THE STATISTICAL ANALYSIS FOR THE THEORETICAL BIO-METHANE MARKET BASED ON THE OPINION OF CAR-OWNERS OF HAJDÚ-BIHAR COUNTY IN HUNGARY

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Abstract: The more expensive fuels and the health-threatening air pollution make even necessary the spread of such a fuel, which serves as a solution to these problems. In our country at present there are three public CNG filling stations, two of them are located in Győr and Szeged and the third one was opened at the end of October in Budapest. The lack of infrastructure obstructs the spread of the methane gas powered cars in Hungary. During my research getting information by means of a test questionnaire I measured the fuel selection of the drivers and their opinion about alternative fuels. Then on the basis of the results I determined the potential target audience of the bio-CNG. As it is also typical in our country, the most of the respondents use gasoline-powered vehicle and drive less than 12 000 km/year on an average. 55% of the respondents would have their car converted in order to refuel cheaper and to protect the environment, consequently there would be demand for CNG. The potential target audience is the urban population below the age of 41 with higher education degree and average salary. One of my future objectives is to design a CNG filling station network in Hajdú-Bihar county considering the demand of car owners.

Key words: biomethane, CNG, potential demand

1. Introduction

Besides more expensive fuel prices and health-threatening air pollution, which are typical today, the spread of such an alternative fuel, that can remedy these problems, becomes more and more important.

Incineration of fossil fuels contributes to the global CO2 emission by 90% (Edgar, 2011). In 2011 global CO2 emission increased by 3%, which was the greatest value ever, since it reached 34 billion tonnes (Jos et. al, 2012). The air quality is polluted to the greatest extent by gasoline with 190 g/km CO2 emission; it is followed by diesel with 160 g/km, while the emission of CNG-powered cars is 120 g/km (Engerer and Horn, 2011).

Natural gas is a fossil fuel formed when layers of buried plants and animals are exposed to intense heat and pressure over thousands of years. The energy that the plants originally obtained from the sun is stored in the form of carbon in natural gas. Natural gas is a nonrenewable resource because it cannot be replenished on a human time frame. Natural gas is found in deep underground rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates. Petroleum is also another resource found in proximity to and with natural gas. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material. Natural gas can be used to fuel almost any kind of vehicle – motorcycles and three wheelers, cars, vans & pickups, lift trucks, buses, trucks, trains, boats, even aircraft. The availability of vehicles or conversion equipment varies greatly from country to country depending on local conditions. (NVG, 2012)

The conventional method of natural gas distribution would require fuel to be transported via pipelines but the compression of natural gas allows CNG to be carried through pressure vessels instead. CNG being one of the two forms of natural gases (the other being Liquefied Natural Gas which is used mostly for heavy duty vehicles and fleet) and is becoming the alternative energy to fuel cars, buses, pick-up trucks and other vehicles. CNG is safe and clean, non-toxic and non-corrosive. It is also tasteless, colorless and odorless. (ANGA, 2010)

The major difference between CNG fueling and conventional liquid fueling of vehicles stems from variances in physical properties between gases and liquids. Conventional fuel retailers, fleet fueling operators, and drivers are accustomed to fueling vehicles with liquid fuels. Natural gas is similarly simple to use, though different from conventional fueling. While liquid fuels such as gasoline or diesel must be transported to stations via over-the-road trucks, CNG is made from natural gas that is typically transported to the station via

an underground pipeline and then compressed. CNG fueling stations can be designed to accommodate any size vehicle and fuel demand. (ANGA, 2010)

Natural gas is a widely used, relatively clean and freely available fuel. According to Darley (2005) it is the second most important energy source following oil. Cars with duel fuel system emit about 10-15% less greenhouse gases (carbon-dioxide, methane) in comparison with gasoline-powered vehicles. Compared to the gasoline-powered vehicles they have 50-60% less nitrogen-oxides emission as well, moreover the quantity of atmospheric sulphur-oxides and carbon deposit is practically zero. The emission of only CNG-fuelled engines is even lower than that (Dudás, 2011). According to Domanovszky statement the easing of traffic regulations could be very helpful in the spread of gas-propelled cars, not to mention the high prices of gasoline and diesel, besides the biogas is much more cleaner and cheaper as a result the CNG could be an alternative solution for the issue.

