Resistive Economics
International Journal

The Open Access Journal of Resistive Economics (OAJRE)/
Volume 4, Number 2, 2016 Published Online July 01
E-ISSN: 2345-4954 http://oajre.ir

Original Article

Pages: 21-39

Cost – Benefit Analysis of Constructing Single – Purpose CNG Stations in Iran by Emphasizing on Different Scenarios

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Received: 2016/02/18 Revised: 2016/04/29 Accepted: 2016/05/28

ABSTRACT: Statistics indicate that manufacturing hybrid cars, Gas burner is remarkably growing and the quantity and quality of CNG refuelling stations should be also increased in parallel. In present study and by examining different scenarios, guidelines are provided to resolve the problem of lacking CNG refuelling stations in Tehran and the economic feasibility is examined. Economic assessment is done by COMFAR EXPERT III. For scenarios 1 to 4, internal rate of return (IRR) is 5.89, 15.76, 4.78 and 12.52 respectively. However, these figures are not justifiable economically due to 20% of domestic banking interest rate. Also the net present value of the scenarios is positive and Payback periods are 12, 7, 12, 8 years respectively .The return rate for private sector would be 23% if an individual's annual income increases 12, 5, 16 and 8 respectively for all four scenarios. Comparing these indicators suggest that although scenario two, that is, constructing small stations by suggested price of 3700 Rials proposed by relevant experts is better than other scenarios, it is not yet economic justification . Therefore, it is better to increase prices for better justification.

KEYWORDS: CNG Refuelling Station, Internal Rate Of Return, Net Present Value, Payback Period.

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1. INTRODUCTION

Natural gas is the cleanest fossil fuel. CNG is produced by compressing natural gas, increasing energy concentration and decreasing the needed volume of stocked gas. CNG energy density is 25% of diesel fuel. For several decades, CNG has been recognized as a proper alternative fuel for transportation fleet agency (CNG Feasibility study, 2012). Using natural gas as an alternative fuel in cars is quickly expanding due to the seriousness of air pollution in big cities. In our country, the main advantages of this fuel include accessibility to huge natural gas reservoirs, transmission lines, technical and engineering capabilities, more sustainability of natural gas reservoirs to crude oil, cheaper prices, predictability, relative sustainability, broad distribution network, decrease in fuel importation, job creation and mitigating environmental pollution (CNG Conference, 2003).

Against such advantages, the possible disadvantages of using CNG include: need to fueling equipment and facilities as well as electronic spares, security, extra power costs to compress natural gas usable by used compressors, high costs of CNG equipment maintenance especially for drier compressors which need constant operational insurance, using sparking combustion engines with lower temperature outcome compared to combines combustion engines in diesel fuel vehicles (CNG Feasibility Study,2012).

With its huge natural gas reservoirs, Iran ranks the second in the world. Since the beginning of the 9^{th} administration in Iran, 862 CNG stations were commissioned. By establishing 10^{th} administration and aggregating responsibilities in NIODC, planning on accelerating the development of CNG stations and balancing the quantity of manufacturing hybrid cars and CNG stations put into agenda in 2009 and till the end of the same year, 1191 CNG stations were equipped and commissioned through the country. In 2010, developing refueling stations was accelerated again and NIODC equipped and commissioned 452 stations countrywide which indicated 140% growth compared to the previous year and increased total CNG stations to 1642. According to NIODC, by increase in natural gas consumption in domestic transportation section in 2012, daily average CNG consumption in CNG stations exceeded 18.03 million cubic meters. Among all provinces, Tehran has the highest number of cars and 219 CNG stations while it ranks 31 in natural gas consumption which is a contemplating rank (Brinckerhoff, 2009).

Due to frequent fueling by gas burner cars, the need to liquid gas stations is more than gasoline and diesel. On the other hand, refueling stations have their own complexities so that that their costs are 10 times more than diesel stations and it has fueled the reluctance of private sector to construct such stations (Ejaz et al, 2009).

In big cities like Tehran, constructing these stations is ignored due to heavy investments and lack of support by private sector. The volume of investments depends on their dimension so that it is estimated 150 and 30 billion Rials for big and small stations respectively. In addition to heavy costs of land and equipment, gas and electricity costs are also important. In present study, a cost – benefit analysis is conducted on constructing and commissioning CNG stations for private sector investors in Tehran by using COMFAR EXPERT III. What distinguishes present study from similar cases addressed to four different scenarios to analyze economic indices is that the scenarios are gathered by the dimensions of stations and current and proposed prices.

In past decade, air pollution has become a big problem and countries are using such initiatives as alternative fuels. In a country like Iran as the second holder of global natural gas reservoirs, CNG has the most potentiality as a clean fuel for cars. Constructing CNG stations would lower fuel costs, greenhouse emissions (over 20%) and dependence to oil (Zamanian et al, 2008).

Statistics indicate that manufacturing hybrid cars, gas burner and gas OEM (Original Equipment Manufacturer) is growing remarkably and the quantity and quality of CNG stations should be increased in parallel. As we know, there is no such balance currently and private sector is reluctant to construct such stations due to their huge costs. Therefore, it is necessary to perform an economic assessment on constructing such stations by considering different scenarios and providing proposals to justify them. In fact, the critical opportunity to develop CNG is to utilize

facilities, to create a wide range of feasibility study services, to conduct cost – benefit analyses and to design and produce modern equipment (Ejaz et al, 2009).
The aim of present economic analysis is to study the justification of constructing CNG refuelling stations which dispensed 2 and 4 respectively. For this research, 4 scenarios are predicted according to below table.

Table 1: research scenarios

Suggested (3700 Rials per cubic meter of CNG)	**Real (3000 Rials per cubic meter of CNG)**	**Price / Stations**
The 2nd scenario	The 1st scenario	Small
The 4th scenario	The 3rd scenario	Big

2. PROBLEM DESCRIPTION AND RESEARCH NECESSITY

In recent years, developing CNG usage in vehicles is considered as a national priority to decrease oil product consumption in transportation sector. One of the affecting factors on moving forward this program is to develop real prices (3000 Rials per cubic meter of CNG stations concerning the need of vehicles' repetitive fuelling) (Behbudi, 2012).

As we know, there is no such balance currently and private sector is reluctant to construct such stations due to their huge costs. Therefore, it is necessary to perform an economic assessment on constructing such stations by considering different scenarios and providing proposals to justify them. In fact, the critical opportunity to develop CNG is to utilize facilities, to create a wide range of feasibility study services, to conduct cost – benefit analyses and to design and produce modern equipment (Ejaz et al, 2009).

