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# DESIGNING OF COMPETITIVE LOGISTICS NETWORK FOR LIQUEFIED PETROLEUM GAS IN CONDITIONS OF IMPERFECT COMPETITION

## ABSTRACT

The existing network for liquefied gas in the Republic of Croatia is characterized by numerous weaknesses, led by lack of investment into LPG branch that has been going on for years, i. e. outdated equipment and apparatuses, insufficient storage space, outdated vehicles. The existing LPG logistics network has the following drawbacks: LPG market without competition, outdated legislative that imposes restrictions on importers, lack of marketing know-how, insufficient investments funding (...). Since foreign investors have been showing increased interest in entering the Croatian LPG market, it seemed appropriate to investigate and elaborate decisive factors and effects of constructing a new competitive logistics network in conditions of imperfect competition.

## KEY WORDS

liquefied petroleum gas, logistics network, imperfect competition

## 1. INTRODUCTION

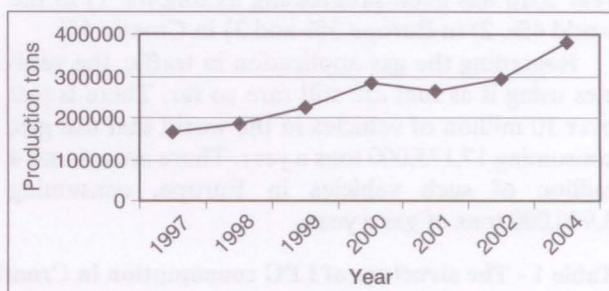
Liquefied petroleum gas (LPG) takes up a small but important place in the world's energetics. More than 500 million people around the world are using it. It is estimated that LPG takes approximately 3% of total world's energy consumption. The demand for LPG is negatively influenced by the supply of natural gas. At the same time, the demand for LPG is positively influenced by two main factors: 1. increase in total energy consumption and 2. substitution of fossil fuels, mainly oil and coal, by liquefied fuels. LPG is being used for cooking in households and restaurants, for heating – and there it competes with natural gas and diesel oil. In the households of underdeveloped countries LPG competes with coal and wood. In industry it can be used instead of natural gas, diesel oil or electricity. As car fuel LPG directly competes with gasoline and diesel oil. In the majority of these sectors

LPG consumption depends on sophisticated supply and distribution infrastructure, as well as prices of alternative fuels.

The existing logistics network for liquefied petroleum gas in the Republic of Croatia is characterised by numerous weaknesses. As foreign investors are showing more interest for entering the Croatian LPG market, a working hypothesis has been set: creation of new logistics LPG network in the Republic of Croatia would significantly increase the quality of delivered LPG and its consumption. As it is, in the Republic of Croatia the LPG consumption per capita is unsatisfactory, far below the European average.

## 2. PRODUCTION AND CONSUMPTION OF LIQUEFIED PETROLEUM GAS IN THE REPUBLIC OF CROATIA

Production of liquefied petroleum gas in the Republic of Croatia shows constant tendency of growth (Graph 1)



Graph 1 - Tendencies of liquefied petroleum gas production in the Republic of Croatia

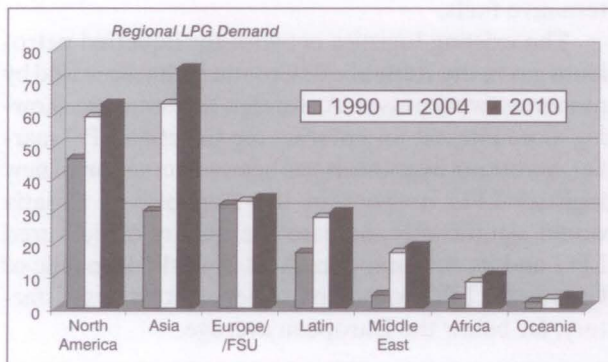
Source: www.ina.hr

INA d. d. produces around 380,000 tons per year, of which two thirds are exported. INA produces liquefied petroleum gas in refineries in Rijeka and Sisak,

while there is an ethylene plant in Ivanić Grad. After the reconstruction of Rijeka and Sisak refineries the LPG production will increase to more than 500,000 tons annually.

