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Regulation on the Transport of Dangerous Goods along the TRACECA Corridor

Azerbaijan, Georgia, Kazakhstan, Turkmenistan and Ukraine

Working Paper 6 Economic Appraisal Report

November 2007

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Country:	Azerbaijan, Georgia, Kazakhstan, Turkmenistan, Ukraine	
	Partner	Contractor
Name:		Consortium led by NEA Transport Research and Training (The Netherlands)
Address:		NEA Head office in the Netherlands: Sir Winston Churchilllaan 297 2280 DZ Rijswijk
Tel. Number:		+ 31 70 3988 340 (NEA office)
Fax number:		+ 31 70 3988 426 (NEA office)
Telex number:		
Contact persons:		Project Manager: Menno Langeveld
Signatures:		

Date of report: November 2007

Author of report: Klaus Broersma, Arndt von Oertzen, Herve Richard

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Abbreviations

cbm	Cubic Metres
CIF	Cost, Insurance and Freight
CIS	Commonwealth of Independent States
CSC	Caspian Shipping Company
DAF	Delivered at Frontier
EC	European Commission
EU	European Union
FCA	Free Carrier-(named place)
FOB	Free on Board-(named port of shipment)
FSU	Former Soviet Union
Ft	Feet
kT	Thousand tonnes
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
mta	Million tonnes
NPV	Net Present Value
RF	Russian Federation
RTC	Rail Tank Car
TCC	Transportation Costs Calculation
TCO	Tengizchevroil
TEN	Trans European Network
TMB	Turkmenbashi
WP	Working Paper
Y	Year

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1 Introduction

1.1 Background

This Working Paper 6 is part of a series of Working Papers that are prepared as part of the project *Regulation on the Transport of Dangerous Goods along the TRACECA Corridor.* The specific objective of the project is to provide a pre-feasibility study[1], which includes the technical, economic, financial, environmental and legal/institutional appraisal for the transport of Liquefied Petroleum Gas (LPG) through the TRACECA corridor.

This report focuses on the economic feasibility of transporting LPG on the TRACECA corridor. Together with Working Paper 3 (technical appraisal), Working Paper 4 (safety appraisal), Working Paper 5 (institutional and legal appraisal), this report provides insight in the overall pre-feasibility assessment of LPG transportation on the TRACECA corridor.

1.2 Objective of Working Paper 6

The objective of the report is to assess the economic feasibility of LPG transport along the TRACECA corridor.

Directly related to this is to provide recommendations on how to make the TRACECA route competitive in relation to alternative routes, notably the Russian route and the Iranian route, as indicated in Table 1.1, which is the project *base case*. It is evident (ref. Working Paper 3) that current transportation costs along the TRACECA corridor must be considerably lowered and substantial investments will be needed to achieve that.

The important aspects or steps of the (pre-) feasibility assessment are the following:

- The LPG-supply side, in Kazakhstan, Turkmenistan and Azerbaijan, is potentially abundant as has been shown in Working Paper 1; the supply side is not likely to pose a constraint for project feasibility under the condition that produced LPG quality will conform to EU-standards. Having said that, considering the dynamic conditions of the energy market, the consultant will provide in this Working Paper an update of LPG supply figures, i.e. quantities currently available on the concerned market (chapter 2).
- A key challenge is to find the consumer markets at the western ends of the TRACECA corridor, as discussed in Working Paper 2, and this is largely dictated by the 'door-to-door' transportation costs, from the site of the LPG producer in the East to the final consumers in the West. An updated potential Black Sea LPG demand for TRACECA LPG is provided in Chapter 2. An Estimation of realistic transportation cost is considered a critical activity and consequently is a central theme in this Working Paper, notably in chapter 4, presenting costs estimated with the help of a LPG Transportation Costs Calculation (TCC) model, which has been developed for this project.
- Potential future volume of LPG to be transported along the TRACECA corridor has been estimated (in Working Paper 2) in the range between 1.0 and 2.3 million tonnes per year. For the supply side, an update of latest export levels is provided in this Working Paper (chapter 2).
- Whether or not this volume-range can indeed be captured depends on the availability of both (i) the physical transport infrastructure and (ii) the "forwarding infrastructure", embedded in the proper multi-country cooperative arrangements ensuring safe LPG transports all the way. Both complexes can come only at considerable (investment) costs. Working Paper 3 already emphasized the need for increase of technical capacities, primarily in (i) a range of transport

[1] The Inception Report defines the pre-feasibility status.

infrastructures and (ii) 'rolling stock' in various modes of transport. This mixture of investment needs is the basis for a proposed staged development or phased approach.

- This Working Paper 6 is focused on (i) most likely feasible solutions in response to the technical barriers as outlined in Working Paper 3, and (ii) investments needed, while considering the gradual growth of the annual LPG throughput volume—in steps: (1) 150,000–200,000 T/yr, (2) 600,000 T/yr, (3) 1.5-2.0 million tonnes/year.
- A possible transport-technology 'switch', notably from rail-based (block train) transport to pipeline complicates the pre-feasibility assessment. There is a certain 'maximum' (limit) that the rail-based system could achieve and there is a 'minimum' (annual volume) needed to justify LPG pipeline transport (either 'sharing' in a LNG pipeline, or a dedicated LPG pipeline—the latter requiring a much higher annual throughput volumes to be economic). Moreover, there could remain a gap between the maximum that the rail-based system could achieve and the minimum that a pipeline solution might require.

As indicated in previous Working Papers, the TRACECA corridor's potential for LPG transports will be evaluated by comparing the 'project' cases with 'base' cases as summarized in Table 1.1.