Worldwide, there were 14.8 million natural gas vehicles by 2011, led by Iran with 2.86 million, Pakistan (2.85 million), Argentina (2.07 million), Brazil (1.70 million), and India (1.10 million). The Asia-Pacific region leads the world with 6.8 million NGVs, followed by Latin America with 4.2 million vehicles. In the Latin American region almost 90% of NGVs have bi-fuel engines, allowing these vehicles to run on either gasoline or CNG. In Pakistan, almost every vehicle converted to (or manufactured for) alternative fuel use typically retains the capability to run on ordinary gasoline. (NGV,2012)

In 2011 altogether 1 014 170 natural gas-powered cars were on record in the Member States of the EU-24, which were served by 2 805 filling stations. As regards the proportion of the Member States Germany (9.4%), Italy (7.6%), Bulgaria (6.0%) and Sweden (4.0%) rise above the others, while Hungary has only 0.03% share. In respect of the number of filling stations the ratio of CNG stations is the following: Germany (32%), Italy (30%), Sweden (6%) and Austria (7%) (Boisen, 2012). CNG can technically be used in any car engine, though ideal applications are vehicles that can do higher than average mileage. Vehicles that only travel low mileage can be used, but it may take longer to recover the cost of conversion or the premium on a new CNG vehicle through fuel cost savings.

There is some kind of shift in consumption from gasoline to diesel. The 2.2 million m^3 CNG use can not be detected in percentages, with this result Hungary is significantly behind the other member states of the European Union. Today Europe uses 10 billion m^3CNG for propelling vehicles, about five thousand times as much as Hungary. CNG has spread to Europe for several reasons, one reason that the use of it causes significantly less emission, which makes the urban environment more liveable. In addition the 5 decibel lower noise level is also an important positive aspect in case of CNG use. Ou et al found that compressed NG (CNG) and liquefied NG (LNG) fuels can save about 10% of carbon as compared to gasoline vehicles.

When Pakistan first started promoting compressed natural gas to the nation's motorists in the 1990s, the alternative to petrol seemed like a wonder fuel. Getting motorists to convert their cars to run on cleaner, cheaper gas would cure urban pollution and lower demand for the imported oil that was gobbling the country's foreign currency reserves. Car owners loved it and today 80% of all cars in Pakistan run off compressed natural gas (CNG), according to the Natural and Bio Gas Vehicle Association (NGVA), a European lobby group. Only Iran has more gas cars running on the road. (Boone, 2013)

Biogas, from which such huge potentials are available that it could cover one quarter of our traffic's fuel demand, can be made the most suitable renewable propellant. Of course even if there is CNG consumption (Dudás, 2011).

2. Materials and methods

The analysis of the demand for CNG was carried out by primary data collection, which was completed by quantitative method. Getting information by means of questionnaire was the method of my analysis, which was carried out in October 2011. Prior to the actual survey I carried out test questioning in order to form accurate and unambiguous questions and to put the appropriate variations of answers into the final questionnaire.

This survey is based on a test questionnaire in order that the final questionnaire could include appropriate and unambiguous questions and adequate variations of answers. Among the 22 questions of the questionnaire there were closed, open, scaling and segmenting questions. With the help of segmentation questions closed and scaling questions were studied through several segments by significance testing. Cross-table is such a statistical technique, which describes simultaneously two or more variables with such a table, that demonstrates the joint distribution of two or more limited number, categorized variables or variables taking up values (Malhotra, 2002).

With the help of cross-table I analysed the correlation between two nominal, ordinal and categorized metric variables (Sajtos and Mitev, 2007). The questionnaire has several parts, in the first part I ask the fuel consumption habit of the respondent, the following part includes the respondent's opinion about alternative fuels and the third part measures the inclination to convert the vehicle and provides information about how much people could spend money on converting their cars. The last part includes the personal questions, on the basis of which I segmented the answers to the questions. Altogether 110 car owners filled out the questionnaire, from which 104 pieces were appreciable. As regards the number of samples according to the data of KSH (2010) there are 371 cars per 1000 residents on an average in the North Great Plain Region, thus on the basis of number of persons there are 549 785 cars in the region. In view of a national survey in case of 1 million persons 1000 completed questionnaire can be considered representative, so proportionately in the case of this study 55 completed questionnaires could be sufficient at regional level.