Liquefied petroleum gas consumption in the Republic of Croatia will constantly increase, especially the one connected to fuelling the vehicles (cars, lorries, buses). Also, in respect of implementation of gas installations in Dalmatia (as per orders of Croatian Government the works should be completed by the year 2009), LPG consumption should not stagnate, but keep increasing, because the land gas is limited to gas-lines and the existing infrastructure, which will predominantly cover major cities and areas adjacent to gas-line. LPG, however, the consumption will be greater on the islands.

The world LPG consumption at the global level (Graph 2) shows a tendency of growth, especially in North America and Asia (China, India).



Graph 2 - World market for LPG gas

It is estimated that by the year 2010 LPG consumption in Asia will reach one third of the world LPG demand. Europe is characterised by moderate increase in LPG consumption. LPG consumption in Croatia, Europe and in the world is clearly seen from Table 1.

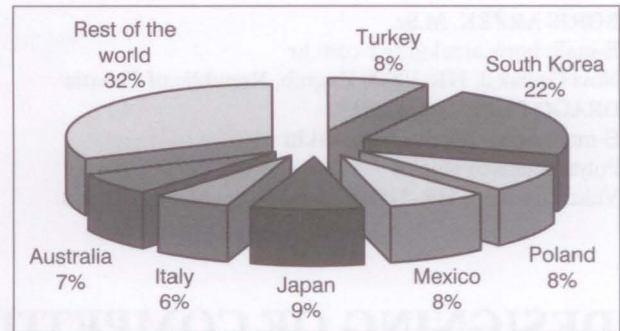
Estimated annual consumption increase until the year 2010 has been progressing as follows: 1) in the world 4%, 2) in Europe 3% and 3) in Croatia 5%.

Regarding the gas application in traffic, the vehicles using it as fuel are still rare so far. There is just over 10 million of vehicles in the world that use gas, consuming 17,175,000 tons a year. There are around 4 million of such vehicles in Europe, consuming 3,976,000 tons of gas a year.

Table 1 - The structure of LPG consumption in Croatia, Europe and the world in 2004

	Total consumption	Households	Chemical industry	Refinery	Autogas	Industry	Agriculture
Croatia	133 thous.t	43 %	-	*9 %	12 %	31 %	5 %
Europe	27 mil.t	36 %	26 %	3 %	15 %	17 %	3 %
World	213 mil.t	50 %	22 %	6 %	8 %	12 %	2 %

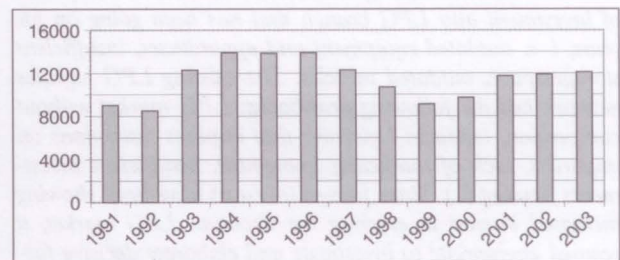
\* Information for Croatia refers to the gashouse Energo Rijeka and Pula



Graph 3 - Global Autogas Consumption

The world consumption of gas in vehicles is concentrated on 7 main markets (Graph 3).

Turkey, Poland and Italy claim two thirds of total European gas consumption. The Republic of Croatia participates with only about 30,000 vehicles powered by gas and some 60 gas filling stations. Annual gas consumption in Croatia is around 13,000 tons (cf. Graph 4).



