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Overview on Iran CNG industry status, opportunities and threats

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Background

Brief study on CNG (Compressed Natural Gas) using as fuel in vehicles, demonstrate that Iran has had most growth rate in NGVs (Natural Gas Vehicles) and CNG refueling stations in last decade in the world. In recent two decades, simultaneous with raising Iran economy and industry development, the local car manufacturing industries have had rapid growth in production capacity and raising quantity of country fleet in sequence. So, above mentioned point from one side and low auto-fuels prices in other side, caused considerable increasing rate of auto-fuels consumption and much high amount subsidies payment annually by government which it put government under -pressure in annual budget planning due to huge share of subsidies paid for fuels in transportation sector. Figure 1 shows the gasoline consumption trend in country in last two decades. As it seen the increasing rate is significant, but a slight decrease rate have been seen in 4 last years that refers to dedicating quota on fuel delivery since 2007 and also the lowering / cutting fuel subsidies since last year (2010).

With above mentioned stories and regarding country's massive natural gas reservoirs (Iran has second largest natural gas reservoirs), using of CNG as auto-fuels are considered in legislations and country development plans by parliament and straightly followed by government in last 10 years. At start of project the considerable subsidies paid (and still be paid in some sectors) through related organisations to make infrastructures, CNG refueling stations' constructions, bi-fuel (CNG + petrol) cars production by OEM's, CNG-based engines design in car manufacturers, equipping and conversion gasoline cars to CNG fuel system and supporting CNG equipments localization in public and private sectors and many other effective efforts. Now Iran with 2.66 million NGVs has biggest CNG fleet in the world after Pakistan where achieved this position only in last 10 years duration. In addition, 1821 CNG refueling stations are in service in country which state developed infrastructures.

Aims

In this paper after review on last figures in Iran last CNG situation, the related strategies are followed, investments done, the subsidies paid by government and the incentives regarding CNG using as fuel in transportation are mentioned too. Then the main exist and potentially opportunities reviewed and major threats against NGVs are hinted.

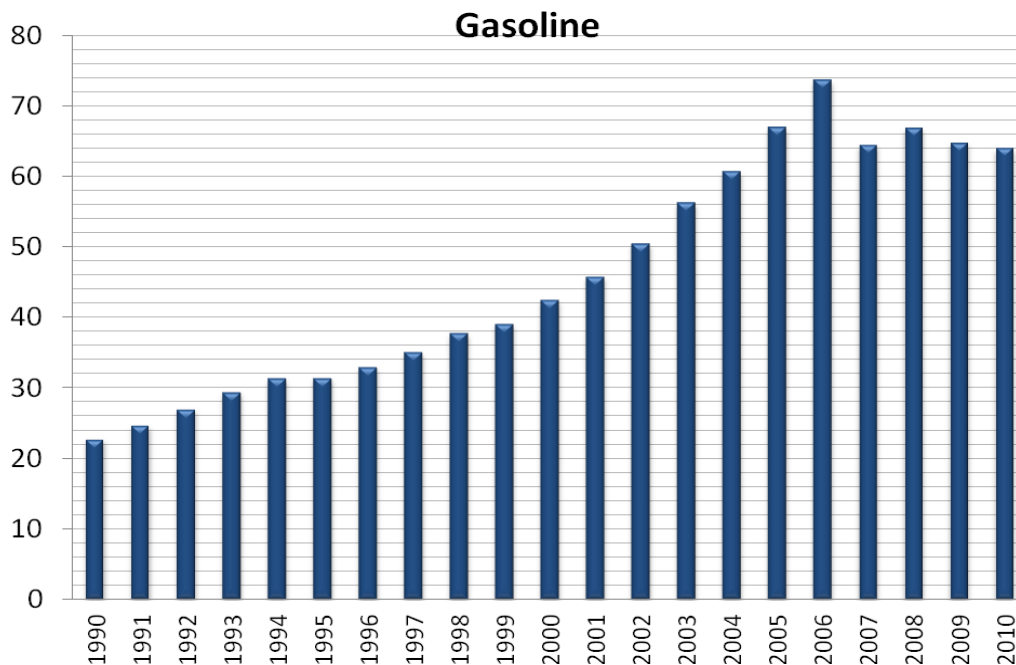


Fig. 1 – Gasoline consumption rate (Million liters / day) in Iran in last two decades (1990-2010)

Country CNG Industry last situation

1- General overview

As a pilot pollutant controlling project, CNG is started by government in 1975 with conversion of 1200 Taxi in Shiraz (biggest city in south-west of Iran) and followed in 1983 with more 1200 cars that equipped to CNG fuel system in Mashhad (Biggest city in north-east of country). There were two CNG refueling stations in each above cities at that time.