Table 1.1 *Definition of base and project cases*

Production	Corridor	Consumption
Kazakhstan	**Base case:** From LPG loading stations in Kazakhstan by rail Kazakhstan- Russian rail-Black Sea via Odessa (today) or via Temryuk/Taman (near future)[2] **Project case:** From LPG loading stations in Kazakhstan to Aktau Caspian-TRACECA rail-Black Sea	Turkey Eastern Balkans, and optionally Central Europe via Ukraine
Turkmenistan	**Base case = Project case[3]:** Turkmenbashi Caspian-TRACECA rail-Black Sea Modernisation of existing corridor	Turkey Eastern Balkans, and optionally Central Europe via Ukraine
Azerbaijan	**Base case = Project case:** Baku-TRACECA rail-Black Sea Modernisation of existing corridor	Turkey Eastern Balkans, and optionally Central Europe via Ukraine

1.3 Contents of the paper

This section of the report provides an update of the demand and supply side of potential TRACECA corridor LPG volumes, providing the necessary basis for an assessment of investments needed along the TRACECA corridor. Next, in chapter 3, each element of the logistic chain from origin (Kazakhstan, Turkmenistan, Azerbaijan) to destination (Turkey, Eastern Balkan, Ukraine) is assessed in terms of most likely feasible solutions and investments needed.

The fourth chapter focuses on the LPG transportation cost comparison between the base case, i.e. LPG transport via the existing and new 'Russian' route and the project cases, i.e. LPG transport along the TRACECA corridor. The fifth chapter looks at the development of transportation of Crude Oil along the TRACECA corridor as a reference case that provides insights in the potential of LPG transport. The final chapter presents conclusions.

[2] Alternatively: from LPG loading stations in Kazakhstan to Aktau - Caspian (Makhachkala)-Russian rail-Black Sea via Taman/Oteko and/or Temryuk/Safinat (future)

[3] LPG exported South from Turkmenistan to Iran may substitute for Iran exports to Turkey (LPG 'swap') but this is not considered to be part of the base case

2 Potential demand and supply

2.1 Introduction

This chapter provides an update of the assessment of potential LPG volumes to be transported along the TRACECA corridor. LPG market prices are considered as well in this chapter in order to illustrate the market potential. This chapter builds on the analyses presented in Working Papers 1-2 and provides a basis for the envisaged transport solutions and investments needed, as described in the next chapter.

The LPG transport routes from origin to destination are presented in Figure 2.1, indicating the current routes, i.e. the base cases, notably through Russia and Iran. Figure 2.1 also illustrates the absence or negligible amounts of LPG volumes[4] transported via the TRACECA route, notwithstanding its geographical position in relation with Kazakhstan, Turkmenistan, etc.

Figure 2.1 *Transport routes from origin to destination*

Source: consultants' estimate

2.2 LPG Market prices for target markets

LPG export prices follow International market price quotations prevailing in each of the three export regions from the TRACECA region: North West Europe (NWE), Mediterranean (MED) and Arabian Gulf (AG) as indicated in Table 2.1.

[4] Other than 'incidental' LPG flows via Batumi Terminal.

Table 2.1 *Market price quotations for export regions*

Export region	Market price quotations
Eastern Europe	**Fixed Prices, Formula (NWE)**, monthly posted NWE (ANSI) + Premium (Average of US$ 33/T for 9 months 2007) DAF Brest (Poland)
Black Sea region	**Formula (MED),** Formula monthly posted MED (SP) -.US$ 30/T FCA Odessa, Fixed prices FOB Kerch, FOB Illichevsk, FOB Temryuk, FOB Batumi.
Iran	**Formula FOB (AG),** monthly posted AG (CP).- Discount (Average of US$ 115/T for first quarter 2007, FCA Turkmenbashi)

Source: Transgas

For the first nine months in 2007 the following information can be added:

- DAF Poland: LPG prices were monthly posted prices North West Europe plus US$ 33/tonne (equivalent to freight costs from Rotterdam).
- Mediterranean: monthly LPG posted price were exceeding Northern European posted prices by US$ 10/tonne. With declining oil and gas productions in Northern Europe, this differential is expected to reverse by 2010 as North Europe will need to import Mediterranean LPG to meet requirements.
- Arabian Gulf: monthly LPG posted price were exceeding Mediterranean posted by US$ 16/tonne and North Europe posted by US$ 26/tonne due to growing Far East demand. AG Prices are expected to continue to exceed MED prices. For LPG FCA Turkmenbashi (more than 80% supplied to Iran, and priced against AG quotations), the average discount to AG was 115 $/T for the first quarter of 2007.

In Annex 1 LPG prices for these regions are analyzed in greater detail, focusing on market price and netback price differentials. This will help to understand better the current LPG export practice from FSU and to identify both pitfalls and possible benefits concerning the TRACECA corridor potential.

Currently, negligible volumes of LPG are exported from Kazakhstan and Turkmenistan along the TRACECA corridor, as illustrated in Figure 2.1.
LPG pricing required for LPG producers to be enticed to use the TRACECA corridor is dealt with in Section 4.3, as well as Annex 1.

2.3 LPG Supply: potential production

International and local oil and gas producers are focused on exploration, production and export logistics for Crude and Gas. LPG potential recovery (about 2% of oil and gas production) is commonly not the priority for the Oil and Gas Companies.

Potential production of LPG at major fields in Kazakhstan (Karachaganak, Kashagan, Kazmunaigas gas fields), in Azerbaijan (ACP, Shah Deniz gas, SOCAR) and in Turkmenistan gas fields still have considerable uncertainty. For example, how much associated gas will be re-injected in the fields is a subject of continuing debate.

Table 2.2 provides an update of Current and Potential LPG production in the TRACECA region. The main difference in total Potential LPG forecast with the earlier WP1 forecast is that the majority of the Production developments programmes are suffering significant delays.

Table 2.2 *Current and Potential LPG production in the TRACECA region (kT/year)*

	2005	2006	2015	2020
Kazakhstan	1,250	1,350	3,340	3,340
Azerbaijan	160	160	1,000	1,000
Turkmenistan	396	400	1,300	2,000
Total	**1,800**	**1,900**	**5,640**	**6,500**
Of which to European Specs EN-589 (TCO):	820	780		
Of which to Gost 20448-90 specs:	980	1,120		

All oil refineries are manufacturing about 700,000 tonnes/year of LPG under existing CIS standards or GOST 20448-90. Investments in units to improve LPG components separation, control of contents of mercaptan, sulphur and other contaminants will need to be made for exports to East Europe, East Balkans and Turkey. All new LPG production from Oil and Gas fields is expected to meet the EN-589 norms.