Graph 4 - Vehicle gas consumption in the Republic of Croatia

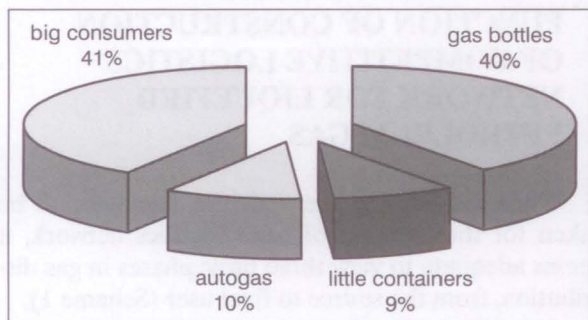
As per data in Graph 4, it is reasonable to expect further increase in consumption of vehicle gas in the Republic of Croatia. Sustaining such claim is also the fact that in 1996 the consumption of gas in the Republic of Croatia was rated fifth. Furthermore, many countries have introduced economic measures to encourage gas consumption up to 10% of the total consumption structure. This indicates the need for increasing the consumption in Croatia up to 130,000 vehicles. The facts supporting gas are: 1) lower emissions of carbon dioxide, up to 30% lower with vehicles using gas compared to those using gasoline, 2) combustion does not produce particles or ash, 3) lower emission of nitrate oxides, 4) sulphur dioxide emission equals zero, 5) favourable price ratio BMB EURO 95 – 42%

prices and 39% of MB 98, 6) drivers save up to 50% on fuel cost, 7) vehicles equipped with gas installation are not required to perform ECO testing during annual technical vehicle examination.

### 3. RELEVANT CHARACTERISTICS OF LIQUEFIED PETROLEUM GAS MARKETS IN CROATIA, EUROPE AND IN THE WORLD

Main competitors are. 1) electricity – universal energy provider, but in some cases too expensive, 2) extra light diesel oil – attractive for its price, but in practice it is fairly limited in use, i. e. central heating and hot water installations, 3) heavy diesel oil – used by large consumers for its favourable price, 4) wood and coal – traditional energy provider, used for heating, favourable pricing, but limited possibility of consumption regulation, dust, waste disposal problem, requires regular chimney, boiler and stove cleaning, 5) natural gas – introduction of natural gas has been stealing the LPG users, and 6) other sources of energy – these have not found a wider area of application, apart from solar energy used in coastal hotel resorts.

LPG sales structure in Croatia is shown in Graph 5.



Graph 5 - LPG sales structure in Croatia

Some estimates speak of a possible 50% share of vehicle gas sales in LPG structure in Croatia during the next 10 years.

When analysing the data on consumption and estimated consumption of liquefied petroleum gas in different countries of south-east Europe (Table 2), taking into account that LPG consumption in Serbia amounts to 150,000 tons, showing the greatest growth tendency among the south-east European countries, it seems appropriate to expect Croatia to become a logistics platform for liquefied petroleum gas supply for the countries in central and south-eastern Europe.

Presently, 27% of total gas consumption passes across international borders. Liquefied natural gas is being delivered from Alaska, Indonesia and Australia to Japan, and from Algiers to Europe. New projects for delivery to the Asian market use natural gas

Table 2 - LPG consumption trends (in 000 t)

	2000	2005	2009
Croatia	110	135	175
Slovenia	71	90	100
B&H	16	30	40
Montenegro	4	6	6

Source: Authors

from Oman and Qatar, from Nigeria – where it is being delivered for the European market, while Trinidad remains the central place for the USA and Spain. By lowering the costs and deregulating the markets new markets are being created, the so-called spot markets for liquefied natural gas. During the year 2000, high prices of natural gas in the USA triggered the import of liquefied gas from Algiers, Australia, Nigeria, Oman and Qatar. Malaysian liquefied gas arrived to the Spanish market. This meant the end of isolationism of national and regional markets, which became dependant on one another. This type of trade is a reaction to regional shortages and excesses, while liquefied gas has become a transmission mechanism.

Liquefied natural gas trade shall continue to expand together with the expansion of new projects, and some of them are already being negotiated in Iran, Yemen, Angola, Venezuela and Bolivia. In this manner, gas has passed over from national to international market, and taking over the global scene is just a matter of time.