3. METHODOLOGY

Research population consists of all current stations countrywide from which stations in Tehran are selected as the sample. To estimate the costs, project investment costs were initially analyzed by a feasibility study and after studying and completing the tables on investment costs, financing methods are provided. It is necessary to finance project investments in the first year by shareholders or domestic or foreign financing through internal/external banking system. Then, it is unavoidable to Analysis of Production costs related to operation period. However, during operation period and based on a 10-year economic standard, the costs of equipment and machinery amortization and other cases are added to production costs. Afterwards, sales extent or annual incomes are computed and annual net profit can be achieved by deducting production costs (Mark et al, 2012). Finally, through computed tables, affecting economic indices on investment such as NPV and IRR are analyzed and then their sensitivities are investigated. To estimate these indices, COMFAR EXPERT III designed by UNIDO is utilized.

4. RESEARCH BACKGROUND

In their study, Aslam et al, (2005) considered CNG as an alternative fuel for petrol burner vehicles. In this paper, they measured, recorded and compared the performance, fuel consumption and emission of greenhouse gases under constant operational circumstance of petrol and CNG. Based on their empirical findings, the return of CNG is higher than petrol while its greenhouse gas emissions (CO, CO2 and HC) are lower.

Frick et al. (2007) studied CNG production optimization in refuelling stations and used a Swiss case study. Swiss natural gas industry intended to invest on extra 350 CNG stations through considering its current 50 stations. To this end, it used cost – benefit analysis method by two

simulations for local explorations that are optimized socially. The results suggested that investments on CNG extra infrastructures are not profitable socially.

Mark et al, (2012) studied technical and economical parameters of natural gas delivery by using CNG. They suggested RFP to focus on current technologies, critical elements such as main stations, transportation equipment and a user scenario and then initial investment and costs of the plan for single use scenario were estimated. Then, they Analysis critical variables including far-distance transportation and provided solutions to select equipment with lowest costs and compared natural gas with other rival fuels such as propane, gas oil and electricity.

Thompson and Bashford (2012) studied CNG as a an alternative fuel for mixer truck by emphasizing that CNG is an alternative fuel which can be used for vehicles including cement mixer trucks. In this study, they investigated costs and savings related to such transfer and used a multivariate financial model. Their findings indicated that cost was a function of numerous operational parameters, governmental policies and accessibility to CNG.

Mirfatah and Saleh (2007) compared types of alternative fuels in transportation sector. Their findings indicated that concerning huge domestic gas reservoirs, both LNG and CNG can be considered as a priority in the list of alternatives. However, it seems necessary to invest on other fuels such as ethanol, methanol, di-methyl Ether and using the capacity of the country to export them.

In their study on cost – benefit analysis to construct and run single-purpose CNG refuelling station for private sector in Tehran, Attabi et al, (2007) studied the economic acceptability of the plan. The computed IRR was 3.56% which was not acceptable economically due to banking interests between 16 – 22%. Additionally, the results indicated that while an individual's annual income increases 81%, IRR in private sector will be 20%

5. RESEARCH FINDINGS

5.1. Investment Costs

Based on planning, the needed time for plan execution is over 1 year. Since 2013 is considered as the basic year, it is necessary to finance all needed investment costs since the running year is considered 2014. Since the standard life cycle of the project is 10 years, running time it till 2023.

Table 2: Investment costs estimation (Rials) [NIOC, 2012]

Investments for scenarios 3 & 4	Investments for scenarios 1 & 2	Types of fixed costs
12,000,000,000	4,000,000,000	Land
5,000,000,000	3,000,000,000	Construction
15,518,000,000	7,759,000,000	Machinery and equipment
360,000,000	90,000,000	Utilities
100,000,000	50,000,000	Furniture and official equipment
1,432,000,000	921,000,000	Membership fees for services
34,410,000,000	15,820,000,000	Total sum

5.1.1. Land

Concerning standard needed space and services, the required land for a small station is at least 400 square meters while it is 1,200sqm for a big station. Concerning different prices in different areas, the minimum predicted priced for land 10,000,000 Rials per square meter.

5.1.2. Construction

Construction details are outlined in table 3. It should be noted that this cost is varied based on shareholders' opinions on constructional operations and predicted costs are in average. Changes in building appearance or amenities could improve the prices several times. However, this is irrational and not justified economically.

Table 3: constructional costs predictions (Rials) [NIOC, 2012]

Investments for scenarios 3 & 4	Investments for scenarios 1 & 2	Description
150,000,000	800,000,000	Landing
1,750,000,000	110,000,000	Foundation
1,750,000,000	110,000,000	Platform and warehouse
5,000,000,000	3,000,000,000	Total sum

5.1.3. Machinery and Equipment

Machinery and equipment include 2 and 4 dispensers for small and big stations respectively as well as gas tank, compressors, electronic and mechanical parts and so forth. These costs are based on predictions and acquired information from NIOC and estimated 7,759,000,000 and 15,518,000,000 Rials for small and big stations respectively. However, it should be noted that if the land is supplied by private sector in urban areas, NIOC would provide the needed equipment free of charge (CNG Feasibility Study, 2012). In present study, it is assumed that the land is out of urban area. Therefore, such costs should be bore by investor.

5.1.4. Utilities

According to obtained information, the costs of utilities include gas pipelining to station (Attabi et al, 2007). The costs are estimated 90,000,000 and 360,000,000 Rials for small and big stations respectively. In constructing CNG stations, distance from station to central line is too vital. For instance, it is assumed that distance between a big station and central pipeline is maximum 1000 meters. Considering 6-inch pipeline and 60,000 Rials as the cost of per inch, one can compute the costs of utilities (National Iranian Oil Products Distribution Company, 2012).

5.1.5. Membership Fees for Services

Membership fees for services such as electricity, gas, water and telephone is shown in table 4 based on tariffs by Energy Ministry, Telecommunication Company and National Iranian Natural Gas Company.

Table 4: membership costs for electricity, gas, water and telephone [NIOC, 2012]

Investments for scenarios 3 & 4	Investments for scenarios 1 & 2	Description
600,000,000	400,000,000	Electricity
80,000,000	500,000,000	Gas
32,000,000	21,000,000	Water and telephone
1,432,000,000	921,000,000	Total sum

5.1.6. Furniture And Official Equipment

To run administrative department of the station, some furniture are needed. Estimations indicate that such fees are 50,000,000 and 100,000,000 Rials for small and big stations respectively. Noteworthy, these are average costs varied in different stations.

5.2. Financing Methods

In past years, 24% of total investment costs were financed by Fuel Consumption Optimization Company and the remained capitals were provided by shareholders (Attabi et al, 2007).

