

The European Union's Tacis TRACECA programme
for Armenia, Azerbaijan, Bulgaria, Georgia, Kazakhstan, Kyrgyz Republic, Moldova,
Romania, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan

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Regulation on the Transport of Dangerous Goods along the TRACECA Corridor

Azerbaijan, Georgia, Kazakhstan, Turkmenistan and
Ukraine

Working Paper 1 MARKET ANALYSIS REPORT



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UMCO and Hoyer Gaslog



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1 Introduction

1.1 The TRACECA programme

In May 1993 the European Commission organised a conference in Brussels with the newly independent states of Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan¹. From this conference the TRACECA (Transport Corridor Europe Caucasus Central Asia) programme was created as a component of the Tacis Interstate Programme of the EU. The main objectives are:

- To stimulate co-operation among the participating states in all matters pertaining to the development and improvement of trade and transport within the region.
- To promote the Central Asian - Trans-Caucasian - Europe transport corridor.
- To identify problems and deficiencies in the regional trade and transport systems and promote solutions.
- To launch a Technical Assistance Programme to be financed by the EU.

On 7-8 September 1998, delegations of 32 countries and 13 international organisations gathered in Baku (Azerbaijan) for the International TRACECA Conference. During this conference the Multi-Lateral Agreement on International Transport in the transport corridor Europe-Caucasus-Central Asia (MLA') and four supplementary technical documents on customs, road, maritime and rail transport were signed. The objectives of the MLA and its Technical Annexes are as follows:

- Assisting in the development of economic relations, trade and transport communications in Europe, black Sea region and Asia
- Ensuring access to the world market of road, rail transport and commercial navigation
- Ensuring traffic security, cargo safety and environmental protection
- Harmonisation of transport policy and legal structure in the field of transport
- Creation of equal conditions of competition for transport operations

In the framework of the technical Assistance Programme and the Multi-lateral Agreement a number of projects have been set up, including this project aimed at improving the transport of dangerous goods along the TRACECA corridor.

1.2 Regulation on the transport of dangerous goods along the TRACECA corridor

In the framework of the TRACECA programme the project "Regulation on the transport of dangerous goods along the TRACECA corridor" was initiated.

This project on the transport of dangerous goods (mainly LPG) along the TRACECA Corridor fits very well in the Strategy of the Intergovernmental Commission (IGC) TRACECA for development of the TRACECA Corridor for the period up to 2015, as presented at the 5th Annual Meeting of the IGC TRACECA, Sofia, May 2006.

In the past by-products for oil and gas production in producing countries Kazakhstan and Turkmenistan were mostly flared. To transform them into LPG was not done on a large scale as transport of LPG was economically not viable due to high transport costs (too far away potential markets). However, set against the background of rising oil prices, the market of LPG becomes more and more attractive to develop. This project specifically looks whether transport of LPG via the TRACECA corridor could become feasible, especially in comparison with other corridors. This will be done within the broader scope of transport of dangerous goods as far as this concerns safety, regulation, environmental and institutional issues.

¹ Recently also Turkey has joined the TRACECA initiative



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This report is focused on the market analysis of demand and supply of LPG in regions relevant for the TRACECA Corridor. For a full understanding of the matter however, first the main findings during the inception phase and the overall project setup will be briefly summarized.

1.3 Findings during the inception phase

After discussions with stakeholders and carefully studying of available documents and reports, the consultant concluded that for this project three LPG production areas are of main importance:

1. Kazakhstan, LPG to be exported from Aktau
2. Turkmenistan, LPG to be exported from Turkmenbashi
3. Azerbaijan, LPG to be exported from Baku.

Other production areas in Kazakhstan are expected to face too much competition from mainly the Chinese consumption market to make transport via TRACECA corridor economically justifiable. Likewise, Turkmenistan is likely to find significant export markets in south-eastern directions.

Major potential consumption areas for the above mentioned 3 production areas are therefore (in order of importance), Turkey, Ukraine to some extent, Eastern Balkans (Bulgaria, Romania), Greece, and to a lesser extent Central Europe.

Other critical assumptions are:

1. LPG will be mainly transported by rail and maritime transport modes as this is at present the common way to transport LPG. Whereas LPG can also be transported by pipeline, the project will keep this option open, depending on early, significant transport volumes and moderate costs of a dedicated pipeline – both required for economic justification of a very large up-front investment.
2. Production in other countries than Kazakhstan, Turkmenistan and Azerbaijan will be neglected as this will mainly purpose local consumption.
3. Whereas Turkey in recent years is a growing consumer market for LPG and closest to the TRACECA corridor, this country will be a potentially important destination of LPG from the three production countries. In addition the Eastern Balkans and Central Europe are also included as consumer markets of LPG.
4. Major source for production and consumption figures will be the Statistical Review of Global LP Gas 2005 of the World LP Gas Association, in combination with figures given by the industry and other stakeholders in the LPG market.
5. In case estimated production figures will see a strong growth in the coming years, the option of an LPG pipeline will become more important to include in our scope of study.
6. The project expects to see prices for major energy sources as oil and natural gas to continue to rise, thereby making LPG an interesting additional source of energy.

Base and project cases corridors

Based on the assumptions above, the project will focus its attention to the following LPG transport corridors as described in the table 1.1 below. Distinction is made between a base case corridor (present LPG transport against a certain figure in EUR/USD and the TRACECA project corridors.

From Kazakhstan we propose to evaluate the TRACECA corridor against the existing rail connection from Aktau via Russian and Ukrainian railways (Odessa) towards Turkey and the Eastern Balkans.

From Turkmenistan we propose to evaluate the TRACECA corridor against the maritime and rail connection from Turkmenbashi via Iran towards Turkey, Eastern Balkans. and the possible extension via Odessa towards Central Europe

From Azerbaijan we propose to evaluate the TRACECA corridor against the existing rail connection from Baku towards Turkey, Eastern Balkans and the possible extension via Odessa towards Central Europe.



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Table 1.1 *Base case corridors and project case corridors from LPG production countries to LPG consumption countries*

Production	Corridor	Consumption
Kazakhstan	Base case: Aktau rail-Russian rail-Black Sea Project case: Aktau Caspian-TRACECA rail-Black Sea	Turkey Eastern Balkans
Turkmenistan	Base case: Turkmenbashi Caspian-Iran rail-Turkey Project case: Turkmenbashi Caspian-TRACECA rail-Black Sea	Turkey Eastern Balkans Central Europe via Ukraine (Ilyichevsk)
Azerbaijan	Base case = Project case: Baku-TRACECA rail-Black Sea Modernisation of existing corridor	Turkey Eastern Balkans Central Europe via Ukraine (Ilyichevsk)

1.4 Project set-up and Work Packages

The following six Working Papers (WP) will be produced:

- WP 1 Market Analysis Report (Task 1A)
- WP 2 Transport Forecast Report (Task 1B)
- WP 3 Transport Facilities Appraisal Report (Task 2A)
- WP 4 Safety Conditions Report (Task 2B)
- WP 5 Legal and Institutional Framework report (Task 3)
- WP 6 Economic Appraisal Report (Task 2C)

WP 1 and 2 are planned to be presented and discussed in Istanbul, Turkey, combined with a short study tour, which makes it possible to have discussions with stakeholders from Turkey as described in the Terms of Reference.

1.5 Work package 1 Market Analysis report

This report contains Work Package 1, the market analysis. The objective of the market analysis is to get an insight in world demand and supply of LPG in order to be able to estimate if there is a potential market for LPG transported via the TRACECA corridor. Furthermore, the market analysis focuses on



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regional production and regional demand for LPG in order to get an insight in the potential volumes that could be transported via the TRACECA corridor. Such an analysis is also necessary in order to be able to present different transport scenario's with varying transport routes and transport modes. The preliminary results of the market analysis have been discussed with main stakeholders from the TRACECA region, including Turkish stakeholders, during a seminar organised in Istanbul on November 1 and 2, 2006.