Globally, the most important event was the creation of SHL GAS on January 1<sup>st</sup> 2000. The company was created by fusion of the French Company Primagaz, British Calor Group and Brazilian and Asian LNG subsidiaries of the Dutch SHV group. The new company is active in 23 countries and four continents – Europe, Asia, Latin America and North Africa. Its competitive position is especially strong in Europe, where the company holds 16% of the regional market. Its nearest competitor – Shell – holds 12% of European LNG consumption. Polish SHV subsidiary – Gaspol, can attribute much of this success to the Polish control of one of the LNG tanker terminals in the Baltic Sea. One of the examples of fast growing investment into infrastructure is Caltex underground warehouse in subterranean cave in Shantou, situated in the Chinese region of Guangdong. The cave has the capacity of 100,000 tons. The American companies United Gas Industries and Energy Transportation Group have mutually constructed import and warehousing terminals in China and Rumania.

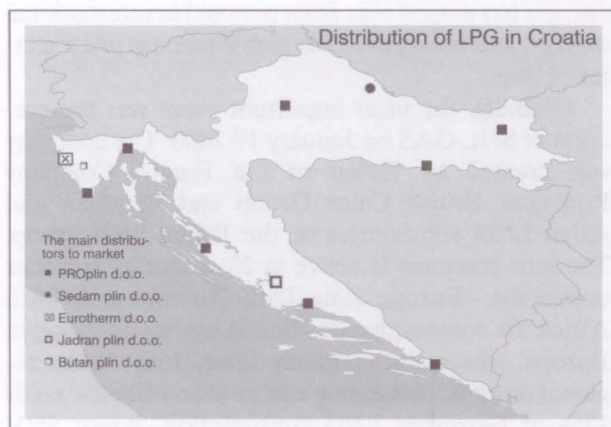
The main characteristics of the European LPG market are shown in the following Table (cf. Table 3).

**Table 3 - Main characteristics of European LNG market**

Market characteristics	Country	LPG powered vehicles
Mature markets	Italy	1,120,000
	the Netherlands	290,150
	Lithuania	170,000
Markets with recent development	France (since 1996)	180,000
	UK (since 1999)	117,000
Growing markets	Poland	1,100,000 +48% between 2002/2004
	Turkey	1,000,000 +19% between 2002/2004

#### 4. THE STRUCTURE OF CROATIAN LPG LOGISTICS NETWORK

When speaking of LPG logistics network in Croatia (map 1), it seems appropriate to say something about PROPLIN Ltd. logistics network, which represents the most developed LPG logistics network in Croatia.



Map 1 - Logistics network for LPG in Croatia

LPG sales in domestic market as well as export have been organised through LPG business centre, which was part of the Refinery processing and wholesales. During the year 2001 changes have been made to extract the LNG distribution in domestic market into a separate company PROPLIN Ltd, 100% owned by INA. Within its business centre there are 8 liquefied gas filling stations and distribution centres used for the distribution throughout Croatia. Alongside domestic points of sales, mainly within distribution centres, liquefied bottled gas or vehicle gas is being sold using INA retail network or other retail networks

(bottled gas). In 2001 a total of 341,000 tons of liquefied gas have been sold, of which 115,000 tons on the domestic market and the remaining 226,000 tons were exported.

In order to perform wholesale and retail LPG commerce in the Republic of Croatia it is necessary to obtain a licence. The following companies have such a licence so far: 1) INA Oil Industry, 2) PROPLIN Ltd, 3) INA - CRO PETROL, 4) EURO THERM Ltd, 5) RADNIK Ltd, 6) SEDAM-PLIN Ltd, 7) BUTAN PLIN Ltd, 8) JADRAN PLIN Ltd, 9) BRALA TRADE Ltd. The retailers do not need to have a licence. It is interesting to notice that some of the existing PROPLIN competitors had initially supplied the Croatian LNG market from abroad. For example, SEDAM imported liquefied gas from Hungary and PB GAS, Pula from Italy. Total LPG import in 1999 amounted to more than a thousand tons, while in 2003 it exceeded seven thousand tons. The existing legislative imposes that every liquefied gas importer must have at least 1000 m<sup>3</sup> of tank space.