Recently, it is approved that if the land is provided by Municipality, in addition to free equipment, the membership fees for electricity and gas should be paid by National Iranian Oil Product Refining and Distribution Company. If the land is provided by private sector, only the equipment is granted free of charge, provided that the land is inside urban area (www.nipdc.ir). In this research, total costs are financed by shareholders.

5.3. Production Costs

It includes costs which should be funded during operations and production. In addition to above costs, the life cycle and economic value of machines and equipment are decreased overtime. Therefore, for each item, a separated table is considered in which relevant costs are entered and added to production costs separately. Due to amortization rate and type in fixed investment costs for each investment item, these amortization costs are computed separately (Attabi et al, 2007).

Below, total production cost table is drawn and each cost is provided separately.

Table 5: production costs prediction for each year (Rials)

Scenrio 4	Scenrio 3	Scenrio 2	Scenrio 1	Description
34,522,065,000	28,953,990,000	19,552,320,000	16,398,720,000	Raw material
216,000,000	216,000,000	216,000,000	216,000,000	Energy subscription
920,000,000	920,000,000	510,000,000	510,000,000	Repairs
33,850,000	33,850,000	22,650,000	22,650,000	Pesronnel costs
35,691,915,000	30,123,840,000	20,300,970,000	17,147,370,000	Total sum

5.3.1. Raw Materials

Needed raw material is natural gas supplied constantly through installed equipment from the main pipeline and stocked in tankers and transferred to car stations through dispensers. Due to

lack of CNG stations, they would serve customers in day and night. On this basis, the annual capacity of stations is computed by needed time to inject CNG.

Based on studies, needed time for fuelling is 5 minutes for each car in average. However, it is true for cars with the capacity of 15 cubic meters. Obviously, fuelling time varies by tank capacity, compression functionality and the quantity of customers. Therefore, the above figure is in average. On this basis, table 6 shows the annual cost to supply raw material in different scenarios. In scenarios 1 and 3, the cost is 2600 Rials per cubic meter while it is 310 Rials for scenarios 2 and 4. Raw material costs are also rendered in table 6.

Table 6: computing consumption amount and annual cost of CNG refuelling stations

Scenarios 2 and 4	Scenarios 1 and 3	Description
5	5	Needed time for fueling (minute)
1440	1440	Minutes per day
8	4	The number of fueling nozzles
2034	1152	The number of cars (daily)
15	15	Consumption (cubic meters)
365	365	Number of days per year
11,136,150	6,307,200	CNG annual consumption

5.3.2. Energy subscription

Concerning current domestic policies especially by Ministry of Energy, in addition to costs of water, electricity and gas as the result of multiplying the amount of consumption in unit cost, relevant organizations should pay fixed costs as energy subscription which should be paid by subscribers irrespective of consumption amount (Attabi et al, 2007). To the same reason, this figure is identical for different scenarios. Table 7 outlines energy subscription costs for a CNG fuelling station.

Table 7: computing energy subscription rate for a CNG fuelling station [NIOC, 2012]

Rate (Rials)	Description
8,000,000	Monthly electricity demand
10,000,000	Monthly gas subscription
12	Months per year
216,000,000	Energy subscription

5.3.3. Maintenance and Overhead Costs

The owners of CNG stations are posed by annual costs as equipment/machinery maintenance costs and also overhead costs like insurance. These are unfixed costs in different stations. In present study, the average costs are predicted in table 5 for small and big stations.

5.3.4. Personnel costs

In the proposal of constructing CNG refuelling stations, personnel costs are computed by tables of Management and Planning Organization on pay salaries as well as the maximum and minimum number of needed personnel. Table 8 renders annual costs for each worker, supervisor and engineer.

Table 8: CNG refuelling stations personnel costs (per person/Rials) [NIOC, 2012]

Engineer	Supervisor	Worker	Description
3,500,000	3,000,000	2,500,000	Monthly wage
800,000	800,000	800,000	Extra work
4,200,000	3,800,000	3,200,000	Total sum
1,000,000	805,000	690,000	Tax and insurace (by employer)
3,000,000	350,000	300,000	Bonus
3,000,000	350,000	300,000	Awards
3,000,000	350,000	300,000	Years of work
14,200,000	5,655,000	4,790,000	Total sum
14,200,000	5,700,000	4,800,000	Total sum with extra etimation

Table 9: personnel costs consumption in minimum conditions (per person/Rials) [NIOC, 2012]

Total (Rials)	Monthly salary (Rials)	QTY	Title
11,200,000	5,600,000	2	Operator
7,100,000	7,100,000	1	Supervisor
4,323,000	13,100,000	0.33	Engineer
22,623,000	25,800,000	3.33	Total sum
22,650,000			Total sum with extra etimation

Table 10: personnel costs consumption in minimum conditions (per person/Rials) [NIOC, 2012]

Total Sum (Rials)	Monthly salary (Rials)	QTY	Title
22,400,000	5,600,00	4	Operator
7,100,000	7,100,000	1	Supervisor
4,323,000	13,100,000	0.33	Engineer
33,823,000	25,800,000	5.33	Total sum
33,850,000			Total sum with extra etimation

Concerning minimum and maximum conditions of employing needed staff, relevant costs are computed in two states. Noteworthy, in COMFAR EXPERT III, personnel costs are considered in minimum conditions for scenarios 1 and 2 (small stations) and they are considered for maximum conditions in scenarios 3 and 4.

5.3.5. Amortization

The period of using fixed assets excluding land and membership fee of the services is limited and to the same reason, land and membership fees of services are blank in table 11. Obviously, the conversion into final price is not occurring suddenly; rather, it is gradually by using the fixed asset and/or its price may be decreased and changed to cost overtime (Attabi et al, 2007).

In computing the amortization of assets, amortization tables in article 151 of Direct Tax Law is used and then the rate and type of applied amortization in COMFAR EXPERT III are shown in table 12. Amortization amount is seen in table 13. Noteworthy, these are production costs.

Table 11: the rate and type of fixed assets amortization for CNG refuelling stations [Davani, 2007]

Rate of amortization	Type of amortization	Description
-	-	Land
10	Linear with scrap value	Constrcution
10	Linear with scrap value	Equipment and machinery
12	Linear with scrap value	Utilities
10	Linear	Furniture
-	-	Membership fees of services

6. SENSITIVITY ANALYSIS

By using sensitivity analysis, one can show that how project profitability changes with different determined values for necessary variables. Often, sensitivity analysis is used when undiscounted evaluation techniques do not show convincing profitability and it is understood that changes in some variables may decrease project profitability.