The evaluation of the questionnaires was carried out by SPSS 17.0 statistical programme and Microsoft Excel, within which I primarily applied descriptive and mathematical statistics. With descriptive statistical calculations I examined the mean, the standard deviation and the distribution of the answers to the questions.

In the course of high-level statistical procedure I carried out non-parametric statistical calculations (Pearson chi-square test). During the significance analysis p=5% probability level was allowed. In order to complete the significance analysis, the respondents of the questionnaire survey were divided into groups in accordance with different aspects. For this I applied the relevant segmenting questions of the questionnaire – gender, age, educational level, settlement type and income – as a grouping criterion.

3. Results and discussion

3.1. Fuel consumption habits

The 65% of the motorists surveyed use gasoline-powered car, this rate is 13% less than the 2010 real HCSO [1]data. The aforementioned data proves that in our country significant part of those who travel by car use gasoline-powered vehicle, which in my later researches will be important information because of the conversion costs.

Considering the number of annually travelled kilometres, 44% of the drivers travel less than 12 000 km/year, and besides 24% of them go more than 20 000 km/year. This difference can arise from the fact that those who travel over 20 000 km usually use company car, thus they have to drive as a result of their work.

Set out from the actual high fuel prices I asked if people are satisfied with the actual prices or if they are not how much they would pay for fuel. 100% of the respondents are not satisfied with the every day higher prices and they would consider acceptable the 200-250 HUF/liter price. Many people might be wondering why the respondents selected the above-mentioned sum, why not they want to pay 50 HUF for a liter fuel. This is the reason why I classified the fuel prices of the recent years and surprisingly the majority did not choose the cheapest category. It can arise from the fact that people try to think in a realistic way and do not live in a dream world.

3.2. Opinions about alternative fuels

Only 16% of the respondents have already heard about CNG as a fuel, however, only 17% of them have not seen a single environment-friendly car yet.

I did not want to influence the respondents' opinion in any kind of way, thus everybody had the opportunity to say or not to say their opinion. For this reason 54% of the surveyed gave even an indifferent answer to my question. 84% of the respondents have positive, 10% of them have indifferent and 3% of them have negative opinion.

[1]Hungarian Central Statistical Office

Among the positive opinions I read several times the word environmental-friendly and low maintenance cost; while the negative opinions usually reflected that CNG can not spread easily due to the high investment cost, the oil lobby and the lack of knowledge about it. Of course the lack of infrastructure does also not facilitate the choice of the drivers, so this existing situation makes the environmentally conscious and cheap driving more difficult in Hungary.

3.2. Inclination to conversion

On the basis of the *Figure 1*., it can be concluded that the greater part of the surveyed show an inclination toward conversion for refuelling cheaper, while the smaller part of them would not have their cars converted. This is due to the fact that people are irresolute and they have only inconsiderable information about CNG, since 84% of the respondents have not heard about it yet. I examined if the answers received are dependent on the age, gender and educational level of the respondents, but there is no significant connection between either of them.

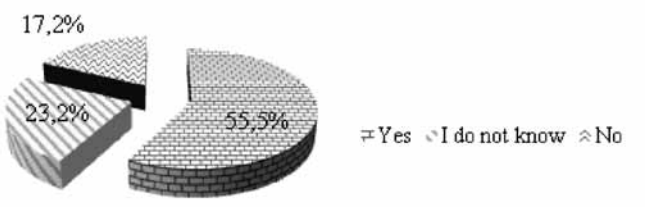

Figure 1: The distribution of conversion
Source: Own survey (2011)

Conversion is influenced by several factors: it depends on the existing knowledge, the infrastructure and the financial condition of the person. Currently the average conversion cost of a gasoline-powered car is 150 thousand HUF. Consequently I made inquiries concerning how much the respondent could and want to spend on conversion.