2.4 LPG Demand: potential consumption

LPG consumption in the Black Sea region, notably in Bulgaria, Romania, Moldova, Serbia, Ukraine and Turkey is growing, particularly in autogas.

With a moderate LPG consumption growth forecast of 20 kg/ha by 2015, total LPG imports from Central Asia and Russia would amount to 1.7 million tonnes per year. In case of a more dynamic growth in consumption of 40 kg/inhabitants reached by 2015, (which is still less than Poland's and Turkey's current LPG consumption levels) LPG demand in the Black Sea region could be 3.4 million tonnes per year in 2015. Table 2.3 provides an overview of (expected) consumption levels in selected countries in the region.

Table 2.3 *LPG consumption in the TRACECA region (kilo tonnes/year)*

Country	Ha	Consumption (kT/Y) in 2006	Consumption (kg/Hab) in 2006 Total/Auto	Import (2006)	Forecast (Kg/Hab) in 2015	Forecast (kT/Y) in 2015	Forecast Imports (kT) in 2015
Ukraine	47.3	836	17.7 / 2.0	62	20	946	310
Moldova	4.45	50	11 / N.A	50	20	90	90
Romania	22.4	400	17.9 / 6.5	20	20	450	100
Bulgaria	7.5	345	46 / 40	220	50	380	260
Serbia	10.8	186	17.2 / 9.2	85	20	220	150
Turkey (1)	68.9	3,580	54.5/ 20	450/2,680	constant	3,750	800 - 2,900
Total		5,397		887		5,836	1,710 – 3,810
Poland	38.6	2,520	65 / 55.7	1,530	constant	2,500	1,500
Hungary	10	341	34.1 / 3.0	60	40	400	0
Azerbaijan	7.9	159	20.1 / 16	-27	20	200	0
Kazakhstan	15.1	470	31.1 / 0 (2)	-805	40	800 (2010) (3)	- 2,540 (2010) (3)

(1) Turkey: imports from Black Sea / Total imports
(2) Kazakhstan is known for developing autogas, while reported as nil in WLP Gas
(3) Kazakhstan Ministry of Energy – 2006. This is an export figure (explaining the minus sign)

In terms of quality, in 2007, only LPG for Turkey, Poland, Czech Republic, Slovakia, Hungary were following European Specs EN-589 for autogas; all other import Countries are still accepting Gost standards. By 2009 only Ukraine, Moldova and Serbia are likely to still accept LPG under GOST 20448-90.

2.5 Potential market for TRACECA LPG

This section focuses on connecting three (potential) LPG production TRACECA countries, i.e. Kazakhstan, Uzbekistan and Azerbaijan to the (potential) market and the way LPG is transported that way.

2.5.1 Kazakhstan to Turkey, Balkans, Ukraine

LPG potential production

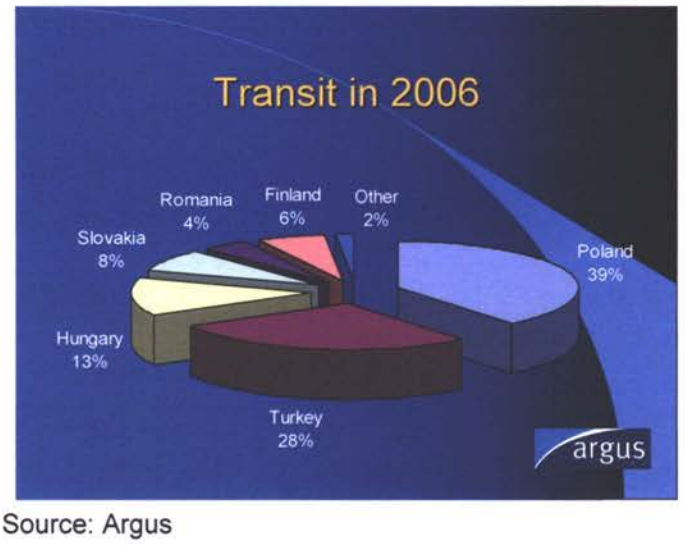
- Tengiz TCO is reported to start a second plant which will double crude oil production and increase LPG production to 1.100 mta instead of the previous plan of 1.450 mta (due to gas re-injection in the field).
- Kachaganak Consortium with potential LPG production of 2.0 mta and Kashagan consortia still have to start to build LPG infrastructure.
- Kazmunaigas forecast increase Gas production from 25 billion cbm in 2005 to 80 billion cbm in 2015. The amount of LPG which are planned to be recovered and the potential LPG demand from a new Atyrau petrochemical plant are not yet clear.

LPG exports

In the **base case of the project**, i.e. as described in Table 1.1, LPG is transported from LPG loading stations in Kazakhstan by rail Kazakhstan- Russian rail-Black Sea via Odessa. In the near future Temryuk, Taman (RF, Azov Sea) provides an alternative.

Currently all Kazakh LPG exports transit through Russia. Exports to the Black Sea, made solely by TCO, are through Odessa[5]. Figure 2.2 presents destinations of LPG transit through Russia.

Figure 2.2 ***LPG*** *Transit via Russia (2006)*



Source: Argus

With New LPG Black Sea terminals Temryuk and Taman and favourable Russian transit tariffs, a substantial amount of Kazakh LPG is expected to be exported to the Black Sea region in preference to East Europe. Taman can load vessels of up to 20,000 tonnes, aimed at exports to the Mediterranean, quantities that cannot be discharged at the Black Sea ports. Batumi with Vessels up to 5,000 tonnes is expected to compete with Temryuk, once draught is improved to 6 metre. Owners of Temryuk are also owners of Russian flag Safinat ferries and are not allowed to call to Baku.

In the **project case**, LPG is transported from LPG loading stations in Kazakhstan to Aktau, cross Caspian, TRACECA landbridge rail to the Black Sea.