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2 General appraisal and information about LPG qualities

2.1 Definition and characteristics of LPG

Liquefied petroleum gas (also called liquefied petroleum gas, liquid petroleum gas, LPG, LP Gas, or auto gas) is a mixture of hydrocarbon gases. They liquefy at moderate pressures, readily vaporizing upon release of pressure.

Varieties of LPG bought and sold include mixes that are primarily propane, mixes that are primarily butane, and mixes including both propane and butane, depending on the season—in winter more propane, in summer more butane. Propylene and butylenes are usually also present in small concentration. A powerful odorant, ethanethiol, is added so that leaks can be detected easily.

At normal temperatures and pressures, LPG will evaporate. Because of this, LPG is supplied in pressurized steel bottles, tanks, containers, vessels, pipelines. In order to allow for thermal expansion they are filled to between 80% and 85% of their capacity. The ratio between the volumes of the vaporised gas and the liquefied gas varies depending on composition, pressure and temperature, but is typically around 250:1. The pressure at which LPG becomes liquid, called its vapour pressure, likewise varies depending on composition and temperature; for example, it is approximately 220 kilopascals (2.2 bar) for pure butane at 20 °C, and approximately 2.2 megapascals (22 bar) for pure propane at 55 °C. Propane gas is heavier than air, and thus will flow along floors and tend to settle in low spots, such as basements. This should be kept in mind to avoid accidental ignition or suffocation hazards.

While butane and propane are different chemical compounds, their properties are similar enough to be useful in mixtures. Butane and Propane are both saturated hydrocarbons. They do not react with other. Butane is less volatile and boils at 0.6 deg C. Propane is more volatile and boils at - 42 deg C. Both products are liquids at atmospheric pressure when cooled to temperatures lower than their boiling points. Vaporization is rapid at temperatures above the boiling points. The calorific (heat) values of both are almost equal. Both are thus mixed together to attain the vapour pressure that is required by the end user and depending on the ambient conditions. If the ambient temperature is very low propane is preferred to achieve higher vapour pressure at the given temperature.

Main characteristics of LPG are as follows:

- It is colourless and cannot be seen
- It is odourless. Hence LPG is odorized by adding an odorant prior to supply to the user
- It is slightly heavier than air and hence if there is a leak it flows to lower lying areas.
- In liquid form, its density is half that of water and hence it floats initially before it is vaporized.
- It is non-toxic but can cause asphyxiation in very high concentrations in air.



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Table 2.1 *Properties of LPG*

Property	Units	Commercial Propane	Commercial Butane	Mixture 50% each
Specific gravity of Liquid at 15 deg C (Water=1)		0.504	0.582	0.543
Specific gravity of Vapor at 15 deg C (Air=1)		1.5	2.01	1.75
Vapor pressure at 38 deg C	Kg/sq.cm	13.8	2.6	8.0
Boiling point at atm pressure	Deg C	- 42	9	+ 9 to – 42
Ignition temperature in air	Deg C	495-605	480-535	480-605
Latent Heat of Vaporization	Btu/lb	184	167	175

2.2 Application and advantages of LPG

LPG is increasingly replacing chlorofluorocarbons as an aerosol propellant and a refrigerant to reduce damage to the ozone layer. The clean burning properties and portability of LPG provide a substitute for traditional fuels such as wood, coal, and other organic matter. This provides a solution to de-forestation and the reduction of particulate matter in the atmosphere (haze), caused by burning the traditional fuels. LPG is used as a fuel for domestic (cooking), industrial, horticultural, agricultural, heating and drying processes. It is further used as an automotive fuel or as a propellant for aerosols, in addition to other specialist applications. LPG can also be used to provide lighting through the use of pressure lanterns.

The main advantages of LPG are as follows:

- Because of its relatively fewer components, it is easy to achieve the correct fuel to air mix ratio that allows the complete combustion of the product. This gives LPG its clean burning characteristics.
- Both Propane and Butane are easily liquefied and stored in pressure containers. These properties make the fuel highly portable, and hence, can be easily transported in cylinders or tanks to end-users.
- LPG is a good substitute for petrol in spark ignition engines. Its clean burning properties, in a properly tuned engine, give reduced exhaust emissions, extended lubricant and spark plug life.

Table 2.2 *LPG compared to petrol and diesel*

<i>Compared to petrol</i>	<i>Compared to diesel</i>
- 75 % less carbon monoxide	- 60% less carbon monoxide
- 40% less oxides of nitrogen	- 90% less oxides of nitrogen
- 87% less ozone forming potential	- 70% less ozone forming potential
- 85% less hydro carbons	- 90% less particulates
- 10% less carbon dioxide	



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2.3 Formation and production

LPG comes from two sources. It can be obtained from the refining of crude oil. Simple refining in a crude distillation tower will yield about two percent LPG. When produced this way it is generally in pressurized form. LPG is also extracted from natural gas or crude oil streams coming from underground reservoirs. It is formed naturally in oil and gas fields and is pumped out from the wells mixed in with other fuels, typically about 0,2 to 0,4 percent of the produced crude oil but much higher proportion is possible. At the oil and gas facilities, butane and propane gases are separated from the heavier fuel and stored in purpose-built storages. About 60% of LPG in the world today is produced this way whereas about 40% of LPG is extracted from refining of crude oil.

The characteristics made LPG a late developer in the hydrocarbon business. The first commercial production had to wait until the 1920's, the first international trade until the 1950's. Seaborne trade in LPG was less than 1 million tons in 1960, reached 17 million tons by 1980, and was in excess of 47 million tons by the year 2000.

2.4 Differences between LPG, LNG and CNG

Liquid petroleum gas (LPG, and sometimes called propane) is often confused with LNG and vice versa. They are not the same and the differences are significant. LPG has a higher calorific value (94 MJ/m³) than natural gas/methane (38 MJ/m³), which means that LPG can not simply be substituted for natural gas.

Liquefied natural gas or LNG is natural gas consisting primarily of methane (CH₄, typically, at least 90%), the shortest and lightest hydrocarbon molecule but it may also contain ethane, propane and heavier hydrocarbons. It has been processed to remove impurities and heavy hydrocarbons and then condensed into a liquid at atmospheric pressure by cooling it to approximately -163 degrees Celsius. LNG is transported by specially designed vessels and stored in specially designed tanks. LNG is about 1/600th the volume of natural gas at standard temperature and pressure (STP), making it much more cost-efficient to transport over long distances where pipelines do not exist. LNG is odourless, colourless, non-corrosive, and non-toxic. When vaporized it burns only in concentrations of 5% to 15% when mixed with air. Neither LNG, nor its vapour, can explode in an unconfined environment.

Compressed natural gas (CNG) is natural gas pressurized and stored in welded bottle-like tanks at pressures up to 3,600 psig. Typically, it has the same composition as the local "pipeline" gas, with some of the water removed. CNG and LNG are both delivered to engines as low pressure vapour (ounces to 300 psig). CNG is often misrepresented as the only form of natural gas that can be used as vehicle fuel. LNG can be used to make CNG. This process requires much less capital intensive equipment and less operating and maintenance costs.

2.5 LPG quality requirements

The quality of LPG produced is an important aspect in the determination of export potential. In the EU and in other importing countries governments have strict criteria regarding the quality of LPG that one is allowed to import.

Requirements in the EU for LPG Parameters are determined inter alia by regulations as follows :



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Table 2.3 *EU quality requirements for LPG*

Description	Requirement
Propane (min.)	85 vol%
Propene (max.)	10.0 vol%
Pentenenes +heavier (max.)	0.5 vol%
Butene (max.)	2.0 max%
Vapor Pressure (max.)	208 psig
Volatility Residue: (max.) - Evap. Temp, 95% - Butanes	-37oF, or 5.0 vol%
Residual Matter: - Residue on evap. of 100 ml on oil stain	0.05 ml
Sulfur (max.)	80 ppmw

As another example for strict quality requirements we may look at the Turkish import market :
Desired mix of propane/butane is around 70%/30%
No blending operations are allowed in Turkey

Producing TRACECA countries should therefore undertake to match such specifications, which cannot always be met because of poor equipments at the production sides. Adhering or not to such quality requirements may open or close various interesting markets for LPG.