The serious attention to NGVs were done after Iran Council Assembly (parliament) related laws issued in 2001 and consequently in the same year cabinet started to plan and execution national scale projects via establishing some governmental companies and defining new missions for other exist related ones to pursue necessary actions for production NGVs in local car manufacturers, conversion public transportations and specially taxis to CNG, making infrastructures and development projects for promotion NGVs in country-wide. The essential reasons for these serious plans are economical, energy security and environmental concern in accordingly. In figure 2 the NGVs numbers from beginning up to now seen that divided in OEM's production and after-sale conversion in workshops. The official statistical shows tot ally more than 2.6 million NGVs (mainly passenger cars and light duty pick -ups that consist 20% of total

country light duty population) are in services, although it expected the figures much higher than mentioned ones because some un-registered conversions in unofficial workshops. In figure 2 the progress in construction of CNG refueling stations are showed in right axis. In past ten years more than 1821 big and medium CNG refueling stations with 1.9 million cubic meters capacity per hour were constructed and 448 stations under-construction. The construction of CNG stations will reach to 2530 station till 2013 according exist plans. In tables are showed in here in below articles, useful information about NGVs and refueling stations and also related investments and subsidies paid by government are seen in details.

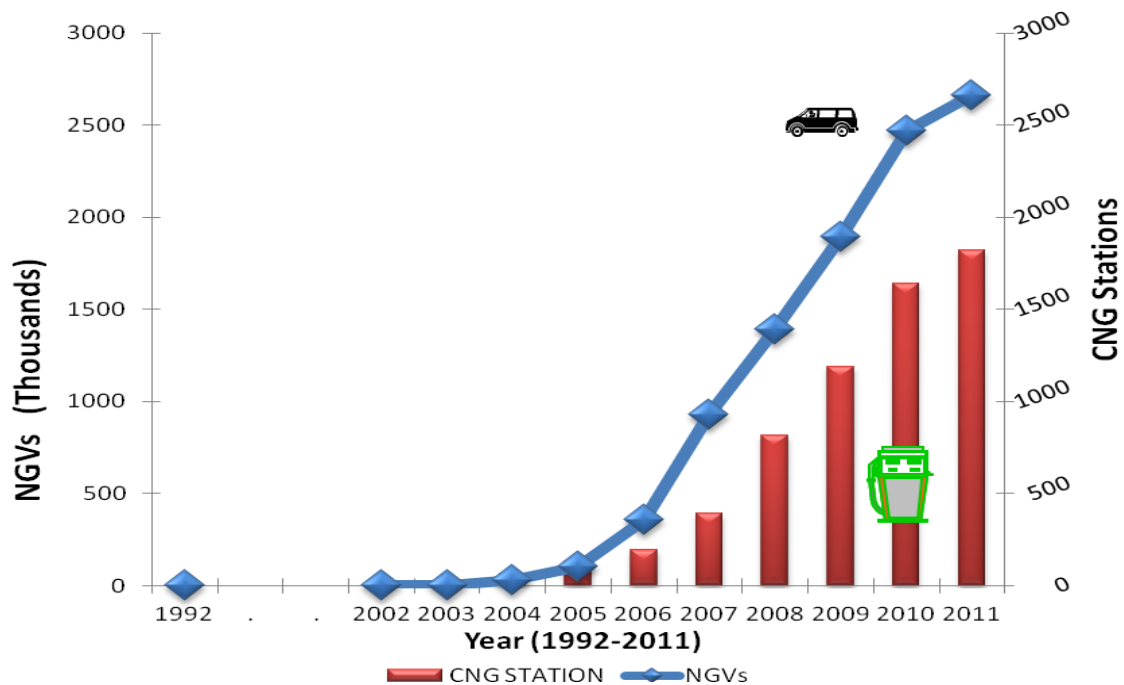


Fig. 2 – NGVs and CNG refueling stations trend in recent decade in Iran

2- NGVs and CNG refueling stations detailed figures

In below tables the main important detailed information including NGVs produced by OEM's and others which converted by workshops as after sale conversion , NGVs annually growth in country and its share in the world, main strategies and policies about NGVs promotion are presented. Also detailed information including CNG stations constructed by governmental companies and private sectors, annually rate growth, main strategies and policies about CNG stations that followed by country are presented. The subsidies and supports have done by government for promotion NGVs and totally investments volume is summarized.