With the recent development of Kazmunaigas expected to become the owner of Batumi terminal and Batumi Port[6], the LPG TRACECA corridor export route is expected to obtain further impetus in making

[5] All volumes are sold to AYGAZ under a renewable one year contract based on formula pricing and are supplied to Turkey.
[6] To be finalized by end of 2007 as advised by Addax, Seller

it viable for LPG exports and getting closer to a target price of about 95 $/tonne FCA Kulsary-FCA Batumi.

In order to be competitive, Kazakh LPG Rail tariffs to Aktau port would need to support this new LPG export route as has been done for crude oil. Likewise Aktau transhipment and port expenses would also need to be reconsidered. This will be required in response to developments in Russian railways that have decreased transportation costs to Russian ports to favour both Russian exports and transit through Russian ports. In view of the large Kazakh LPG export potential, a possible export scenario is presented in Table 2.4.

Table 2.4 *Kazakhstan 2015 LPG export scenario (kT/year)*

	2006	2006 (%)	Potential scenario 2015	2015 (%)
East Europe, DAF	510	64	600	24
Black Sea - Odessa to Turkey	220	28	600	24
TRACECA Corridor	**0**	**0**	**1,000**	**39**
Others (Incl. China)	70	8	340	13
Total export	800		2,540	

Note: the total of 2,540 kT is as presented in Table 2.3

2.5.2 Turkmenistan to Turkey, Balkan, Ukraine

LPG Potential production

- Dragon Oil is planning to produce 100,000 tonnes by 2009
- Petronas is planning to produce 340, 000 tonnes by 2015
- Gas fields in East Turkmenistan with 20 stabilization plants plan to avoid flaring and recover LPG. The total capacity involved is still uncertain at this stage.

LPG Exports

In the current situation, during the first four months of 2007, 85 percent of LPG was reported to be exported to Iran (and through Iran to Iraq, Armenia). The remaining 15 percent is exported to Afghanistan and in neighbouring Countries.

In the project case LPG is transported via Turkmenbashi, cross Caspian, TRACECA landbridge by rail to the Black Sea. Table 2.5 presents potential LPG export volumes.

Table 2.5 *Turkmenistan 2015 LPG export scenario (kT/year)*

	2006	2006 (%)	Potential scenario 2015	2015 (%)
Iran and Iran Transit	255	85	600	50
Afghanistan	45	15	100	8
TRACECA Corridor	**0**	**0**	**500**	**42**
Total export	300	300	1,200	

In relation with Table 2.5 the following remarks can be made:

- Iran can receive 1.2 million tons per year under swap arrangements (Butane April 2006),
- Pars Energy (Iranian Company) has built storage of 3,000 tonnes at Neka (two spheres) and has developed a new LPG terminal at Kiyanly in Turkmenistan with 3,000 tonnes storage and a jetty to accommodate two LPG vessels simultaneously,
- Amirabad is to complete a 6,000 tonnes LPG storage by end of 2008. In addition Safinat is planning to utillize one ferry for supply to Amirabad (Maktren nafta Nov 2007).

This illustrates the Iranian strategy to supply LPG to Iran to meet local growing LPG demands. However, as LPG production is developing in Turkmenistan, the need for alternate export routes for Turkmen LPG is likely to stimulate LPG transport along the TRACECA Corridor.

2.5.3 Azerbaijan to Turkey, Balkan, Ukraine

LPG potential production
Oil refineries are producing about 130 kT/Y of LPG under Gost standards. Substantial investments are required to meet EN-589 specifications.ACG and Shah Deniz consortia led by BP could potentially recover up to 900,000 T of LPG by 2012. It is understood that LPG recovery is under review to determine whether this would be economically justified at this stage. Future LPG production developments in Azerbaijan are unclear as yet; in Table 2.2. Production in 2015 is provisionally estimated at 1,000 kT/Y.

LPG Exports
In 2006 some 27 kT of LPG was exported[7]. The Batumi LPG terminal is currently underutilized.

In the project case (which equals the base case), LPG would be transported via TRACECA landbridge rail to the Black Sea. A potential export scenario, based on a substantial growth in LPG production[8], is presented in Table 2.6.

Table 2.6 *Azerbaijan 2015 LPG export scenario (kT/year)*

	2006	2006 (%)	Potential scenario 2015	2015 (%)
TRACECA Corridor	27	100	800	100
Others	0	0	0	0
Total export	27		800	

2.5.4 Ukraine

Ukraine LPG transit represents 1 million tonnes in 2006 and the first seven months of 2007 indicate a growing amount of LPG transit. Several new elements will affect LPG transport in Ukraine:

- More restrictive Quality norms applicable in EU Countries
- New LPG Black Sea terminals in Russia (Temryuk, Taman)
- Growing Ukraine LPG consumption and import requirements
- Potential new LPG transit possibilities from the Traceca corridor
- Potential growth of LPG transit along Danube river.

No significant change is expected in LPG Ukraine transit to East Europe as a result of more restrictive quality norms in East Europe.

Ukraine is becoming a growing LPG net importer. No major increase in LPG production is forecast, unless new field production is developed and LPG recovered. A very modest LPG consumption growth in Ukraine of 20 Kg/ha by 2015 (compared to current 17.7 Kg/ha) will result in a net LPG import of about 310 kT/Year, while with growing GDP and current LPG distribution infrastructure development a rate of 40 kg/ha can be anticipated (still less than current consumption levels in Poland, Turkey, Bulgaria). This would result in 1,250 kT/Year net LPG imports to Ukraine around 2015.

Figure 2.3 presents the transit potential via the Danube. Reni could play a pivotal role in further developing the Ukraine transit potential via the Danube. This route would link the TEN and TRACECA network. Reni Port, Reni LPG terminal and the Ukrainian Ministry of transport are developing the

[7] Source: WLP Gas Oct 2007
[8] Azerbaijan authorities could consider providing an incentive to BP ACG and Shah Deniz consortia to recover up to 900 kT/Year of LPG. In addition to refinery benefits mentioned, substantial benefits may accrue to the transit countries Azerbaijan and Georgia through economies of scale.

possibility for accepting LPG tankers to import inland as already done for Moldova and transhipment onto LPG barges (to be built) for ongoing supply along the Danube river with an LPG potential of 100,000 to 250,000 T/year[9].