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3 World demand and supply of LPG

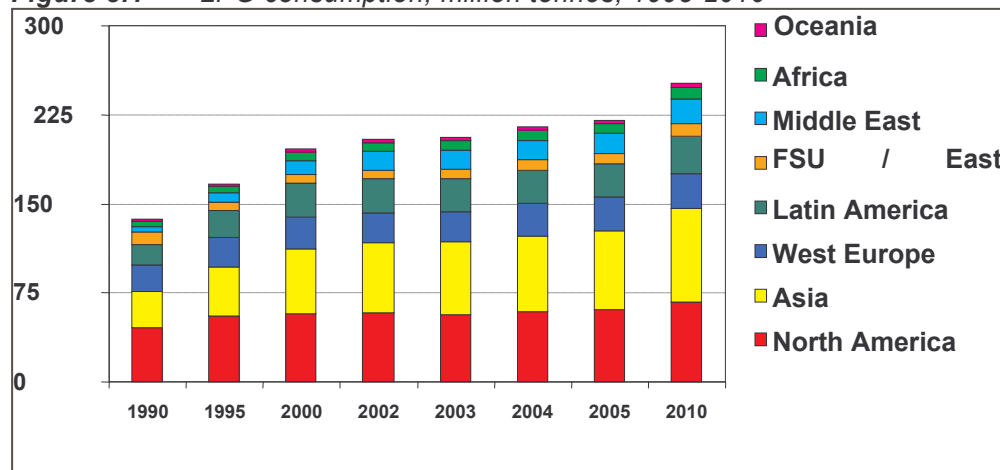
3.1 Introduction

In order to assess the feasibility of transporting LPG via the TRACECA corridor to markets like Turkey, The Balkans and the EU an analysis of demand and supply of LPG relevant for the region is necessary. In this chapter the demand and supply of LPG will be analysed, starting with world demand and supply and then focusing on the relevant consumer regions for LPG from the TRACECA region.

3.2 World demand of LPG

The world consumption of LPG was 212 million tonnes in 2004, an increase of 2.4% compared to the previous year. The next figure shows the consumption per region in millions of tonnes for the period 1990 to 2005 and a forecast of world consumption for 2010.

Figure 3.1 LPG consumption, million tonnes, 1995-2010



Source: Purvin & Gertz

The figure shows that the world demand for LPG is projected to continue to increase, driven by strong growth in Asia. Asian LPG consumption should reach a third of world demand by 2010.

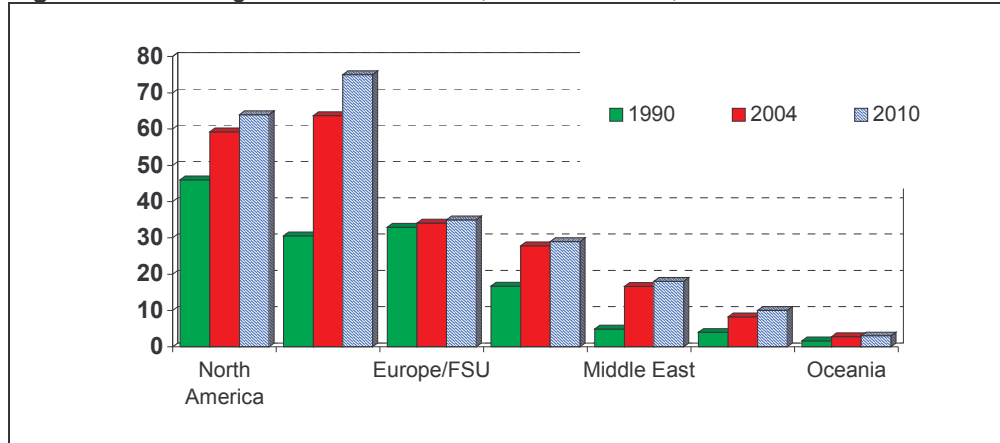
The following figure shows LPG demand per region, in million tonnes for the years 1990, 2004 and 2010.



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Figure 3.2 *Regional LPG demand, million tonnes, 1990/2004/2010*



Source: Purvin & Gertz

According to Purvin & Gertz the following issues will drive global LPG demand in the coming years:

- Crude oil markets
- Very high prices and price volatility
- Unstable market conditions
- Ongoing concern about potential Middle East crude oil supply disruptions
- No end in sight to the unstable situation in Iraq
- Iran nuclear industry standoff has intensified
- Reduced LPG demand growth in developing countries due to high LPG prices
- Global LPG supplies are building
- Shifts in LPG supply/demand balances East of the Suez are impacting global LPG markets
- Record North American natural gas prices in 2005

Other factors influencing world demand for LPG are:

- Economic growth (GDP), particularly personal income growth
- Population growth
- Access to / investment in LPG infrastructure
- Environmental policies
- Suitable regulatory framework with enforcement of good practices



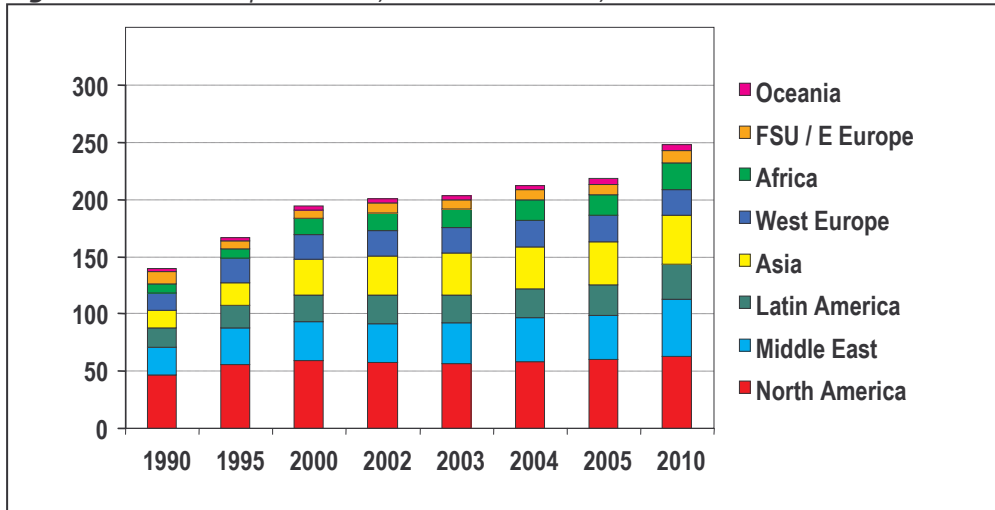
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3.3 World supply of LPG

The world supply of LPG was around 210 million tonnes in 2004, an increase of around 2.1 % compared to the previous year. The next figure shows the supply per region in millions of tonnes for the period 1990 to 2005 and a forecast of world supply for 2010.