Table 1 – NGVs and refueling stations growth rate during 2004 -2011

Year	NGVs				Refueling Stations			
	By OEM s	Conver- ted	Total year	Annually growth rate	Private	Public	Total Year	Annually growth rate
2004	155	28,111	28,266		0	63	63	
2005	14,979	59,385	74,364	263%	4	64	68	108%
2006	146,035	111,403	257,438	251%	3	58	61	47%
2007	428,343	139,063	567,406	158%	15	187	202	105%
2008	332,261	132,090	464,351	50%	42	382	424	108%
2009	305,433	194,888	500,321	36%	15	357	372	45%
2010	490,927	84,789	575,716	30%	33	418	451	38%
2011	109,845	85,464	195,309	8%	37	143	180	11%
Total 2004- 2011	1,827,978	835,193	2,663,171	9422%	149	1672	1821	2890%
Share in the world								
18.6%					8.8%			

Table 2 – Investments and subsidies
(Costs of stations equipments and kit components installed on NGVs are included)

	NGVs	Refueling stations
Investment (Approximate)	2.4 Billion USD	3.4 Billion USD *
Total Investment (subsidies included)	5.8 Billion USD	
Subsidies paid (Approximate)	600 million USD	700 million USD
Total Subsidies	1.3 Billion USD	

* The Investment figures are include 1821 constructed and 450 under -construction stations



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Table 3 – Main Strategies and policies

Current main policies on NGVs and refueling stations
<ul style="list-style-type: none">- Focus on CNG based designed engines and vehicles in local car manufacturers and decreasing and even stopping the conversion of petrol based engines- Making more necessary incentives for private investors to increasing private sector for construction and operation CNG stations.- Support of local CNG equipments manufacturers via some necessary legislation.- Attention to safety concern especially on quality of imported commodities and required NGVs and stations periodic inspections.

Opportunities

In this part, the opportunities that are exist for developing and sustainable development for NGVs promotion are reviewed briefly in different divisions. There are unique special regarding NGVs and give Iran particular position for using NGVs in contrary to other countries.

1- Natural Gas Reserves

As mentioned Iran has more than 16% of world natural gas reservoirs and with 29.6 trillion cubic meters natural gas resources has biggest reservoirs after Russia. The country almost fully covered by 190 thousands kilometers pipeline networks spread in 872 cities, 10186 villages and 25834 industrial units. More than 95% of cities and 47% villages' population and totally 83% of country population covered by mentioned natural gas pipeline network. Daily averaged country natural gas consumption in 2011 achieved to 445 million cubic meters (162.2 Billion Cubic meter in year) and it's expected rising in future with switching remained major industrial units to natural gas. Also with execution and developing huge South Pars gas fields the Iran become the second gas producer in the world soon.

2- CNG refueling stations in country -wide

With the figures in the above article, construction and developing of CNG refueling stations is more achievable in comparison with countries with out enough gas resources and not developed pipeline networks. So it's not unexpected that in short ten years duration from starting the CNG project in country till now, more than 1820 big and medium CNG refueling stations with 10546 nozzles dispensing and more than 1.9 million cubic meters delivering capacity per hour (17 million cubic meters per day are delivered to NGVs in stations now) constructed and have come to service in all big and small cities that have gas pipelines. It's planned in next 6 months these stations increased to 2269 and almost 2530 stations come to operation till 2013. This capacity can feed more than 3 million NGVs.



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3- OEMs and workshops capabilities for production NGVs or conversion

With strategies that followed in start of CNG project in country (seriously since 2002), car manufacturers (OEMs) supported financially by government (petroleum ministry) and also enforced by making related legislation to contribute the big plans of country to promotion NGVs. In beginning years, the two biggest Iran car manufacturers (Iran Khodro and SAIPA) started to design bi-fuel CNG OEM cars, equipping their production lines, obtaining related standard certificates and finally production of NGVs in 2004 in small quantity. In next years by government pushing and applying new legislations the capacity and infrastructure of NGV production increased and also are done by other existing car manufacturers where in 2007 till now approximately the 25% of production capacity are allocated to NGVs as figures in table 1 shows the major share of OEMs in NGV promotion. Not only the NGVs production now fully developed by OEM's, with considerable supports of petroleum ministry, the design of bi-fuel CNG based engine as first national brand of internal combustion engine are completed with cooperation to leading engine designer in Germany and now are installed on NGVs are produced by local car manufacturers. Since 2004 till now more than 1.8 million bi-fuel CNG OEM cars / light pickups produced by local manufacturers. Since 2008 the share of bi-fuel CNG based cars production increased and expected in next years followed as only option by manufacturers in comparison to bi-fuel gasoline based cars that at present comes out from OEMs.