Figure 2.3 *LPG transit potential via the Danube*

Source: Danube research

More background information on Ukraine LPG potential is presented in Annex 2.

2.5.5 On aggregate

The table below summarizes the potential LPG TRACECA corridor throughput under a 2015 potential Black Sea LPG demand (Bulgaria, Romania, Moldova, Serbia, Ukraine, Turkey) suited for up to 5,000 tonnes pressurized vessels, without the need to supply in the Mediterranean (via Bosporus), and LPG TRACECA region potential export, alternative competitive routes and market pricing.

Table 2.7 *Potential TRACECA corridor LPG throughput in 2015 (kT/Y)*

	Kazakhstan	Turkmenistan	Azerbaijan	Total TRACECA corridor
Total potential export	2,350	1,200	800	4,350
TRACECA Corridor export	1,000	500	800	2,300
Total Black Sea potential import				1,710 – 3,810

Based on and in relation to Table 2.7 the following remarks can be made:

[9] In September 2004, EBRD granted a €16 million non sovereign loan to the Administration of Constanta Port to finance a new barge terminal in what has been the first non sovereign guaranteed loan by the Bank for a state owned company in the Romanian Transport sector. The port of Constanta is placed at the crossroads of the commercial routes between Eastern and Western Europe and the Middle East. Due to its access to the Danube, the port is perfectly positioned for business with the Black Sea neighbouring countries as well as with those countries connected to the Danube (Austria, Germany, Hungary, Serbia and Montenegro).

- **LPG production**: uncertainties still remain in LPG production forecasts, especially in Azerbaijan where potential LPG recovery from gas and oil fields are not clear.
- **LPG demand:** this is growing in the Black Sea region and Ukraine is expected to become a substantial net importer. LPG demand growth rates could be accelerated with tax incentives and investments in infrastructure. LPG demand in the Black Sea region could be expanded to the Danube regional countries provided that adequate infrastructure can be developed. For example at Reni, along the Danube and with a new LPG barge fleet.
- **LPG quality:** the Black Sea region will require European specs EN-589 by 2009, except Ukraine, Moldova, and Serbia. All Oil refineries in the TRACECA region (About 700 kT/Y) needs upgrading to meet EN-589 export norms. New facilities at Oil and Gas fields are expected to meet EN-589 specs.
- **LPG vessels**: typical pressurized vessels in the 5,000 T size range will be suitable to call at Black Sea terminals that are restricted in storage and vessel size acceptance.

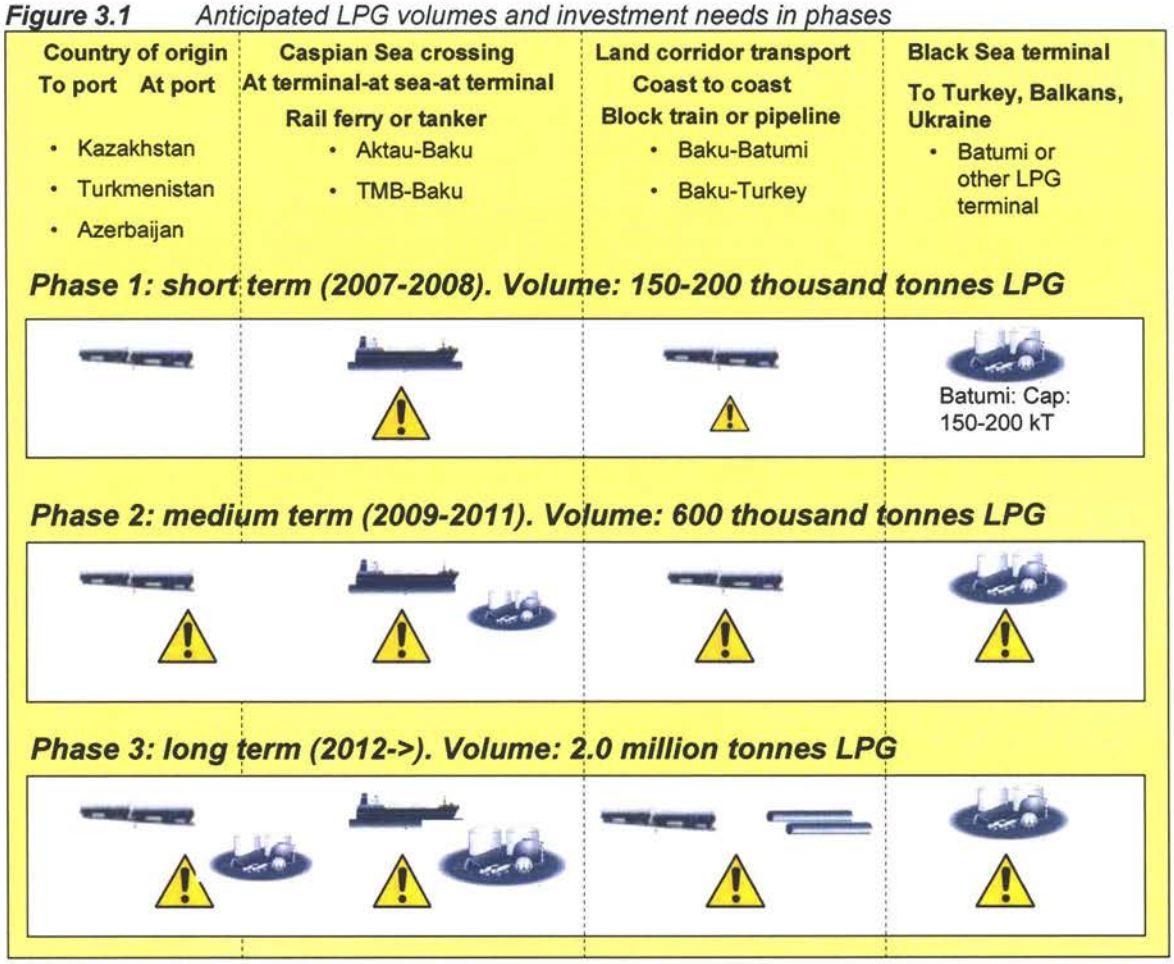
The estimated 2.3 million tonnes of LPG transported along the TRACECA corridor represent the upper range of the estimate. This is a potential that can be met if market conditions are met and if investments in infrastructure, superstructure, rolling stock and services are made. In reality the transported amount of LPG may be at a lower level. The indicated range of 1.0-2.3 million tonnes of LPG transported along the TRACECA route, as presented in Section 1.2 and WP 2 is considered to be in line with latest analysis as presented in this chapter.