Inflation rate estimation:

Based on conducted studies, the target inflation rate is in 25% by the end of 2014. In the second part of subsidies reform plan, we will face increases in the prices of petrol and other energy carriers. Therefore, inflation expectations would be increased and inflation rate would be also increased exponentially within ten years as predicted in sales income sector by COMFAR EXPERT III. Project net present value is shown as 15% for different scenarios in the basic year in table 12.

Table 12: financial results from executing CNG fuelling station proposal

Unit	Scenario 4	Scenario 3	Scenario 2	Scenario 1	Decription
%	12.52	4.78	15.76	5.89	IRR
%	12.52	4.78	15.76	5.89	IRRE
Rials	20,563,851,760	2,125,340,120	13,632,082,160	2,877,702,180	NPV

As seen in table 12, the internal rate of return is too low for scenarios 1 and 3 and low for scenario 2 in the perspective of investors while it is more plausible for scenario 4. However, it is not a plausible rate compared to more economic firms like banks. Concerning current domestic economic circumstances and 20% banking interest rate, it is considered a riskless investment. If the risk of investment in economic plans is assumed as 3%, it is necessary to determine investment return rate as 23% while it is seen that in the best conditions, CNG fuelling station return rate is determined as 15% which shows 8% difference from expected return rates. Thus, concerning the existence of more economic firms such banks, private sector is reluctant to attend and invest in this arena.

6.1. Irr Sensitivity Analysis

Sensitivity analysis is a very fruitful process to examine the risk of investment. In present study, after computing IRRs for different scenarios based on user's inputs, important affecting factors to compute these rates are changes in positive and negative orientations to investigate their impact on IRRs. IRR is mainly influenced by sales income, fixed investment costs and productions costs. On this basis, as seen in figures 1 to 4, these three parameters are changed +20% compared to basis state. Although these three parameters are changed, other parameters are remained unchanged.

Figure 1: the results of IRR sensitivity analysis for scenario 1 by COMFAR EXPERT III concerning the conditions of three parameters namely sales income, fixed asset increases and operational costs

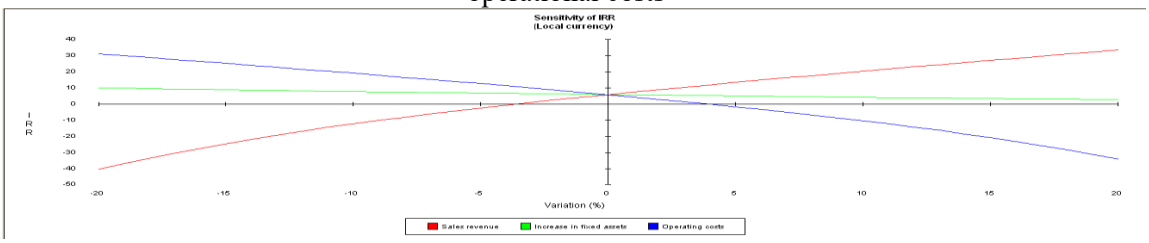


Figure 2: the results of IRR sensitivity analysis for scenario 2 by COMFAR EXPERT III concerning the conditions of three parameters namely sales income, fixed asset increases and operational costs

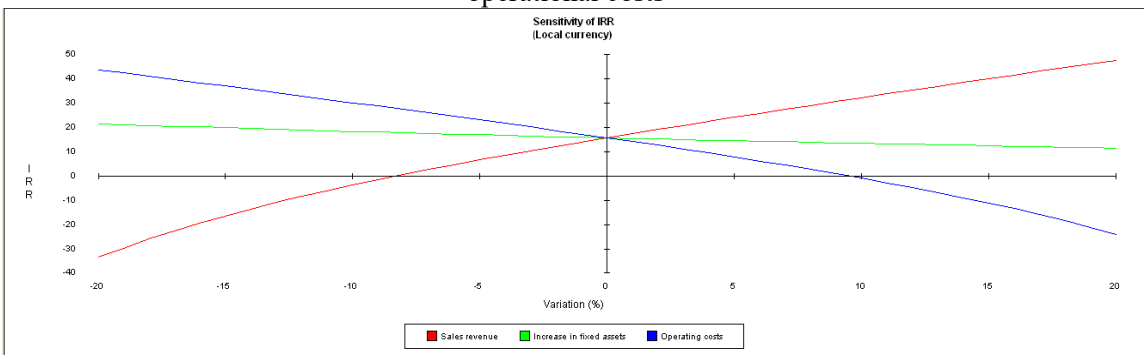


Figure 3: the results of IRR sensitivity analysis for scenario 3 by COMFAR EXPERT III concerning the conditions of three parameters namely sales income, fixed asset increases and operational costs

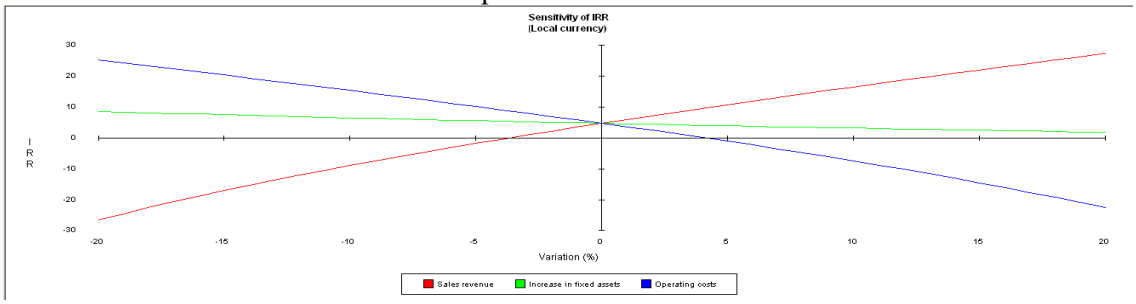
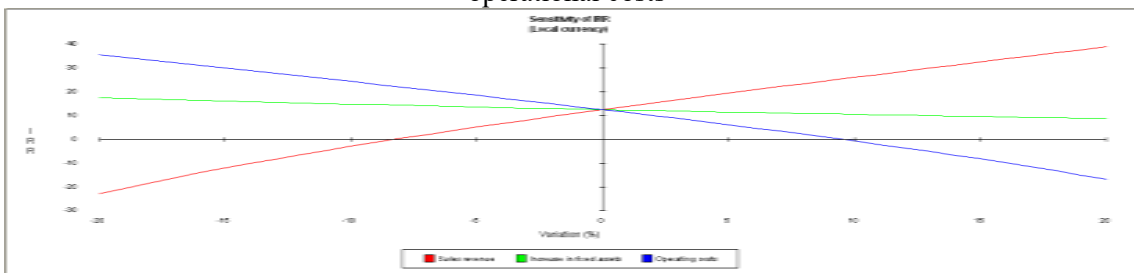