Another measure that raised by government for control the increasing rate of gasoline consumption is conversion the existing fleets with high fuel consumption especially in public transportation sectors. So by financially support more than 90% costs of CNG kit equipments, storage cylinder and conversion as subsidies, almost 835 thousands cars / light pickups converted to CNG system in 220 certified and qualified workshops in up-country. Of course after applying quota on gasoline in 2007 and lowering / cutting fuels subsidies in 2010 considerable number of drivers have converted their cars in workshops without subsidies and they paid all related costs and therefore these cars identifications are not registered in comprehensive data bank of NGVs that is made by Petroleum Ministry from starting the CNG project. Government does not support this type of conversion due to making congestion and long queue in metropolises CNG refueling stations.

So, the country has necessary infrastructures in both OEMs production line for producing CNG bi-fuel and CNG based cars and conversion existing fleets to CNG systems as well in certified and good experienced workshops.

4- CNG components and equipments localization

According to base policies, transferring know-how and manufacturing and test technology from abroad and consequently production localization for CNG refueling stations equipments and CNG fuel system of NGVs are mentioned from the beginning of CNG project in country via making several Joint Venture partnerships between foreign manufacturer that are active and had long experience in CNG equipments production and local company for establishing line production by cooperation with foreign partner. As result, now major parts of CNG kits that



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installed on natural gas vehicles, are produced inside the country and more than 8 producers are active in this field with approximately 500 thousands kit capacity production annually. Local CNG storage cylinders production line have come to service since 2007 and at present the several local manufacturer s have full ability for production of CNG cylinders and equipped with complete test facilities, totally capacity is higher than 400 thousands pieces in different sizes per year. Also main CNG compressors equipment and whole compressor package now are made inside the country by several local manufacturers.

5- Fuels in transportation and Plans

As historical background in Iran, government has paid significant subsidies for fuels and as result the auto fuel prices in Iran were been more lower in comparison to the world average fuel prices. This situation was one of main causes that were effective for high consumption trend of fuels in transportation. Of course it should not been forgot the aged fleets belong to old generation carburetor fuel systems without any consumption control units and increasing rate of locally car producing in recent years are the main other causes that have effective roles in high rate consumption of fuels in recent decades. Gasoline consumption growth rate in Iran during 1996-2006 was 8.35 % in contrary to 1.75 % averagely in the world.

For managing and improvement the conditions, government enacted quota system on delivering to subsidized gasoline and diesel fuel through smart cards since 2007 and since 2010 simultaneously with governmental subsidies reform law, the major parts of before paid subsidies for fuels were cut by government and therefore the fuel prices dramatically increased, as well as gasoline, diesel fuel and CNG. In the table 4 the fuels prices are shown before and after cutting subsidies. As it was showed the ratio of CNG on gasoline prices before applying subsidies reform Act was 40% and now this ratio raised to 75% and 43% for two present gasoline prices, 4000 IRR (Iran currency) per liter for quota gasoline known as semi-subsidized gasoline and 7000 IRR/ liter for non quota non subsidized gasoline. It's expected in next year the quota semi-subsidized gasoline is cut by government, so motivations for using NGVs will be increased.

Other essential cause that is so impressive in NGVs roles in transportation sector is the decision was enacted by cabinet in last year (2011) regarding the arrangements should be done for keeping the share of different fuels in transportation. According to mentioned approved decision the share of NGVs should be raised and kept on 25% where gasoline and diesel cars share specified as 70% and 5% for hybrid, electrical and other energy systems. According to the mentioned decision all related organisations must do their plans and necessary actions and arrangements to achieve goals of the decision until 2014 and try to keep mentioned share in future. It shows the share of NGVs in country transportation (especially public transportation in cities) is 25% and it is considerable share.