3 Investment needed for LPG Transport along TRACECA corridor

3.1 Introduction

In order to achieve the LPG transport volumes as presented in Chapter 2 substantial investments are needed along the TRACECA corridor. These investments are placed in a timeframe and phased in accordance with the phases as defined in Working Paper 3. These three phases, which can be regarded as scenarios for LPG transportation potential along the TRACECA corridor, have a specific timeframe and anticipated volume of LPG transported, as presented in Figure 3.1.

Figure 3.1 *Anticipated LPG volumes and investment needs in phases*



Source: consultants' estimate

The phases as presented in Figure 3.1 represent a certain volume of LPG transported along the TRACECA corridor. Each phase has its own capacity restrictions, caused by the 'weakest' capacity link. For example, the maximum capacity in the first phase is directed by the handling capacity of the Batumi LPG terminal, which is estimated at 150-200 thousand tonnes of LPG. In this phase investments are needed in cross Caspian LPG transport (rail ferries and terminals used for rail ferries) and rolling stock for cross-land-bridge transport. The volumes and investment requirements per phase are presented in more detail below.

3.2 Short-term investments

The short-term investment horizon coincides with phase 1, as presented in Figure 3.1, catering for LPG volumes of some 150,000-200,000 tonnes LPG along the TRACECA corridor. The key elements for phase 1 are summarised in the box below.

Volume: 150,000-200,000 tonnes
Critical investment decisions: Optimal use of existing situation to cater for relatively small amounts of LPG transported.
Critical parts of logistic chain: rolling stock, rail-ferry terminal

Required investments per section of the logistic chain are presented per country below.

3.2.1 Kazakhstan

Starting point is considered to be *Kulsary railhead* [truck transport from LPG production site to railhead is the same for both base case/rail transport via Russian Federation (RF) and project case/TRACECA corridor]. The first rail-link is Kulsary-Aktau (project case) or Kulsary-Temryuk/ Taman and/or Kulsary-Odessa/Ukraine (base or reference case). In the base case, via RF, the Black Sea terminal (Temryuk/Taman and/or Odessa/Ukraine) is reached directly by rail. In the project (TRACECA) case, the LPG-RTCs will be taken by ferry across the Caspian Sea, from Aktau to Baku from where railway transport takes over again to the Batumi terminal on the Black Sea. Aktau- Makhachkala (RF) also across the Caspian Sea, and significantly shorter than Aktau-Baku, is another (base case) option with rail transport continuing to Temryuk/Taman or Odessa/Ukraine.

The continuation across the Black Sea is by tanker vessel[10] (from Batumi or Odessa) or by tanker vessel (from Temryuk/Taman), but the basic cost comparison will be between FOB prices (tanker vessel) Batumi and Odessa, Temryuk/Taman.

3.2.2 Turkmenistan

Starting point is considered to be Turkmenbashi port from where LPG is shipped either to (i) Baku (TRACECA route), (ii) Makhachkala (Russian Federation → Temryuk/Taman or Odessa/Ukraine), or (iii) Iran (possible 'substitution' of LPG exported onwards to the West/Turkey in the first place). The rail-detour via Uzbekistan and Kazakhstan to Russia is considered to be prohibitively expensive in comparison with these three corridors to the West.

The follow-on rail links are Baku-Batumi in the project (TRACECA) case versus Makhachkala-Temryuk/Taman or Odessa/Ukraine in the base case, the same as for Kazakhstan.

3.2.3 Azerbaijan

Starting point is considered to be Baku LPG storage(s) where trains to the Black Sea (Batumi) can be loaded directly, therefore Baku railhead. Project and base case are the same—there seems no competitive route via e.g. Russia (to the West).

The short-term target throughput volume is 150-200,000 tonnes per year, calling for 150 block trains per year (carrying an average of 1,000-1,300 ton/train, i.e. 28-37 RTCs/train with 35+ tonnes each), or 3 LPG block trains per week. This should be achievable in the short-term, aiming at an average turnaround time of 5 days (2 x 1.5 day travel time and 2 x 1 day for loading or unloading and train preparation operations).

[10] Tanker vessel size may also be a 'function' of LPG terminal storage capacity.

The composition of the target throughput volume of 150-200,000 tonnes per year from the possible LPG-origins of Kazakhstan, Turkmenistan and Azerbaijan will depend on the FOB (train) Baku prices, and Azerbaijan-originated LPG would be clearly in an advantageous position.

Added cost components for Kazakhstan are the Kulsary-Aktau train costs and the Caspian Sea crossing (Aktau-Baku) costs. Added cost component for Turkmenistan are the Caspian Sea crossing (Turkmenbashi-Baku) costs.

Minimizing the Caspian Sea crossing costs (Aktau-Baku and Turkmenbashi-Baku) is therefore a critical challenge[11] The short-term (immediate) improvements possible are limited to (i) adaptation of existing CSC ferries and (ii) the rail-ferry terminals in Baku, Aktau and Turkmenbashi (considering in particular 'dangerous goods' safety requirements). Any improvements in Aktau and Turkmenbashi rail-ferry terminals will also bring benefits for the Caspian crossing to Makhachkala (the competitor of TRACECA).