Figure 4: the results of IRR sensitivity analysis for scenario 4 by COMFAR EXPERT III concerning the conditions of three parameters namely sales income, fixed asset increases and operational costs



By any change, IRR is computed and provided; the results are shown in table 13 and figures 1 to 4 on IRR sensitivity analysis. As seen in table 13 and figure 1 for scenario 1, when change rate is 0, IRR is 3.89%. Figure 1 indicates that the highest IRR sensitivity analysis belongs to sales income so that if income decreases 20% and other parameters are fixed, IRR will be -40.36% while income increases 20%, IRR would achieve 33.57%. It is in the conditions that by 20% decrease in fixed costs and operational costs, IRR arrives at 10.71% and 31.79% respectively. It is observed that in the case of any change in parameters B and C, IRR deviation rate is lower than parameter A. however, one can see that due to the nature of sales income, the impact by this parameter on IRR is reversed compared two other parameters.

Table 13: the results of IRR sensitivity analysis by COMFAR EXPERT III concerning three parameters of sales income (A), increase in fixed costs (B) and operational costs (C)

Scenario 4			**Scenario 3**			**Scenario 2**			**Scenario 1**			
Parameter C	Parameter B	Parameter A	Parameter C	Parameter B	Parameter A	Parameter C	Parameter B	Parameter A	Parameter C	Parameter B	Parameter A	Changes
35.83	18.06	-22.50	25.24	9.05	-25.71	43.93	21.79	-33.57	31.79	10.71	-40.36	-20
31.11	17.78	-14.44	21.19	7.86	-18.57	38.93	20.36	-19.29	27.14	10	-27.50	-16
27.50	17.50	-8.06	18.10	7.38	-10.48	36.64	18.93	-6.43	22.50	8.93	-16.07	-12
23.33	16.11	1.39	14.05	5.71	-6.67	28.57	18.21	1.07	17.50	8.57	-7.50	-8
18.06	13.06	7.22	8.81	5	-0.71	22.50	17.14	8.57	12.14	7.86	-0.71	-4
12.52	12.52	12.52	4.78	4.78	4.78	15.76	15.76	15.76	5.89	5.89	5.89	0
7.78	11.67	18.33	-2.14	3.81	10	10.36	15.36	24.64	0	5.36	11.79	4
4.17	11.94	25	-4.05	2.79	14.05	2.86	13.93	27.14	-6.79	4.64	17.50	8
-1.11	9.72	25.83	-10.71	2.48	18.81	-4.64	13.57	36.64	-14.29	4.29	23.10	12
-9.44	9.17	33.33	-15.48	2.16	23.10	-12.14	12.50	42.14	-22.86	3.57	28.93	16
-16.39	9.44	39.72	-24.05	1.22	27.62	-23.57	11.79	48.21	-33.57	3.21	33.57	20

To achieve the corresponding IRR (23%), the percentage of needed changes for parameters A, B and C defined in table 13 are computed by COMFAR EXPERT III. The results are outlined in table 14.

Table 14: the percentage of needed changes to achieve considered IRR

4	**3**	**2**	**1**	**Scenario/parameters**
+8	+16	+5	+12	A
-37	-62	-25	-57	B
-9	-18	-5	-14	C

6.2. The Reason of Selecting Discounted Rate As 15% for Compute Project Net Profit Value (NPV)

Based on criteria and measures announced by the Central Bank for industry section, inflation rate, risk-taking rate by private investors and early return of the project as well as investment opportunity costs are estimated in this project.

Figure 5: NPV by different IRRs for scenario 1 by COMFAR EXPERT III

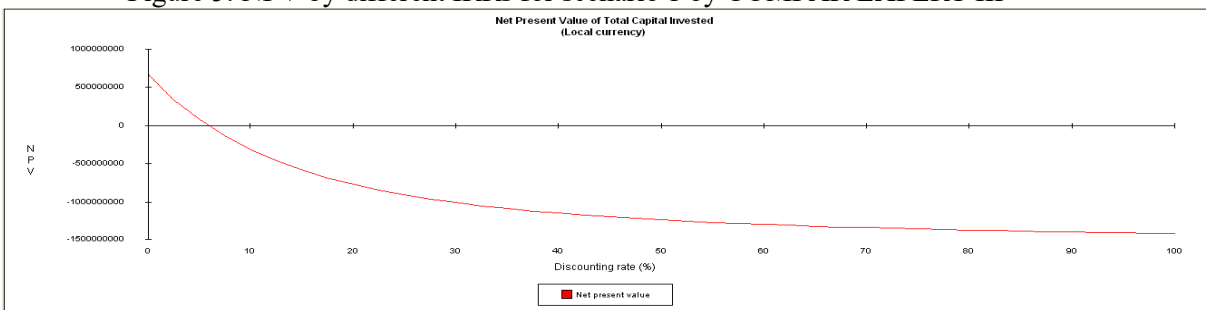


Table 15: NPV sensitivity to discounted rate for different scenarios (Rials)

NPV for Scenario 4	NPV for Scenario 3	NPV for Scenario 2	NPV for Scenario 1	Discounted rate
340,706,900,000	12,474,650,000	19,420,2000	6,805,800,000	0%
4,438,055,160	8,876,099,090	14,618,519,630	3,118,726,270	10%
-9,361,384,520	-18,479,143,720	-2,427,647,160	-7,698,546,890	20%
-16,624,249,570	-23,369,805,150	-6,207,596,810	-10,089,083,640	30%
-20,861,345,220	-26,141,259,350	-8,447,099,570	-11,473,816,620	40%
-23,551,323,520	-27,858,849,190	-9,885,814,400	-12,347,884,950	50%
-25,379,627,580	-29,004,163,540	-10,872,181,430	-12,939,279,930	60%
-26,691,706,790	-29,814,152,030	-11,584,417,350	-13,362,213,120	70%
-27,674,913,210	-30,4143,473,150	-12,120,423,830	-13,678,287,210	80%
-28,437,545,690	-30,876,311,210	-12,537,410,080	-13,922,941,370	90%
-29,045,756,420	-31,242,385,490	-12,870,634,820	-14,117,734,690	100%

Figure 6: NPV based on different discounted rates for scenario 2 by using COMFAR EXPERT III