Figure 3.3 *LPG production, million of tonnes, 1990-2010*

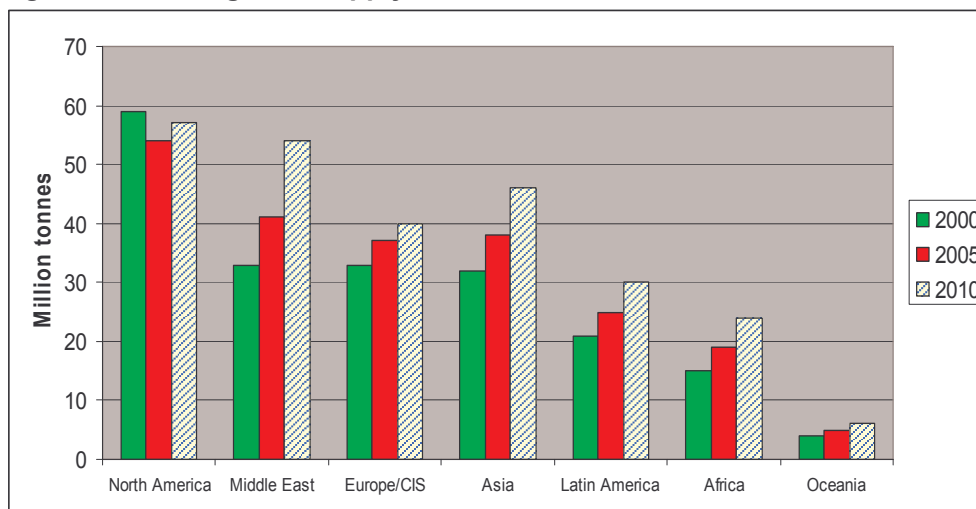


Source: Purvin & Gertz

In the period 2000-2005 LPG production increased with 2.1% per year, while in the period from 2006 till 2010 LPG production is expected to grow with 3.3% per year.

The following figure shows LPG supply per region, in million tonnes for the years 1990, 2005 and 2010.

Figure 3.4 *Regional supply, million tonnes, 2000/2005/2010*



Source: Purvin & Gertz



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Figure 3.4 shows that supply is increasing in all regions, but especially in the Middle East and Asia. This is supported by a statement of a general manager of the liquefied petroleum gas consulting at Poten & Partners commenting on LPG production and demand. "The potential growth in LPG volumes out of the Middle East is very large". "Qatar has indicated it will have 10 million tons per year to market by the end of this decade". "Saudi Arabia, Iran and Abu Dhabi are increasing production potential".

Another interesting figure related to world supply and demand, is that the total LPG export increased in the period 2000-2005 with 3.4% per year, and it is expected that total export will increase in the period 2005-2010 with 3.6% per year.

Table 3.1 *Top Ten LPG Producers in 2004*

	Countries	Million Tonnes
1	USA	45.0
2	Saudi Arabia	19.8
3	China	12.6
4	Canada	10.7
5	Algeria	9.4
6	India	7.9
7	Mexico	7.3
8	Russia	6.6
9	UK	5.9
10	Abu Dhabi	5.6

3.4 Conclusions

World demand and world supply of LPG are currently around 210 million tonnes per year. Expectations are that in the year 2010 demand and supply will have increased to around 250 million tonnes, with a strong accent on growing demand in Asia and a strong growth of production in especially Asia and in the Middle East.

The analysis shows that world trends in supply and demand of LPG seem not to hinder the potential transport of LPG from Kazakhstan, Turkmenistan and Azerbaijan to consumer markets in the West, though the increasing demand in the East could generate interesting consumer markets for this LPG flow. For instance, it could be more profitable to export Turkmen LPG via Iran to the East, or at least use swap transactions whereby Turkmen LPG is imported into Iran and Iranian LPG is exported (see also chapter 5).



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4 LPG production from TRACECA countries

As a general remark please note that (by-) gas from crude oil production can be used as follows:

- Flaring
- LPG production
- Re-injection into the crude fields to increase borehole pressure for improved/cheaper extraction of crude oil

Flaring is getting more and more prohibited due to environmental (and economical) reasons. Therefore crude producers have to choose between the other two alternatives. The decision making process if LPG is produced or the Gas is re-injected considers various technical factors – last but not least economics play the key role.

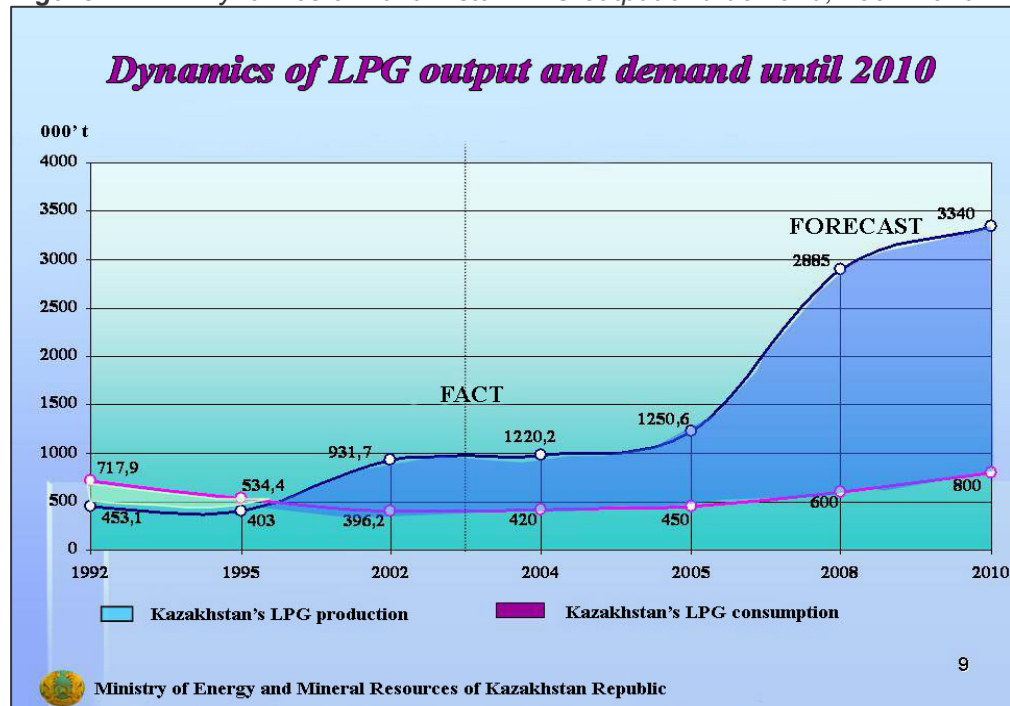
For this project the most relevant LPG producing countries in the TRACECA region are Kazakhstan, Turkmenistan and Azerbaijan. Production from the Ukraine is currently not considered because :

- LPG is mainly used for inland consumption
- Production levels depend on the production levels of the refineries

4.1 Kazakhstan

The following figure shows the LPG production and consumption of Kazakhstan for the period 1992-2010.

Figure 4.1 Dynamics of Kazakhstan LPG output and demand, 1992-2010



Source: Ministry of Energy and Mineral resources, Kazakhstan



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The figure shows that in 2005 production reached 1,250,600 tonnes while it is expected that output will grow in the year 2010 to 3,340,000 tonnes per year. Domestic consumption is expected to increase from around 450,000 tonnes in 2005 to around 800,000 tonnes in the year 2010.

LPG is produced by three refineries, located in Pavlodar, Chimkent and Atyrau.

Production of LPG at these refineries increases by around 20% annually.

LPG is also produced at three gas processing plants: Tengiz GPP (Atyrau region), Kazakhstan GPP (Janaozen city) and Zhanazhol GPP (Aktyubinsk city). The three plants produced 941,680 tonnes of LPG in 2005, compared to 947,500 tonnes in 2004.

Total LPG output by all the refineries stood at 1,250,600 in 2005 which is 2.4% more as compared to 2004. Production of LPG by oil and gas processing plants increases by around 10% annually.