The second critical factor is the Batumi LPG terminal (annual) throughput capacity. At the current storage capacity of 1,200 cbm (equivalent with 600 ton), a 150,000 tonnes/yr annual throughput (capacity) would imply a 250-turnover factor, i.e. 5 times per week refill of the storage capacity, however delivered by 3 block trains/week (carrying 1,000 tonnes/train) creating a disparity. Reportedly, however, one of the Batumi LPG terminal shareholders is financing the extension of the storage capacity to 4000 cbm (equivalent with 1,850 tonnes LPG)[12]. The extended storage capacity represents about two LPG block train loads (of some 1,000 tonnes/train). An annual throughput of 200,000 tonnes calls for a Batumi LPG terminal turnover factor of 108 which seems more realistic than the 250-turnover factor. A (Black Sea) tanker vessel size of 1,500-3,000 tonnes (loaded at a rate of 120 tonnes/hour – taking 12-24 hours) would seem a logical choice in this context; some 45 vessels (50-50% mix of 1,500 and 3,000 tonnes tankers) would be carrying the annual throughput of 200,000 tonnes and further increase of this annual throughput would still be possible.

3.2.4 Summary phase 1: short-term investments

In phase 1 the following short-term investments are required:

- ***LPG block train system***: The LPG block train of either 52 RTCs of 29 tonnes load capacity or 40 RTCs of 40 tonnes load capacity (carrying 1,500-1,600 tonnes LPG per trip) could supply an annual volume of 180-190,000 tonnes at a 3-day turnaround sequence (Kulsary-Aktau) and an annual volume of 135-140,000 tonnes at a 4-day turnaround sequence (Baku-Batumi). The level of investment for a typical LPG block train is estimated to be in the order of **US$ 9-10 million** (US$ 5 million for one locomotive and US$ 4-5 million for RTCs).

- ***Rail-ferry terminals***: Required improvements of the rail-ferry terminals at Baku, Aktau and TMB have not yet been established (they are primarily related to modern safety requirements). A provisional sum of **US$ 3 million**[13] might be reserved for this purpose (perhaps most of this would need to be spend at the Baku-side).

- ***Rail-ferry***: A (new) Caspian Sea crossing rail-ferry would be able to transit 180,000 tonnes/year from Aktau to Baku or 230,000 tonnes/year from TMB to Baku. If it would be deployed on both routes, it may transit around 200,000 tonnes/year across the Caspian Sea. The concerned investment costs (one train ferry) are estimated at **US$ 22.5 million**.

[11] The RF port of Makhachkala is Baku's main competitor here with Caspian Sea crossing-times similar for Aktau-Makhachkala and Turkmenbashi-Baku (shorter), and also similar for Aktau-Baku and Turkmenbashi-Makhachkala (longer)

[12] To increase throughput capacity for export up to 8000 T/month from Baku refinery and potential for 3-4,000 T/month from Turkmenbashi, altogether up to 12,000 T/month (which would come close to 150,000 T/yr), and 3-4 times the volume of 3-4,000 T/month of LPG from Baku refinery (recently exported to Italy)

[13] Another estimate (AvO) puts this figure at US$ 15 million.

- ***Total, under stated assumptions***: When assuming that (i) Kazakhstan could provide the LPG-train transport to Aktau[14], and (ii) one additional block train would be sufficient to supplement the already available Baku-Batumi LPG-train capacity, the total short-term investment requirement would be in the order of **US$ 35 million;** this excludes any investment that might be needed to upgrade the railway infrastructure between Baku and Batumi, and which would serve wider interests than just the LPG transports.

3.3 Medium-term investments

The medium-term investment horizon corresponds with phase 2, shown in Figure 3.1, and would deal with an annual LPG volumes of some 600,000 tonnes LPG along the TRACECA corridor.

The key elements for phase 2 are summarised in the box below.

Volume: 600,000 tonnes
Critical investment decisions: How to manage and further trigger volume growth. With sufficient volumes a combination of tankers and LPG terminals are likely to be more economical than rail-ferry transport.
Critical parts of logistic chain: Caspian Sea crossing (rail-ferry or tanker), rail capacity-block train system, Georgian coast LPG terminal capacity.

3.3.1 Around Caspian Sea

Phase 2 calls for a decision on either a continued rail ferry concept or a concept based on LPG tankers. The rail-ferry concept must be compared with the alternative concept of (i) LPG terminals[15] at Aktau or Kurik (both Kazakhstan) and Turkmenbashi (Turkmenistan)—say with annual throughput capacities of 300,000 tonnes each[16]—and Baku (Azerbaijan) with annual throughput capacity of 600,000 tonnes or more[17] (perhaps two separate terminals), and (ii) tanker vessels of say 4,000 tonnes capacity to ship LPG across the Caspian Sea. Calculations on both options are presented in Section 3.3.3 below.

3.3.2 Around Black Sea

Shuttle LPG block trains between Baku and the Black Sea LPG terminal(s) are supposed to be the main carrier overland, just as in phase 1, but now at a level of up to eight (8) block trains per week (8 x 50 weeks x 1,500-1,600 tonnes/train = 600-640,000 tonnes/year maximum).

Two Black Sea terminals, the existing one in Batumi (extended) and a second one, each served by four (4) block trains/week from Baku, will then be needed, each with an annual throughput of approximately 300,000 tonnes; this is the equivalent of 100 tanker-vessels (3,000 tonne LPG capoacity)- for transport across the Black Sea, i.e. two tankers per week (per terminal) on average.

A storage capacity (per LPG terminal) of 6,500 cubic metre or roughly 3,000 tonnes, corresponds with about two block train loads (3,000 tonnes) and one tanker load (3,000 tonnes). The present (extended) Batumi terminal would require an additional 2,500 cubic metre tank (with accessories) and

[14] Any rail investment (LPG rolling stock) on the Kazakh side had been left out here—if one 'standard' block train had to be added, this would represesent an additional investment of US$ 9-10 million. Thus total phase 1 investment requirement could be as high as **US$ 56.5 million** (35+12+9.5).
[15] Roughly US$ 25 million per LPG terminal with ~ 300,000 ton/year throughput capacity
[16] Considering that such terminals would also be used to export (from Kazakhstan and Turkmenistan respectively) to Russia and Iran.
[17] Considering that these terminals would also be used to store Azeri-produced LPG for transport via TRACECA corridor—estimated to cost say US$ 35 million.

a second 300,000 ton/year capacity terminal (like the then twice-extended-Batumi or Temryuk/RF) would be needed. There would be no need yet for a second terminal IF about 50 percent of the LPG block trains (i.e. 4 per week) would continue on the (new) railway line connection to Turkey (from Tbilisi).