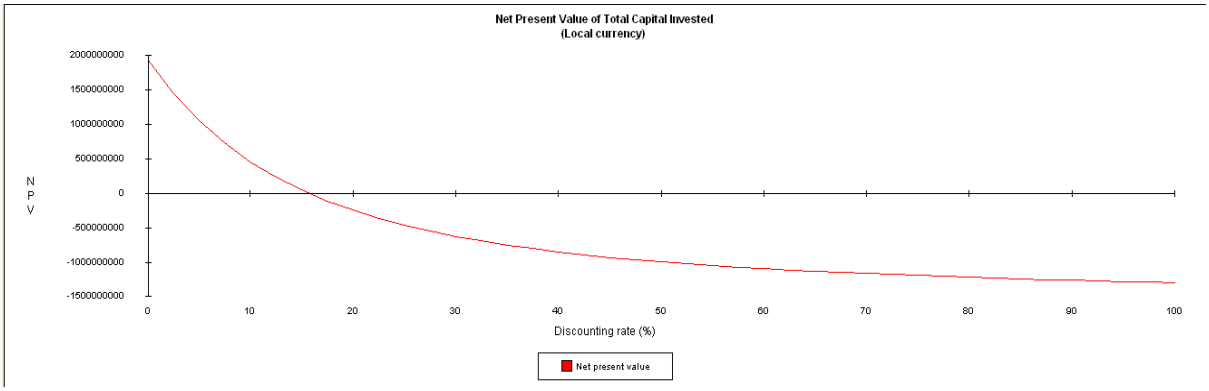


Figure 7: NPV based on different discounted rates for scenario 3 by using COMFAR EXPERT III

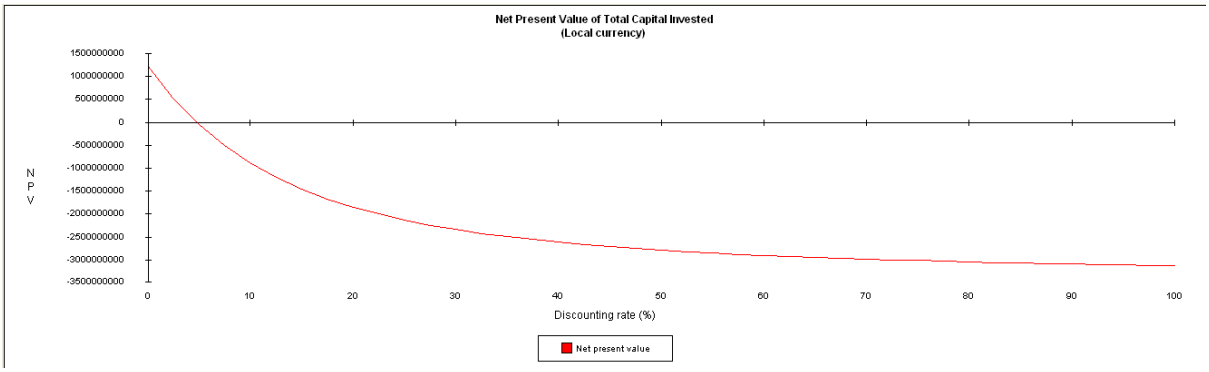
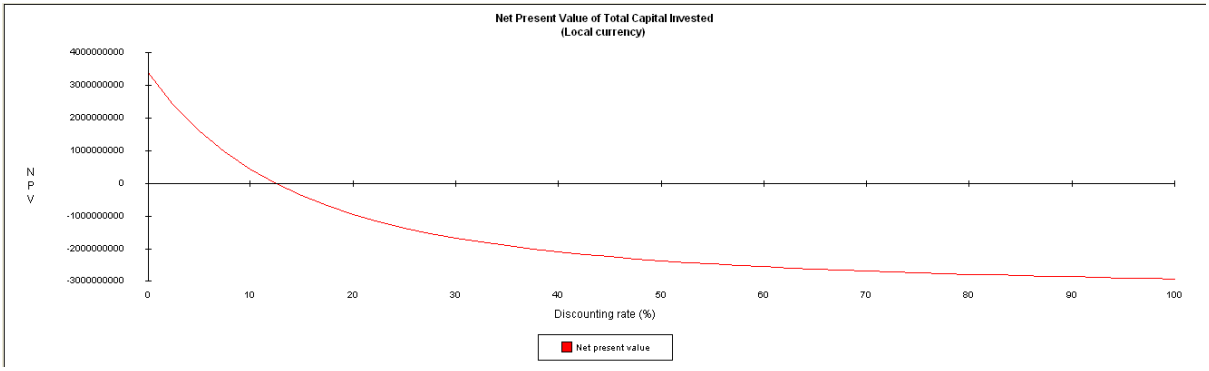


Figure 8: NPV based on different discounted rates for scenario 4 by using COMFAR EXPERT III



6.3. Npv Parametric Analysis

NPV parametric analysis is conducted by three variables including sales income, fixed assets increase and operational costs. Due to more sensitivity by IRR to sales income, this variable is changed 10% in both positive and negative directions and changes in other two variables are ignored. In accordance with figures 9 to 12, 10% increase in scenarios 2 and 4 leads into IRR more than considered rate (23%) while these changes are not sufficient for scenarios 1 and 3. Therefore, the results of this analysis indicate IRR sensitivity analysis in table 14.