Kazakhstan's domestic consumption of LPG totaled 430,400 tonnes over 2005, while the rest (820,200 tonnes) was exported. In summary:

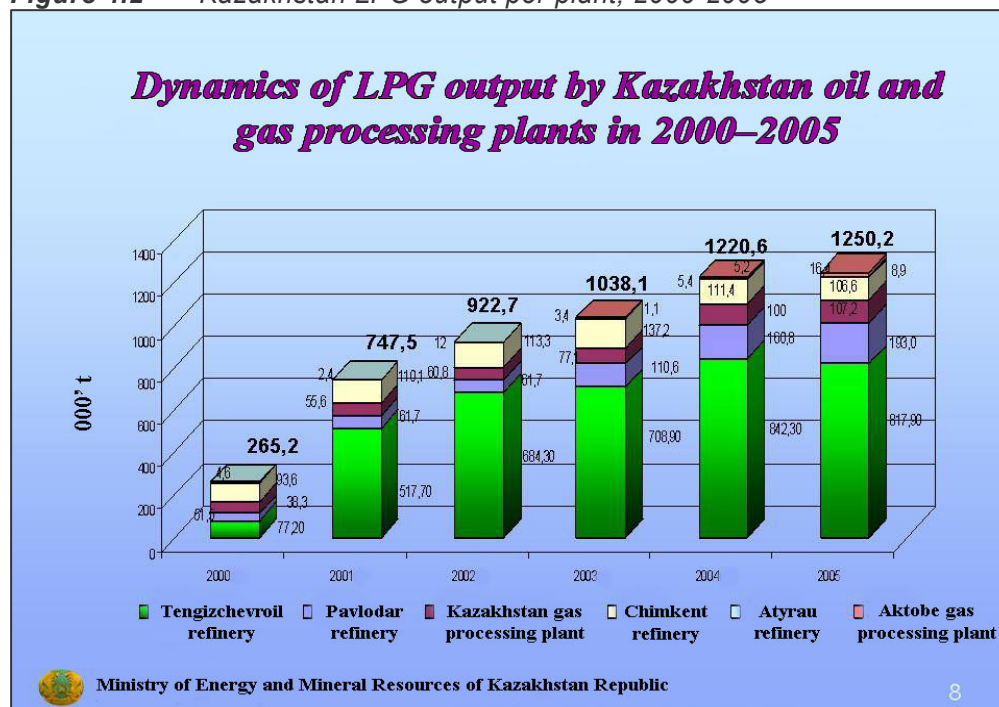
Table 4.1 *Kazakhstan: Production and domestic consumption of LPG, in tonnes, 2005-2010*

	2005	2010
Total production	1,250,600	3,340,000
Domestic consumption	430,400	800,000
Export (potential)	820,200	2,540,000

Source: Ministry of Energy and Mineral Resources of the Kazakhstan Republic

The following figure shows production information of LPG per field.

Figure 4.2 *Kazakhstan LPG output per plant, 2000-2005*





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Figure 3.6 shows that the Tengizchevroil field is the most important for LPG production. As stated earlier this field will be considered as a main export source for the transport of LPG via TRACECA corridors. Tengizchevroil starts up a new refinery in 2007, which is to boost production to 120,000t/month. State programmes on associated gas utilisation will encourage further expansion of LPG production capacity. Construction of Kashagan GPP is to be completed in 2008-2010. These initiatives explain the rather high estimate of production levels in 2010 of almost 3.5 million tonnes.

The main policy objectives of the Kazakhstan gas sector are the following:

- Modernisation and restructuring of existing LPG production facilities
- Use of low capacity module units for gas liquation at small production fields
- Modernisation of LPG transportation infrastructure for steady shipments of big product volumes across the country and to sea ports
- Development of infrastructure for use of LPG as motor fuel
- Modernisation of LPG infrastructure in big cities where the product is traditionally used
- To preserve various rail transportation routes
- Cooperation with other CIS countries having access to the sea on construction and mutual use of LPG terminals (Baltic region, Black Sea, Far East) for product transportation to consumer markets.

4.2 Azerbaijan

The Azeri production potential can be assessed via the production estimates of crude oil and gas. The following table gives an overview of current production volumes and estimates for the year 2010.

Table 4.2 Azeri production figures for crude oil and gas

Product	Current production per year	Estimates 2010
Crude oil	25 million tonnes	50-60 million tonnes
Gas	0.18 trillion cubic feet	0.7 trillion cubic feet

The above figures do theoretically allow a LPG production of up to 2 Mio. tons per year (2-4 % from crude oil production). However since the bulk of the crude oil production is coming from off shore fields and due to :

- prevailing more difficult technical circumstances for LPG storage and transport from off shore fields;
 - probably still some more relaxed environmental conditions – thus flaring/re-injection still takes place;
 - a general 'low interest' of the crude oil producers in LPG production as a side product;
- the Azeri LPG production is running at very low levels and there are no current plans for increase. LPG is exported in very small quantities and to Georgia only. Indications are that current production is around 200,000 tonnes per year.

4.3 Turkmenistan

LPG is mainly produced by the Turkmenbashi Complex of Oil Refineries and by an industrial complex in Nayip. The total combined production capacity of these plants exceeds 470,000 tonnes of LPG per year. Following the installation of a new catalytic cracker and reformer, the capacity of the Turkmenbashi refineries for producing commercial liquefied gases has grown from 16,000 tonnes to 365,000 tonnes per year. Of these, 95,000 tonnes are used for polypropylene production, so the yield of commercial liquefied gases is 270,000 tonnes per year.

Total LPG production in Turkmenistan rose by 10% in 2005 as compared to 2004 to 396,000 tonnes.



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Turkmenistan plans to increase its LPG production to 620,000 tonnes by 2010 and to 2 million tonnes by 2020². In order to achieve these objectives, up to 20 midsize LPG plants will be built. Their production capacity should range between 50,000 tonnes and 70,000 tonnes of LPG per annum.

According to plans, the plants will be built in the fields of Western Turkmenistan where associated gas has not been commercialized yet, as well as in Eastern Turkmenistan where natural gas is produced with a high content of propane-butane fractions. Mini-plants will also be built at the fields with insignificant gas reserves.

Besides consumer markets in the West, Iran is also considered as an important export market for LPG from Turkmenistan. In chapter 5 on the regional demand for LPG some attention to the possible Iranian market will be given.

4.4 Conclusions

The supply side of the LPG market in Kazakhstan, Turkmenistan and Azerbaijan, is potentially abundant given the envisaged oil and gas production programmes and plans, and considering expected, more strict enforcement of environmental (non-flaring) legislation. The next table gives a summary of potential production:

Table 4.3 *Current and potential LPG production in the TRACECA region*

	2005	2010
Kazakhstan	1,250,600	3,340,000
Turkmenistan	396,000	620,000
Azerbaijan	200,000	2,000,000

Actual implementation of supply and export will be determined largely by the 'door-to-door' transport cost to reach the LPG consumer markets on the West side of the Black Sea (East) coast. Crossing two seas and the intermediate land implies a time-consuming and costly transport chain in comparison with e.g. direct delivery by rail, albeit over very large distances.

Main conclusion is that the LPG market relevant for this study is not likely to be 'supply-constrained', but 'transport-cost constrained'.

² According to Mr Arthur Minsov, chairman of the board of "Maktren-Nafta" (port of Temryuk) Turkmenistan should reach production levels of 2 million tonnes already in 2010.



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5 Regional demand for LPG

5.1 Introduction

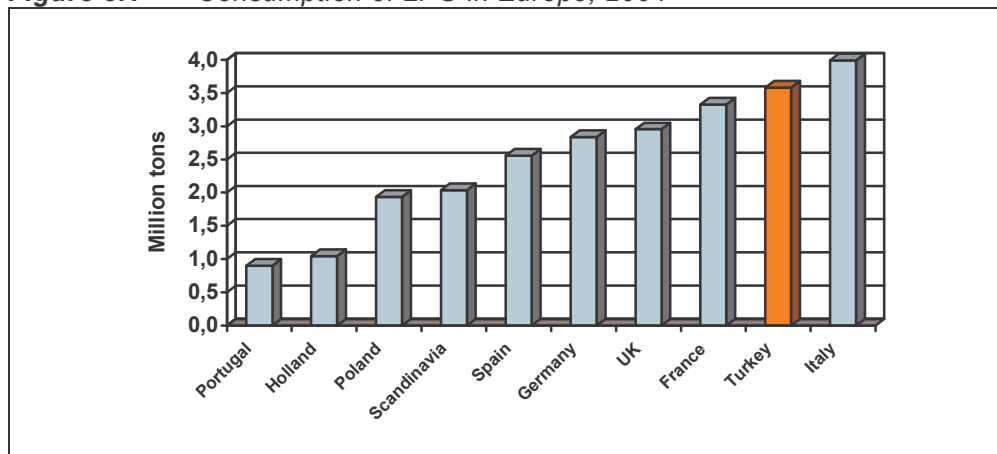
In this chapter the demand and supply situation of a number of potential interesting markets for LPG from the TRACECA region will be described. Special attention will be given to Turkey because Turkey is in principle an interesting market for LPG via the TRACECA corridors because of its relatively high use of LPG and its geographical position.