Table 4 – Fuels Prices before and after applying subsidies reform Act in Iran, Dec, 2010

Fuels		Before cut subsidies		After cut subsidies	
		IRR*	Equal in Cents (USD)	IRR	Equal in Cents (USD)
Regular Gasoline (Prices / liter)	quota 60 liters/month/car	1000	9	4000	36
	non quota	4000	36	7000	63
CNG (Prices / m3)	non quota	400	3.6	3000	27
Diesel Fuel (Prices / liter)	quota	165	1.5	1500	14
	non quota			3000	27

* IRR (Iranian Rial) is Iran currency, Each 11000 IRR = 1 USD

6- Environmental view

No doubt, natural gas is one of cleanest fuel that practically could be used in vehicles. In worst situation and without attention to type and generation of engines and CNG systems installed on NGVs, a terrific reduction on main exhaust emission are happened, where at least the 60% reduction on CO (carbon monoxide) ,95% reduction on non methane UHC (unburned hydrocarbons) and aromatic cyclic hydrocarbons (that are one of main factors causing serious diseases and cancers) and 25% reduction on CO₂ (Carbone dioxide) emissions are seen in laboratory tests on NGVs in comparison with the engines consume gasoline.

Iran metropolitans and especially capital Tehran are faced to very dangerous pollutants mainly (near to 70%) due emission of gaso line cars. So production of NGV s and converting the public cars especially taxis to CNG system have had and will have essential effects on reduction capital air hazard pollutants (CO, Non-methane UHC and Particulate Matter). Also the reduction of CO₂ green house gases so considerable (increasing of green houses gas emission became a most environmental challenges of human in current century). A s one simple calculation the 2.6 million NGV s caused at least 4 million tones reduction in green house CO₂ annually in comparison to condition those vehicles with same technical conditions consumed gasoline.



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7- Economical and energy supplying security

Today's figures show daily delivering of 17 million cubic meters of natural gas in CNG stations. It means saving approximately 17 million liters gasoline daily and consequently the saving of 4.6 billion USD which required for importing gasoline from abroad annually (or can be export if exceed from internal consumption) where the gasoline current world average price is 2.8 USD/Gallon.

Another main advantages of using CNG as fuel for transportation is energy supplying security. In other words, using CNG as transportation fuel, makes country needless to importing gasoline or focus on increasing the high octane gasoline production capacities in refineries via doing huge investment or using special technology refining that hardly can be supplied and exclusively patent of giant companies.

Threats

Although there are so many occasions in Iran for promotion of NGVs that in above articles some of main of them are mentioned, but we should not forget at same time there are some important threats if not supposed, it can make serious problems against promotion and sustainable growth of NGVs. In below lines we try to bold some of important ones:

1- Safety

The safety concerns are main threats against for promotion of NGVs in Iran. These concerns rise from 4 essential points:

- Implementing high level safety standards and quality in production process of CNG high pressure cylinders, CNG kit components especially in high pressure part and CNG stations high pressure equipments.

According to exist experiences, all related authorized organization in country have special attention to this case and in both; CNG equipment production sites inside the country and in importing quality control mechanism in entrance customs the safety standards are kept, but despite the third party inspections certificates based on related international and local standards and manufacturers quality control declarations, some non-conformities were seen during these years experiences. While some of those mentioned non-conformities are so important especially when happened in manufacturing of high pressure cylinders that are installed on vehicles or used as storages in CNG refueling stations and any fails in this regard will caused cars / stations explosion and serious damages that will affect the all positive points and advantages of CNG herein above are mentioned and in ultimately will change the view of people and authorized and law-makers. As summary point, the weak quality monitoring of a small part of CNG cylinders imported which produced by non fully qualified manufacturers and some contraband imported ones without any inspection (that caused several incidents during these years) are main safety concerns in this article.



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- Keeping the safety operation instructions in CNG stations .

Not caring to the operation instructions , incomplete training of operators and inattentions to keeping the safety points in CNG stations such as passenger staying in cars during refueling, can hurt operators and who will attend in stations for refueling if any incidents occur due to any safety faults . In Iran it is tried to keeping the safety points in refueling station operations but they are not enough and should be underlined more than now.

- Periodic Inspection .

According to related standards and manufacturer's instructions, the high pressure on -board CNG cylinders and stations storage cylinders must be inspected periodically every 3-5 years and if any non-conformity or serious damages seen the cylinders shall be removed from service. Although the some efforts have been done by authorized organisations to execute the cylinders periodic inspections , however till now it's not happened systematically. So the concerns are serious for a few cylinders probably have had inherent defectives that are not clarified in manufacturing inspections and expected are diagnosed through periodical inspections or damaged ones during using , both for CNG cylinders installed on vehicles and those used as storage in refueling stations.

