Payback Periods to Various Parameters

The parameters mentioned in the previous section were used to arrive at the discounted payback periods for different levels of annual distance travelled and discount rates of 10 percent and 5 percent and is represented in table 4.3.

<table>
<thead>
<tr>
<th>Annual kms travelled</th>
<th>Payback Period (in years) Discounted at 10%</th>
<th>Payback Period (in years) Discounted at 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7500</td>
<td>5.93</td>
<td>4.97</td>
</tr>
<tr>
<td>10000</td>
<td>4.1</td>
<td>3.617</td>
</tr>
<tr>
<td>15000</td>
<td>2.54</td>
<td>2.39</td>
</tr>
<tr>
<td>20000</td>
<td>1.81</td>
<td>1.79</td>
</tr>
<tr>
<td>30000</td>
<td>1.19</td>
<td>1.13</td>
</tr>
<tr>
<td>40000</td>
<td>0.885</td>
<td>0.846</td>
</tr>
<tr>
<td>50000</td>
<td>0.7</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Source: Primary Probe

Table 4.3 indicates that if one switches over to CNG from petrol/diesel, then the fuel cost savings helps recover the additional investment depending the annual distance travelled by the vehicle. For someone who travels 20,000 kms to 30,000 kms every year, the payback or break occurs in less than 2 years and for more kms travelled the payback occurs within a year of switching over to CNG from petrol. For
someone who drives less would take longer to break even. Soon after the vehicle owner breaks even, he/she can enjoy the benefits on driving a cheaper fuel.

**Fig 4.3**

*Discounted pay back period for private vehicles converting from petrol to CNG*

![Discounted payback period vis-à-vis petrol](image)

Source: Primary Probe

It is however interesting to note (fig 4.3) that the difference in discount rates did not matter much for vehicles that travel large distances annually. Similar analysis was done for vehicle owners who contemplate switching over to CNG from diesel.

Conversion of a diesel vehicle to CNG may not be as beneficial as in the case of petrol. The conversion of a diesel engine usually results in conversion to dedicated CNG combustion. Once converted, these vehicles are then dedicated to CNG fuel systems. However, general observations indicated that conversion of a diesel engine to dual fuel (gas and diesel combined) combustion is not a popular and prevalent approach adopted, at least in India.
Table 4.4
Discounted Pay Back Period (in years) vis-à-vis Diesel

<table>
<thead>
<tr>
<th>Annual kms Travelled</th>
<th>Payback Period (in years) Discounted at 10%</th>
<th>Payback Period (in years) Discounted at 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>7500</td>
<td>12.07</td>
<td>8.5</td>
</tr>
<tr>
<td>10000</td>
<td>7.54</td>
<td>6.07</td>
</tr>
<tr>
<td>15000</td>
<td>4.39</td>
<td>3.82</td>
</tr>
<tr>
<td>20000</td>
<td>3.1</td>
<td>2.8</td>
</tr>
<tr>
<td>30000</td>
<td>1.96</td>
<td>1.83</td>
</tr>
<tr>
<td>50000</td>
<td>1.13</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Source: Primary Probe

Given that the lifetime of vehicles that are retrofitted with CNG kits may be around 5-7 years (refer section 3.3.3), payback periods longer than 5 years cannot be economic, under any assumptions about the discount rate. It was useful, therefore, to examine the cells in the above Table 4.4 for which the pay back is under four years. It can be observed that the retrofit conversions of diesel vehicles are economically viable only if the vehicles are travelled for more than 20,000 kms in a year.

Fig 4.4
Discounted pay back period for private vehicles converting from diesel to CNG

Source: Primary Probe
As observed earlier in case of petrol, the choice of interest rate does not have any significant impact for higher annual distance travelled.

4.4 CONCLUSIONS

The chapter closely reviewed the economic benefits reaped by the consumption of CNG as an automotive fuel. The aspects analyzed in this chapter included estimating operating costs and fuel cost savings registered by private vehicle owners if they decide to switch from petrol/diesel to CNG. Study of the operational cost of vehicles running on alternate fuel showed that given the prices of each fuel and the computed average of mileage as stated by the manufacturers, the vehicle operational cost is least in the case of CNG. Discounted payback periods were also calculated in order to explain the break even phenomena. Break Even analysis that helped explain economics of compressed natural gas, were covered in the chapter in order to explain cost -benefit analysis of the same. Intuitively

- If the vehicle price differential is low and the fuel price differential is high, the pay back is expected to occur in quick time.
- If the vehicle price differential is high, fuel price differentials also need to be at a higher end to meet viable payback criterion
- Higher price differentials are also needed to break even in quick time when interest rates are higher. A lower interest rate increases the social value of fuel savings, implying a lower cost for any policy that promotes energy efficiency investments [9].

Favorable government policies like rebates on vehicle purchase price can also be combined with subsidies for natural gas as a transportation fuel to strengthen the natural advantage of CNG.
REFERENCES