Figure 9: NPV sensitivity to sales income by 10% changes for scenario 1

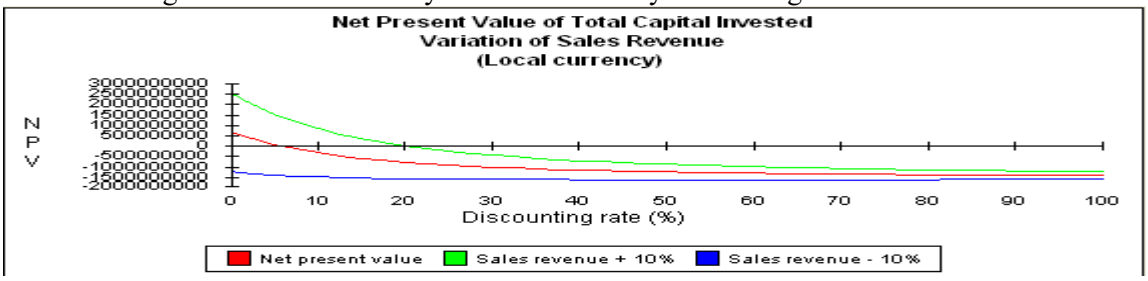


Figure 10: NPV sensitivity to sales income by 10% changes for scenario 2

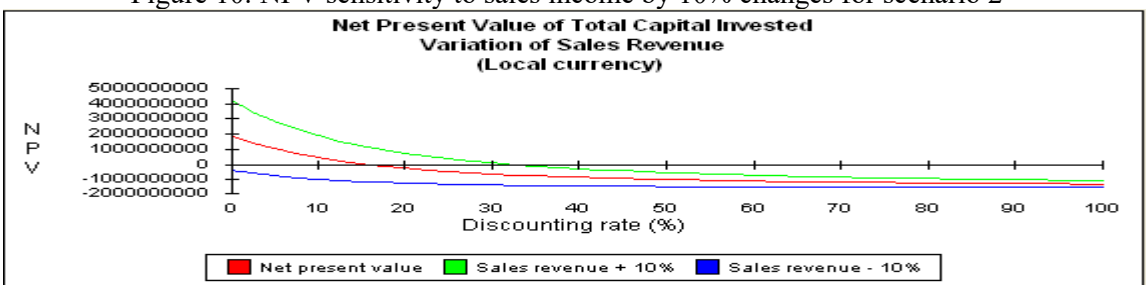


Figure 11: NPV sensitivity to sales income by 10% changes for scenario 3

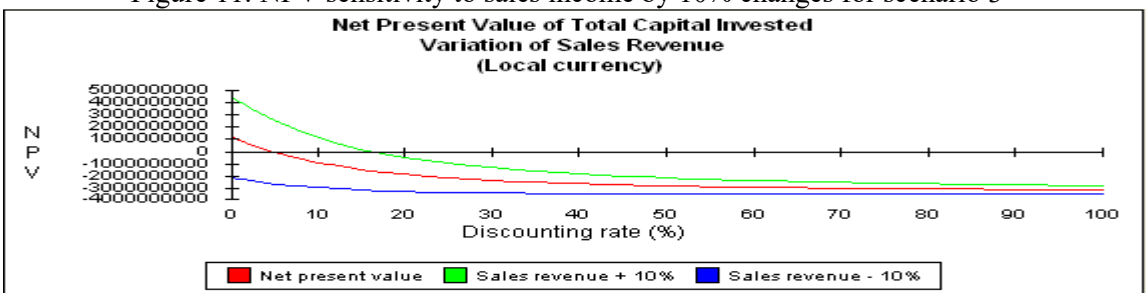
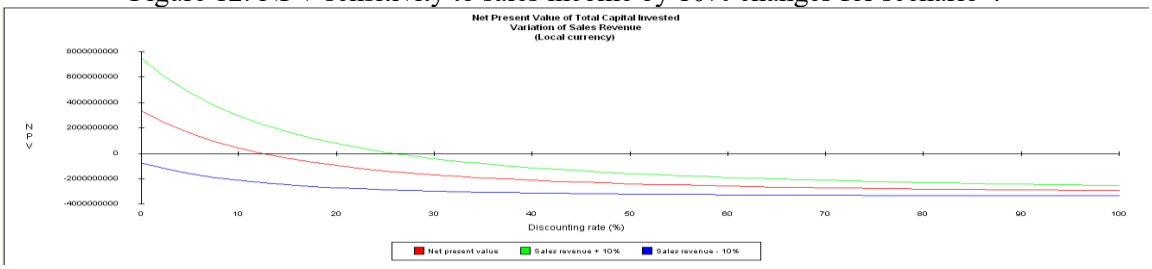


Figure 12: NPV sensitivity to sales income by 10% changes for scenario 4



6.4. Capital Return Time

By using the same software, capital return time as one of the most important affecting factors in investment decision making is computed. According to figures 9 – 12, it is seen that expected profit is achieved after 10 years in scenarios 1 and 3. Since the operation period is considered as ten years, these two projects are fully noneconomic while in NPV is positive since 2019 and 2021 for scenarios 2 and 4 respectively. Therefore, they are more economic than two first scenarios.