Regarding the quantities of cylinders (at least 3.5 million cylinders installed on vehicles or used in stations as storages) it's strongly required that responsible governmental or public authorized organisations follow seriously the case and pay attention to periodically inspections. So if the current situation continued without necessary attentions by responsible organisations, cause some incidents that strongly affect the NGVs public interest and country policy makers in future.

- NGVs users awareness .

Most of NGVs incidents in Iran are happened during repairing or applying changes on vehicles CNG systems by unqualified people or NGV users. So it is so important that public awareness increase via media programs or other effective ways to avoid similar incidents happened in future.

2- Refueling Stations operation

The maintenance costs, reliable operation and economy of refueling stations are essential factors for success of CNG industry in a country and satisfying owners of stations and NGV users. The main challenges in current stations operation in Iran that need special attention to them and should be solved including:

- With present natural gas feed price and fee is paid to stations (the stations buy natural gas from government by specified prices and sale with constant specified price, therefore they receive given fee per cubic meter natural gas sold) the operation of stations is not economical for owners. In the other word the net income of stations doesn't make proper encourages against the investment and financial turn over engaged for refueling stations. So there are not enough advantages for private sectors to come to this market and if it happened



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they face to serious problems to paying maintenance and operation costs and directly will affect on reliability of operation accordingly. Therefore it is expected from government increase the margin of stations.

- Ownership of more than 90% of stations and managing responsibility belong to public sectors (municipalities). So inattention or less attention to regular maintenances and on-time overhaul caused using the stations without full capacity or many shut downs in operation that makes long queue behind the stations or even going out of services for days and causing NGV users unsatisfied. This type of operation will increase the maintenance costs too.

- Supplying original spare parts and very quick after sale services is essential factor in stations operation and preventing to going out of services. Some existing problems for supplying the original spare parts for main CNG equipments used in refueling stations especially for those parts provided from abroad and also no reliable and on-time after sale services especially in cities are far from centers, are serious challenges for long term of stations operation.

Results

Many subjects are discussed and numerous figures about NGVs growth rate are mentioned in the paper, but as main results we can highlight on:

- Iran NGVs growth is the highest in the world starting seriously since 2002 till now. Regarding to fully-developed wide natural gas pipeline networks and huge gas reservoirs and recently prepared infrastructures for using CNG as transportation fuel, Iran has strategic and unique conditions and advantages for using NGVs.
- Although the considerable investments have done for NGVs promotion (totally 5.8 billion USD from beginning until now including all related costs and land values), but it has resulted more than 4.6 billion USD annually saving in gasoline consumption and almost 4 million tones reduction annually in CO₂ green house gases and considerable reduction in hazards CO and Non-Methane UHC gases and particulate matters.
- CNG applying have increased fuel supplying security and country dependency reduction to gasoline importing from abroad or huge investments for increasing current gasoline capacity production in the refineries.
 - The trustable infrastructures have been made for using sustainable and reliable CNG using as vehicle fuels but the safety concerns and CNG stations reliable operations are main bottlenecks against NGVs that should be resolved by authorized organisations.



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Summary

In the paper the last situation of Iran NGVs and related infrastructures studied. Iran opportunities for more NGVs promotion are considered and the main shortages and threats against NGVs are mentioned. The important figures and subjects mentioned in the paper summarized as follows:

- Iran has second world gas reservoirs (with 16% share) and 190 thousands kilometers natural gas pipeline networks in upcountry that provide strategic and unique condition for NGVs promotion.
- At present 1821 CNG stations are delivering 17 million cubic meters natural gas per day to more than 2.6 million NGVs (consist 20% of total light duty population) in country. With 450 more under-construction CNG stations and other planned, it's expected the CNG refueling stations raised to 2530 stations till 2013 year.
- According to legislations the NGVs share in country fleets should be raised and kept to 25% of total fleet population. The OEMs bi-fuel (CNG + Gasoline) share is considerable and consist 68% of current NGVs population. Also according to planned strategies, the CNG based NGVs manufactured by OEMs should be focused on future instead the current bi-fuel gasoline based and workshop conversion.
- The amount of investment done for CNG stations construction, NGVs production and conversion the after sale gasoline cars to CNG, establishing or equipping local manufacturers and making related infrastructures (including all related costs and stations land value) exceeds 5.8 billion USD that approximately 1.3 billion USD paid by government as subsidies. Of course CNG using resulted the 4.5 billion USD annually gasoline importing saving.
- Iran has so many occasions to obtain sustainable CNG using in NGVs if the main safety concerns solved and CNG refueling stations operation is responded in reliable manner.

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