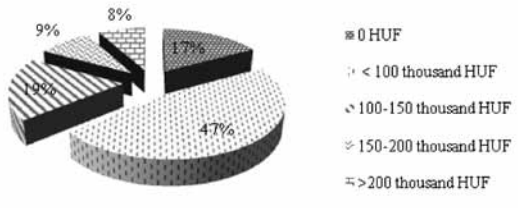

Figure 2: The distribution of the assumed conversion costs
Source: Own survey (2011)

The above-mentioned figure demonstrates the sum respondents would tend to spend on having their cars converted. 47% of them would assign a sum below 100 thousand HUF to this, while 17% of them would not spend money on it at all. On the basis of significance analysis there was no significance result by p=0.687 probability level examined by Pearson chi-square test; therefore the assumption, that people with higher income would spend more money on conversion, can not be proved.

The following figure segments the respondents on the score of educational level regarding the question of conversion.

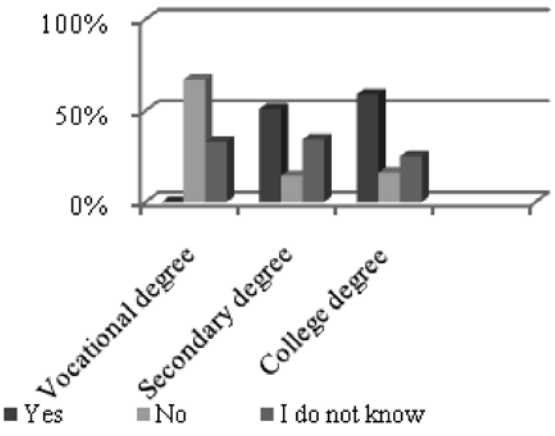

Figure 3: **Distribution of conversion by educational level**
Source: Own survey (2011)

As regards the educational level it can be seen that people with higher educational level present a greater proportion among those who would have their cars converted. It can be due to their broader scope of knowledge in the topic and it is strengthened by the fact that the uncertainty, i.e. the rate of "I do not know" answers, is the smallest in this group.

Considering the age of those who tend to convert their cars the rate of people aged below 41 was the determining, it was almost 90%. This ratio is not surprising, since we can even experience it in our own environment, that the elders insist on their old, accustomed routine and for them it is hard to open up new things whether it is a good one. As regards income categories we can consider that people with higher income have higher inclination to have their cars converted than people in lower-income category. This tendency can not be observed among my respondents. The greatest part of those who tend to conversion (41.7%) earn 100-150 thousand HUF/ month, while only 24% would have their cars converted from those who classified themselves in the high-income category. The reason for this could be that respondents who come under the category of higher salary do not have to spare on money and find alternatives in order to decrease their expenditures even by fuel.

Taking the city structure into consideration citizens are more prepared to have their cars converted than those who live in the country.

Summary

To sum up it can be concluded that on the basis of my questionnaire I found the target audience of biomethane, they are the urban population below the age of 41, with higher education degree and average salary.

My hypothesis, whereas car owners would be ready to have their cars converted into CNG-powered in order to refuel cheaper, was proved.

In my view advertisings and various presentations could help with familiarise people with this alternative fuel so that more people learn about its benefits; in this way demand for CNG could increase. CNG motoring should be available for everyone, the first step in this process is not the construction of a filling station network, but to make people aware of this alternative fuel. At present in the three filling stations people can refuel methane free of excise duty, but the question is what will happen later, when the demand for it increases. There are concerns that the government will not support it, because it does not produce revenue. Exemption from excise duty should be granted for cheaper and environmental-friendly CNGs by state aid, which also could support their spread. CNG is to become widely accepted and the market for fueling infrastructure is to grow beyond these high fuel use fleets, accommodating a variety of vehicle classes and fueling needs, and ultimately connecting fueling infrastructure between cities, counties, regions, and states, retail and truck stop outlets need to be developed in numbers that allow reasonably convenient access to CNG.

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