LPG distribution network of INA and Proplin competitors is far more modest, as these networks mostly cover only several regions.

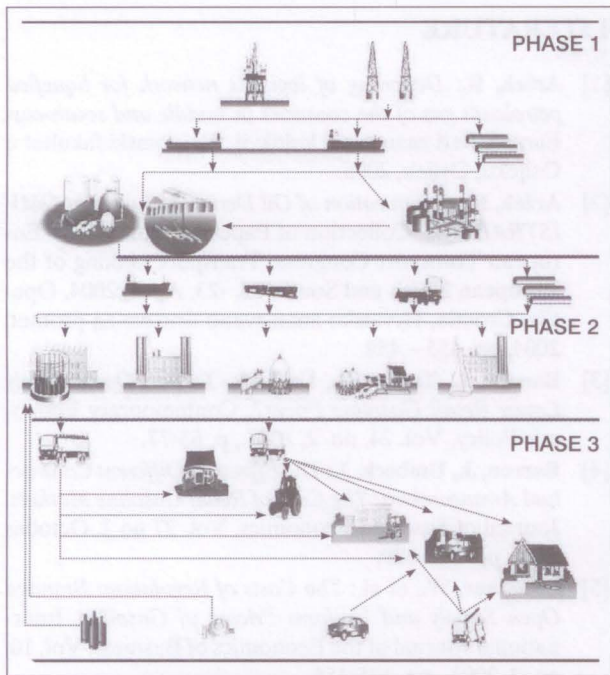
#### 5. SUGGESTED ACTIVITIES IN FUNCTION OF CONSTRUCTION OF COMPETITIVE LOGISTICS NETWORK FOR LIQUEFIED PETROLEUM GAS

When considering the activities that have to be taken for the creation of LPG logistics network, it seems adequate to view three basic phases in gas distribution, from the source to final user (Scheme 1).

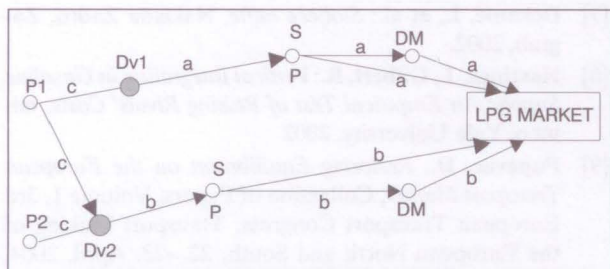
According to the above Scheme 1 it is obvious that in the first phase oil and gas are being transported from the source to the refineries and storage spaces. In the second phase LPG is being transported to the filling stations for bottling, industrial and municipal consumers, while in the third phase LPG is being distributed for other uses: vehicle gas, households, agriculture (...).

Accordingly, in order to create a competitive logistics network for liquefied petroleum gas it seems appropriate to begin with the following scheme (cf. Scheme 2)

In the logistics network P1 represents domestic liquefied petroleum gas producer, P2 represents foreign liquefied petroleum gas producer, while Dv1 denotes domestic LPG wholesale distributor and Dv2 stands for foreign liquefied petroleum gas distributor. S and P stand for liquefied petroleum gas storages and filling stations, respectively. DM denotes retail liquefied petroleum gas distributors, and



Scheme 1 - Basic phases in gas distribution from the source to final user



Scheme 2 - Competitive logistics network for liquefied petroleum gas

$c$  represents cost of contact between LPG producer and wholesale distributor,  $b$  for transport cost for LPG foreign distributor and  $a$  for transport cost of domestic liquefied petroleum gas distributor. The scheme shows that liquefied petroleum gas can be supplied to the market directly from the wholesaler distributor's storage (filling station) or through retail network. The market winner is the logistics chain capable of satisfying the demand at lower prices. Low LPG prices on the Croatian market are the main cause of non-existing competition.