Figure 13: capital return time as discounted for scenario 1

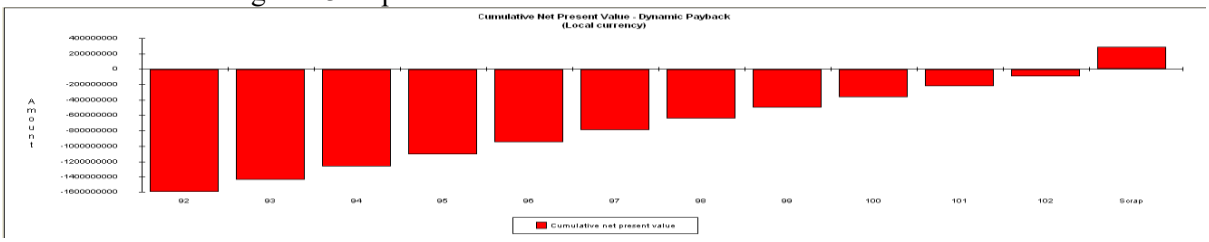


Figure 14: capital return time as discounted for scenario 2

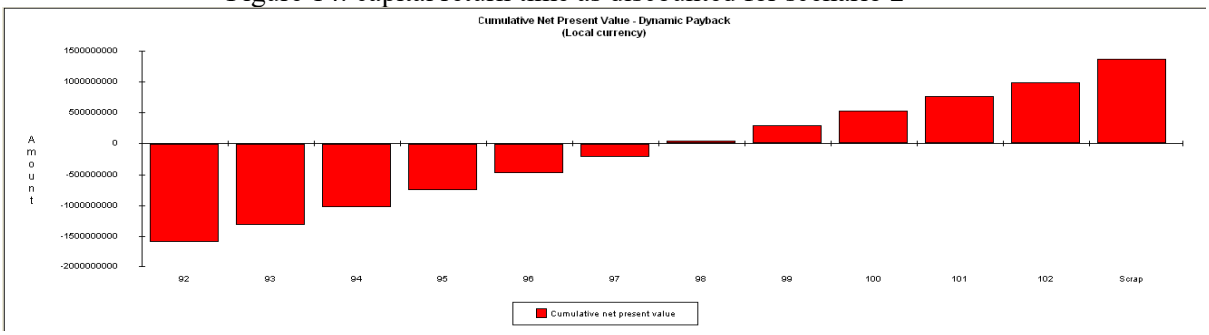


Figure 15: capital return time as discounted for scenario 3

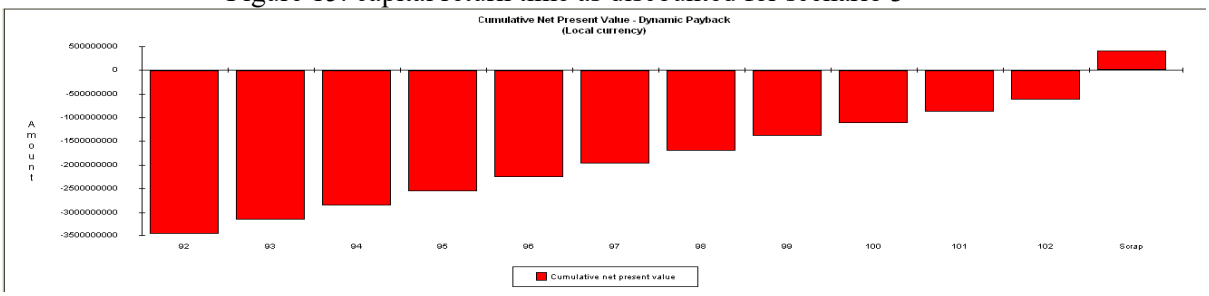


Figure 16: capital return time as discounted for scenario 4

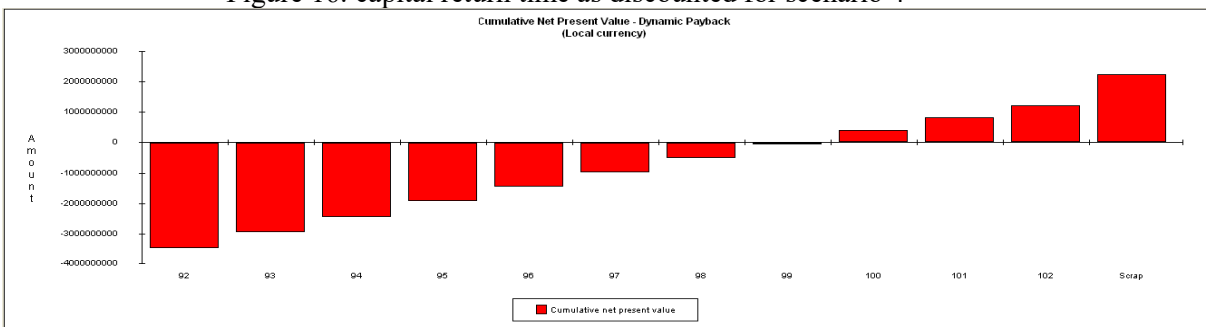


Table 16: NPV calculation in different years to determine capital return time (Rials)

NPV for Scenario 4	NPV for Scenario 3	NPV for Scenario 2	NPV for Scenario 1	Year
-34,410,000,000	-34,410,000,000	-1,582,000,000	-1,582,000,000	2013
29,354,042,130	-31,471,363,920	-13,040,517,920	-14,239,726,010	2014
-24,165,377,990	-28,382,067,170	-10,182,786,310	-12,570,999,650	2015
-19,127,623,820	-25,382,543,950	-7,408,150,010	-10,950,759,650	2016
-14,236,600,360	-22,470,385,500	-4,714,328,360	-9,377,711,100	2017
-9,488,033,890	-19,643,047,190	-2,098,967,540	-78,504,479,500	2018
4,877,775,180	-16,898,055,840	440,217,720	-6,367,730,370	2019
-401,795,850	-13,693,330,500	2,905,446,140	-4,928168,100	2020
3,943,815,140	-11,095,915,430	5,298,871,780	-3,530,534,850	2021
8,162,854,950	-8,583,861,960	7,622,586,000	-2,173,609,350	2022
12,259,010,100	-6,144,975,100	9,878,619,220	-856,205,960	2023

7. CONCLUSION AND RECOMMENDATION

In present study, the economic justification of constructing and running CNG refuelling stations were examined in small and big refuelling stations through real and proposed prices. Based on achieved information and field studies, the needed investment for constructing a CNG refuelling station in scenarios 1 and 2 equals 15,820,000,000 Rials and 34,410,000,000 Rials for scenarios 3 and 4 while IRR for scenarios 1 to 4 is 5.89%, 15.76%, 4.78& and 12.52% respectively. These figures are compared by banking interest rate. So, they are not economically justifiable and it is confirmed in similar studies. The distinguished characteristic of present study from similar ones is its capability to make scenarios and predicting the justifiability of such proposals in the case of increases in CNG prices by considering different aspects of fuelling stations .

Based on conducted analyses, there are three ways to prove the justification of these proposals including sales income, investment cost mitigation and operational cost mitigation. Therefore, several recommendations are provided to realize such guidelines. For the first guideline, determining profitable prices and increases in CNG sales prices as 5% and 8% for scenarios 2 and 4 respectively that are more justifiable, providing services including engine oil exchanges, selling types of goods used in vehicles and paying commission would cause that people receive proper services along with increases in the profits of stations owners. On the other hand, land added – value in Tehran has caused that despite of many facilities by Oil Ministry, constructing refuelling stations is not seen economically justifiable. Therefore, supportive policies by government such as mitigating the prices of lands with servicing functionality and granting facilities to purchase land can mitigate above costs remarkably (since purchasing a land constitutes the major part of investment fees). In addition, free equipment is provided only if the land owned by private sector is located in urban area. The government is recommended to cooperate with private sector concerning membership fees for services (i.e. electricity, water, gas, etc.). To decrease operational costs, such guidelines are recommended: improving the level of safety standards, promoting internal capabilities by creating modern technologies to improve the current performance of CNG refuelling stations in order to mitigate maintenance costs, building a culture to use CNG properly especially in automotive industry, paving the ground for collaboration with active international companies in CNG industry, stimulating private sector investment through tax exempts and other financial incentives and instruments.

ACKNOWLEDGMENTS

None.

ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

APPENDIX:

The most recent situation of constructing equipping and commissioning CNG stations in Iran

Total	Double-purpose	Single-purpose	Item
1191	530	661	The quantity of commissioned equipment to end 2009
452	197	255	The quantity of commissioned equipment in 2010
1642	727	915	The quantity of commissioned equipment so far
9460	2960	6500	The quantity of commissioned equipment nozzles so far
1,674,272	485,950	1,188,322	The quantity of commissioned equipment so far (Nm3/h)
589	131	458	The number of under-construction stations
1820	797	1023	The number of carried equipment

[www.niopdc.ir]

The status of countries in terms of possessing natural gas in the world [CNG Conference]

Percentage of global natural gas	Country
32.3	Russia
15.5	Iran
7.5	Qatar
4	Saudi Arabia
4	UAE
3.2	USA
33.7	Others

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