5.2 The Turkish LPG market

5.2.1 Introduction

Turkey is the fifth consumption market for LPG in the world and after Italy the second largest market for LPG in Europe. The next figure shows the demand for LPG in Europe in 2004.

Figure 5.1 Consumption of LPG in Europe, 2004



Source: Aygaz (main LPG distributor in Turkey)

The Turkish LPG market has the following characteristics:

- First filling plant started operation in 1961
- Now LPG used in 13 million households, 1,5 million vehicles and 81 cities
- All LPG segments are present : Cylinder, Bulk, Autogas
- 55 distribution companies, 15,000 cylinder dealers, 4500 autogaz stations, 50,000 vehicles on LPG, 450,000 employees, 66 brands
- 2, 12, 24, 45 kg steel cylinders
- Only one refinery company
- Changing market:



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Table 5.1 Breakdown Turkish LPG market bulk, cylinder, autogas, 1999-2005

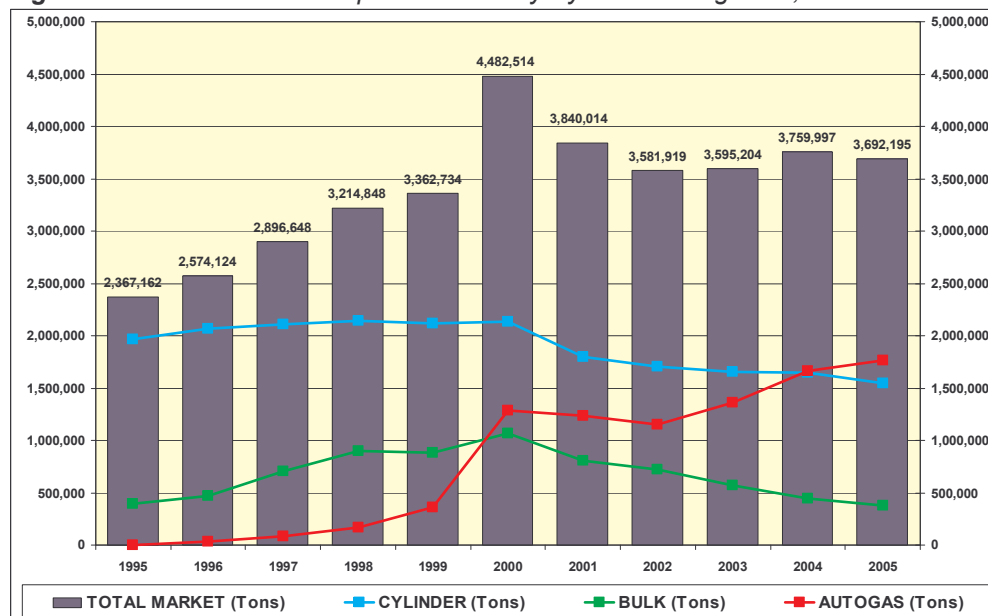
Type	1999	2005
Cylinder	62%	42%
Bulk	27%	10%
Autogas	11%	48%

- Total turnover : 5,2 billion €
- Total tax : 2,2 billion €
- Filling plants : 138
- Filling capacity : 16.200 t/day i.e. 4,2 mln t/year
- Storage capacity : 285.000 t
- Sea terminals : 11 in 6 locations
- Tanker trucks : 1.600
- Cylinder production : 16 companies
- Tank production : 11 companies
- Supply : Tupras and 9 LPG distributors

5.2.2 Demand of LPG in Turkey

The following figure shows the LPG consumption in Turkey per market segment for the period 1995-2005.

Figure 5.2 LPG consumption in Turkey by market segment, 1995-2005



Source: Aygaz

The figure clearly shows the changing market in Turkey. The market for cylinders was the most important until 2004. The declining market share can be contributed to the expanding network for natural gas.



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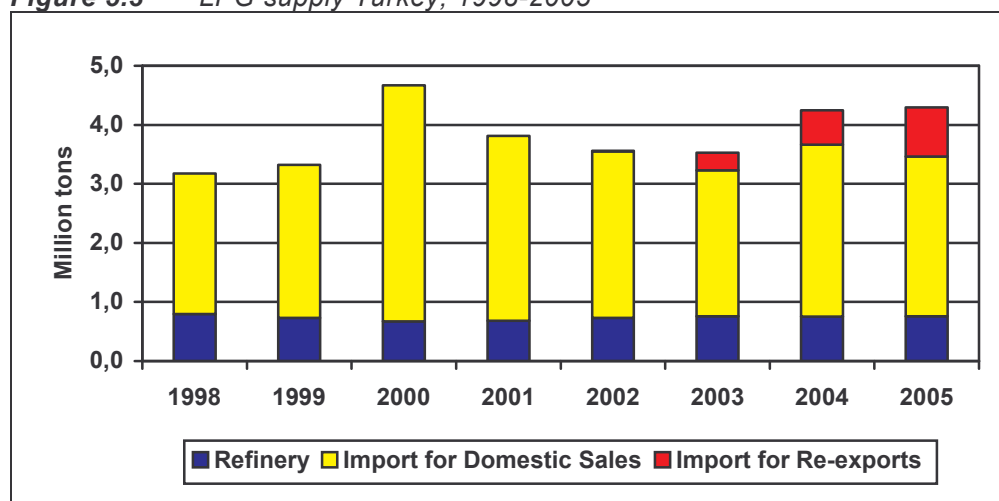
The increase of consumption of autogas is strongly related to government policy, favouring the use of autogas since the year 2000.

During the project interviews have been conducted with main stakeholders in the Turkish LPG markets. These stakeholders all expressed the opinion that the total Turkish market for LPG is declining slowly.

5.2.3 LPG supply

The following figure shows an overview of total supply of LPG. The figure shows that only a small part of LPG is produced locally (refinery), while the largest part is imported. Small quantities were imported for re-export to the Balkans (RO & BG) and Iraq, but stakeholders expressed the view that this re-export has already stopped in 2006 because of payment problems..

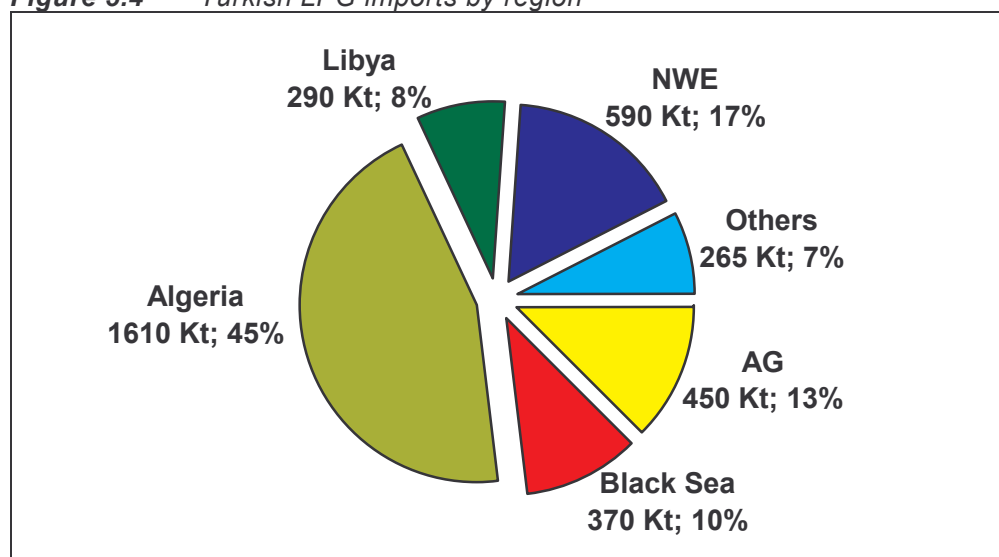
Figure 5.3 *LPG supply Turkey, 1998-2005*



Source: Aygaz

The next figure shows from which countries the LPG consumed in Turkey is imported.