Scheme 2 also shows that developing a competitive network requires construction of warehouses and filling stations. Regarding the logistics network, it is best to have both warehouse and filling station close together. This primarily reduces the cost of construction. As warehouses require purchase of large pieces of land (in respect to regulated distances between buildings), construction of road, loading and unloading facilities, and connecting it with pipelines to storage tanks, the least expense is the construction of bot-

ties filling station. It does not need to occupy more than 200 square meters, and if not automatic (medium capacity 400 – 100 bottles per hour), total cost of construction and mounting does not exceed 200,000 euro. Also, in case the filling station is being built alongside the warehouse, there is virtually no transport cost, nor LPG evaporation while converting from one means to the other. LPG substantially evaporates, i. e. it evaporates more than its competitor extra light diesel oil.

Due to relatively low cost of construction, in the Republic of Croatia there are many more filling stations than storage tanks. Distributors are more willing to invest into one or more filling stations than into building storage tanks or warehouses. They buy LPG from INA or Proplin at wholesale prices, transport it to their small tanks within the filling station and proceed with bottling it, then transport it to final users. Such transport is their advantage over Proplin, because they operate 24 hours including Sundays and holidays. In this manner they supply the customers with small tanks. Accordingly, to distribute liquefied petroleum gas it is necessary to have several small and large tank lorries, and several lorries for bottles distribution. As there are not many private tank lorries in Croatia, tank lorries could be used not only for the distribution to one's own warehouses, but also for the transport to other wholesale buyers. In this way extra profit could be made on transport for others. Besides, it is necessary to secure own bottles and small tanks of 1800, 2700 and 5000 litres. Further manipulation would also require a lorry equipped with a crane.

## 6. CONCLUSION

Thanks to its flammable and other characteristics liquefied petroleum gas (LPG) has become useful and valuable fuel and is widely used in the developed countries. The Republic of Croatia produces more liquefied petroleum gas than its consumption, therefore there is a strong need for the creation of a stable logistics network for liquefied petroleum gas, which could prove as the main factor for increasing export to countries of central and south-eastern Europe. Liquefied petroleum gas market in Croatia can be labelled as one with imperfect competition. Market competition in liquefied petroleum gas distribution should be attributed to the increase in quality, price reduction and increase of consumption of LPG on the Croatian market, but also the markets of countries in central and south-eastern Europe. Thus, logistics expenditure has become the main factor of differentiation in sectors previously dominated by monopolist competition.

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## SAŽETAK

### IZGRADNJA KONKURENTSKE LOGISTIČKE MREŽE ZA UKAPLJENI NAFTNI PLIN U UVJETIMA NEPOTPUNE KONKURENCIJE

Postojeću logističku mrežu za ukapljeni naftni plin u Republici Hrvatskoj odlikuju brojne slabosti od kojih se izdvaja višegodišnje neulaganje u UNP djelatnost, odnosno stara oprema i uređaji, nedovoljan spremnički prostor, zastarjeli vozni park. Nadalje, kao slabosti logističke mreže za UNP mogu se izdvojiti: tržište za UNP je gotovo bez konkurencije, zastarjela zakonska regulativa koja se ogleda u postavljenim ograničenjima uvoznicima, nedostatak marketinških znanja, nedostatna sredstava za investicije (...). Kako strani ulagači pokazuju sve veći interes za ulazak na tržište UNP Republike Hrvatske, čini se primjerenim istražiti i elaborirati opredjeljujuće čimbenike i učinke izgradnje nove konkurentske logističke mreže u uvjetima nepotpune konkurencije.

## KLJUČNE RIJEČI

ukapljeni naftni plin, logistička mreža, nepotpuna konkurencija

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