Figure 5.4 *Turkish LPG imports by region*



Source: Aygaz, NB. AG=Arabian Gulf



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The figure shows that 45% of consumed LPG is imported from Algeria. The second place is for LPG imported from North Western Europe (Norway). In total 370,000 tonnes (10% of total consumption) are imported via the Black Sea.

According to Aygaz, Turkish main distributor of LPG, Turkey has a diversification strategy regarding LPG imports. **In principle, or in principle** LPG imported from Algeria, Libya and North Western Europe is attractive because it can be shipped in very large vessels (see also table 5.2). However, Turkey doesn't want to become too dependent on just a few sources, and therefore also imports LPG from other regions.

Regarding Turkey's import infrastructure the following information is available:

- 7 importers (including Tüpraş refinery)
- 6 ports
- 11 terminals
- Terminal storage capacities up to 32 Kt
- Only Tüpraş has pipeline connection to all distributors

All imports are transported over sea to Turkish ports and terminals. The following table gives an overview of the vessel sizes used to accommodate the imports.

Table 5.2 Turkish LPG imports by vessel size

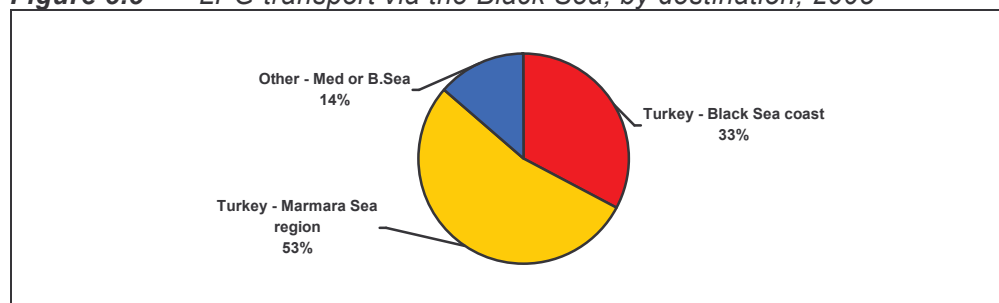
Vessel size	Volume	%	Deliveries	%
VLGC	1,610,000	45	41	14
LGC	1,060,000	30	34	11
8-20 Kt	315,000	9	26	9
Small	590,000	17	198	66
Total	3,575,000	100	299	100

Source: Aygaz

The table shows that almost half of the total import is carried by VLGC's (very large gas container ships), and in total 75% by VLGC's and LGC's. This part of the import is related to Algeria, Libya and North-West Europe.

Figure 5.4 showed that 370,000 tonnes of LPG or 10% of the total Turkish LPG import comes via the Black Sea. The following figures give some detail about this LPG flow.

Figure 5.5 LPG transport via the Black Sea, by destination, 2005



Source: Aygaz



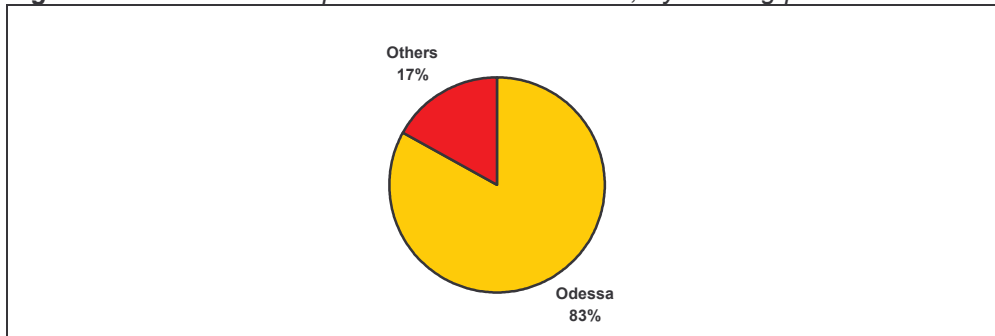
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Figure 5.5 shows that 86% of the LPG transported on the Black Sea has Turkey as its destination. The larger part goes to the Istanbul region (the Marmara Sea), while 33% goes to the Black Sea coast, mainly the port of Samsun.

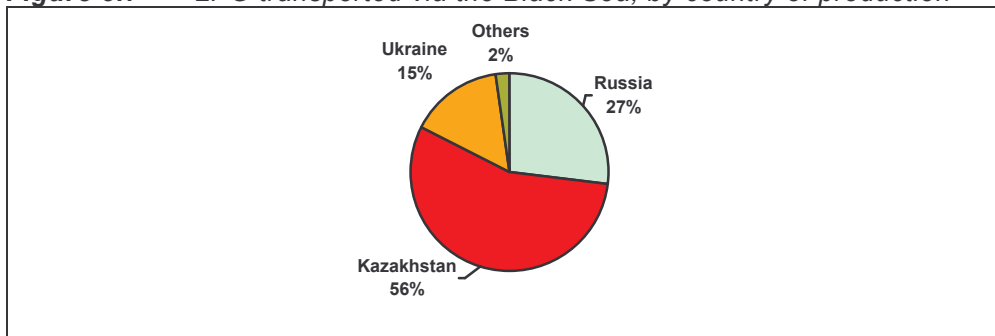
Figure 5.6 shows the largest part (83) of the LPG transported via the Black Sea is loaded in Odessa³. The combination of the two figures make clear that LPG transport on the Black Sea is mainly related to LPG transport from Odessa to Turkey.

Figure 5.6 *LPG transported via the Black Sea, by loading port*



Source: Aygaz

Figure 5.7 *LPG transported via the Black Sea, by country of production*



Source: Aygaz

Figure 5.7 finally shows that 56% of the LPG transported via the Black Sea was produced in Kazakhstan and 27% in Russia.

The conclusion is that currently some 370,000 tonnes or 10% of the imported LPG by Turkey comes mainly from Kazakhstan and/or Russia, is transported by Russian rail to Odessa, and via Odessa shipped to the Marmara Sea area and the port of Samsun in Turkey.

5.2.4 Conclusions on Turkey

The main conclusions about the potential of Turkey as a market for LPG produced in Kazakhstan, Turkmenistan and Azerbaijan, and transported via the TRACECA corridor are:

- Though Turkey, with a total consumption of 3,692,195 tonnes of LPG of which 3,575,000 tonnes is imported, is the second largest LPG market in Europe after Italy and has seen impressive growth figures the last five years, the expectations are that the Turkish LPG market will be declining. This is mainly related to the expansion of the natural gas network.

³ Interesting is that Russia is building a LPG facility at Temryuk Sea port, located on the Taman coast of the Azov Sea, part of the Krasnodar region. This plant aims to facilitate Russian and Central Asian LPG to be exported to consumer markets in the West by shipping connections via the Black Sea.



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- Because Turkey has a diversification strategy regarding the import of LPG aiming not to become too dependent on just a few sources, there still is a potential market for LPG from Kazakhstan, Turkmenistan and Azerbaijan. In the current situation about 10% of the total import comes to Turkey via Odessa by small to medium vessels.
- On the basis of an analysis of the current situation and on the basis of expert's opinions of main stakeholders the potential market for LPG transported via the TRACECA corridor can be estimated at around 0.6 to 1 million tonnes per year. According to stakeholders even 1 million tonnes per year would be rather optimistic. Also, it is expected that for instance Algeria would lower its price in such a case.

5.3 Ukraine

Ukraine is at this point of time only considered as a possible transit corridor. The consultant believes that in principle around 0.2 – 1.0 million tonnes could be transported via the TRACECA corridor and transiting Ukraine to other western markets.

5.4 The Eastern Balkans

Lukoil Bulgaria is the main (and almost only) LPG player with about 40 % coming from own production, mainly from the Lukoil refinery in Varna. Very recently the company Burmarket sold 2 Gas terminals to Lukoil and also 2 gas carriers are in their possession. It seems that the overall strategy of this major oil company Lukoil is to enlarge themselves very strongly in the Black Sea Area. Bulgaria imports 35-40 % of the total demand. The current total market consumption is 2-2,5 Mio. tons p.a. The market figures are predicted to be stagnating or declining whereby the consumption areas are autogas and households.

5.5 Iran

Although Iran itself is a net exporter of LPG, there is significant demand for LPG imported from the Former Soviet Union. LPG from Turkmenistan, Uzbekistan and Kazakhstan is being exported to Iran, and each year the quantities have been growing steadily, and Iran functions as a transit country to the Middle East, Caucasus and Central Asia. Iran has an extensive rail infrastructure and common border with Turkmenistan. There is rising demand from Armenia, Afghanistan and Iraq. Butane International handles the import of 420,000 tonnes per year of Turkmen LPG, of which 250,000 tonnes is for export.

Kazak LPG from the Tengiz fields could be destined to Iran, but unfortunately until this date this has not happened. The primary reason has been due to American involvement in Tengiz and the political pressure from the USA to bar any transactions with Iran. When LPG shipping in the Caspian Sea starts, it would be very attractive to ship Tengiz LPG from Aktau, Kazakhstan to Neka, Iran. Hopefully, with the easing of political tensions between the USA and Iran, the LPG trade from Tengiz toward Iran will flourish.

Turkmen LPG comes from Turkmenbashi (former Krasnovodsk), shipped to the import terminal in Mashhad. From Mashhad LPG is transported by rail to Bandar Abbas, Iran's largest commercial port in the Mid East Gulf. Company Butane has had contracts with Turkmenistan since 2003 for the import of over 120,000 tonnes per year, for export. Iran consumes 2 million tonnes, while production is at 3,5-4 million tonnes per year. This will strongly increase as South Pars offshore fields come on stream. However the Iranian market has the following speciality :

- The northern areas are heavily populated and industrialized
- Crude oil production is effected in the south
- Both parts are 'divided' by highly mountainous areas



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Altogether Iran is heavily interested to import all kinds of crude oils/oil products and LPG from the Caspian Sea. LPG exports to Iran may have three primary uses: direct consumption, swapped for LPG in the south of Iran, and transit through Iran to other countries.

Direct consumption is currently not a feasible option, because the Iranian price policy holds LPG for domestic consumption at USD 5/ton, which is much lower than prices of import LPG.

Iranian LPG producers which are obliged by law to supply the domestic market are in a position to “swap” the LPG being imported from the FSU for LPG produced in the south of Iran. Today, there are effectively two Iranian entities which are in a position to carry out this swap operation: (1) the National Petrochemical Companies (NPC) and (2) the National Iranian Oil Refining and Distribution Company (NIORDC).

The transit of LPG through Iran to neighboring countries and the Persian Gulf is a viable option/ Eastern Turkey is an interesting market which could be served from the FSU. However, at the present time, Turkey has a serious problem with product specifications and it is difficult for Turkey to accept the product available today. Markets such as Afghanistan, Armenia and Pakistan are also being supplied via Iran.

Transit of LPG from the FSU to the Persian Gulf was carried out in 2004 via Bandar Mahshahr (near Bandar Imam Khomeini) on numerous occasions. However, with the rising demand in Iraq, all of the LPG available was diverted to that market. In the future, Iran foresees the possibility of exporting to the Persian Gulf via Bandar Abbas. A direct rail link from Sarakhs to Bandar Abbas has been established and this makes the transportation of LPG to the Persian Gulf very attractive.

In general, the demand for LPG in small pressurized shipments in the Indian Ocean is rising. At the same time, the LPG production in Turkmenistan, Uzbekistan, Kazakhstan and Russia is also rising. Much of this product can be made available at the port of Bandar Abbas for supplying the growing markets in the Indian Ocean.

Since it is expected that shipping in the Caspian Sea will start soon between Neka (Iran) and Turkmenbashi⁴, the economics of trading Kazakh and Russian LPG into Iran will change favorably. Therefore it is expected that Iran is becoming a serious destination for FSU LPG.

Other possibilities are the transport of LPG from Kazakhstan, Uzbekistan and Russia using road tankers, and using RO/RO vessel that link Astrakhan (Russia) with Bandar Anzali in Iran. This possibility has been studied in the past, but several issues must be resolved before such movement of LPG can become possible: (1) the IMDG rules for transportation of hazardous and flammable materials on board ships must be reviewed and the ferry operators must agree to take road tankers on board, and (2) refineries in the region must arrange to have loading facilities to be able to load the road tankers.

LPG production in Turkmenistan is currently running at about 800.000 tons per year. These figures will heavily increase because flaring of gases will be prohibited. The production increase is estimated to be 3-5 times as of today's figures.

Other Markets

LPG for Afghanistan (60,000 t/yr) is shipped from Iran to Herat. Competing LPG supplies come from Uzbekistan and Kazakhstan. Armenia imports 24,000 t/yr from Turkmenistan, transiting northern Iran, while Pakistan buys small volumes (2,000 t/yr).

5.6 Conclusions

The following table shows the consultant's estimate of potential demand for LPG transported via the TRACECA corridor for Turkey, the Balkans and transit Ukraine.

⁴ **As we've been informed**, Turkmenistan and Iran are building 3000 tonnes LPG terminals in the cities of Turkmenbashi (Krasnovodsk) and Neka. These terminals will be operational in the second half of 2006.



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Table 5.3 *Potential demand for LPG transported via the TRACECA corridor*

Country	Demand
Turkey	0.6 – 1.0 mln tonnes
Balkans	0.2 – 0.3 mln tonnes
Transit Ukraine	0.2 – 1.0 mln tonnes
Total	1.0 – 2.3 mln tonnes

It is estimated that in total 1.0 to 2.3 million tonnes could be transported via the TRACECA corridor to markets like Turkey, the Balkans and west of Ukraine.



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6 Conclusions

On the basis of the analysis of world and regional LPG demand and supply, the consultant proposes to apply a supply/demand scenario to test the viability/ feasibility of TRACECA corridor LPG transport options in the range of 1 (minimum) to 2.3 (maximum) million tonnes per year to be achieved in the period 2010+.

The supply-demand margin (1-2.3 mln T/yr) via TRACECA corridor can be broken down or disaggregated as follows:

Table 6.1 *LPG supply and demand scenario's for the TRACECA corridor*

	Supply		Demand
Kazakhstan	0.7 – 1.5 mln tonnes	Turkey	0.6 – 1.0 mln tonnes
Turkmenistan	0.3 – 0.8 mln tonnes	Balkans	0.2 – 0.3 mln tonnes
Azerbaijan	0.0 – 0.2 mln tonnes	Transit Ukraine	0.2 – 1.0 mln tonnes
Total	1.0 – 2.5 mln tonnes	Total	1.0 – 2.3 mln tonnes

It must be noted however that the LPG market – mainly the autogas market – can more or less easily be influenced via taxation of fuels. As is the case in Turkey, the demand for LPG (autogas) could be considerably stimulated if taxation policies are introduced which stimulate the use of autogas.



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