On first sight, the envisaged 'bottlenecks' at the Black Sea end seem to be manageable in principle: (i) further capacity extension (with ~ 2,500 cubic metre) at Batumi terminal, (ii) second Black Sea terminal of ~ 300,000 tonnes/year capacity (at ~ US$ 25 million) and/or (iii) accommodating LPG block trains on the new direct rail link to Turkey (calling for agreements with Turkish Railways and 'Safety Agencies').

Eight LPG block trains each week between Baku and Batumi (each way), two or three/day both ways, should not pose problems, if sufficient rolling stock and traction power will be (made) available.

Another question is how this average volume of eight LPG block trains/week can be supplied by the Baku-Caspian Sea train ferry systems from Aktau/Kurik (Kazakhstan) and Turkmenbashi (Turkmenistan). Deploying new ferries with 52 RTCs-block train carrying capacity ('Makhachkala Class') performing 280 trips/year, i.e. 155 trips/year Turkmenbashi-Baku, and 125 trips/year Aktau/Kurik-Baku, a total volume of approximately 420,000 tonnes/year could be carried across the Caspian Sea. The balance of 180,000-220,000 tonnes (to reach a total of 600-640,000 tonnes/year) then would have to be supplied from Baku LPG (Azeri) production site(s).

3.3.3 Summary phase 2: medium-term investments

In phase 2 the following short-term investments are required:

Rail-ferry or tanker-terminal
In order to handle envisaged phase 2 volumes, a second LPG rail ferry (~ **US$ 22.5 million**) would need to be constructed to handle increased volumes.

For the tanker-terminal option the total investment sum needed is estimated at roughly **US$ 135 million** for the Caspian Sea LPG terminals (**US$ 85 million**) and two LPG tankers (capable to transit annually up to 320,000 - 390,000 tonnes of LPG from Aktau/Kurik and TMB respectively to Baku-- **US$ 50 million**).

As will be shown in the comparative transportation costs estimates in the next chapter, the latter concept (LPG rail terminals on both sides of the Caspian Sea and LPG tanker transport across the Caspian Sea) could lead to lower LPG transportation costs (FCA Kulsary/Kazakh or Nebiddag/Turkmen – FOB Georgian Black Sea coast), as indicated in Table 3.1.

Table 3.1 *Transportation cost comparison (US$/tonne)*

	Rail-ferry concept	Tanker-terminal concept
Aktau-Baku	43.38	34.17
TMB-Baku	38.85	31.89

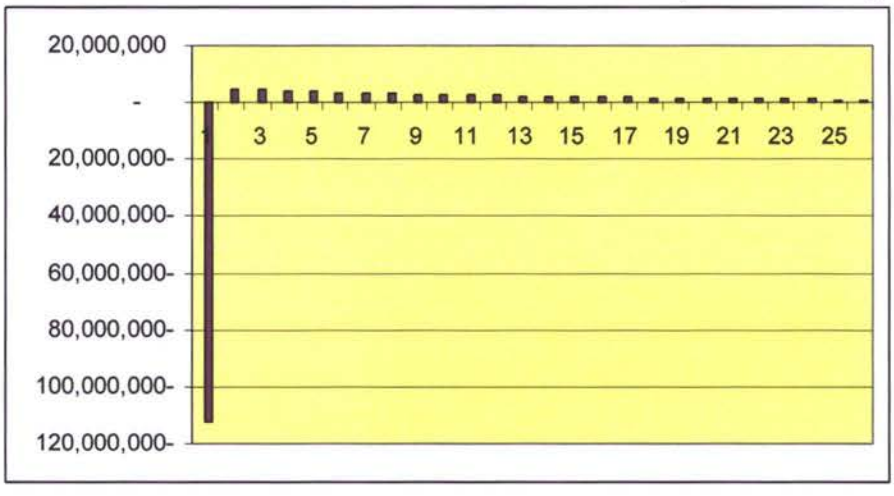
Source: TCC-model

Table 3.1 indicates that at volume levels of 600,000 tonnes tanker-terminal transportation costs (measures at US$/tonne) are approximately 20 percent lower than in case of the rail-ferry concept. Figure 3.2 provides a NPV calculation of investment in the tanker-terminal option (project case), as compared to the rail ferry case (base case). The result of the NPV calculation at a constant annual volume of 600,000 tonnes LPG and based on the transportation costs savings, as indicated in Table 3.1, is approximately US$-50 million, thus quite negative[18]. Calculations are presented in Annex 3.

[18] For investment costs the US$ 135 million involved in the tanker-terminal combination is compared to the US$ 22.5 million involved in improved rail ferry, leaving a total of US$ 112.5 million for investment. A project duration of

It should be noted that the outcome of the NPV calculations are sensitive to the LPG volumes transported. As an indication, doubling the volumes LPG transported, would result in a positive NPV at given investment and cost savings levels[19].

Figure 3.2 *Investment in LPG tankers and terminals compared to rail ferry option*



LPG block trains and Georgian terminal capacity

Four more LPG block trains Baku-Georgian coast (approximately **US$ 9.5 million**/typical block train) and extended LPG terminal capacity at the Georgian Black Sea coast (say **US$ 15 million** for Batumi terminal, and **US$ 25 million** for a second, 300,000 T/yr throughput terminal) would altogether amount to somewhat more than **US$ 100 million** (on top of the phase 1 investment estimate of US$ 35 million, that provided already for one rail-ferry, one typical TRACECA LPG block train and the reconstruction of the Caspian Sea rail-ferry terminals/ramps); this assumes that the LPG train transport up to the Caspian East coast (Aktau and TMB) could be properly arranged by Kazakhstan and Turkmenistan parties respectively—without up-front external investment.

In the case of the Caspian Sea tanker-terminals option, the additional (4) LPG block trains (Baku-Georgian coast) would also be needed as well as the extended LPG terminal capacity on the Georgian Black Sea side—an additional **US$ 78 million.**

Total, two options

The total investment in phase 2 depends on the chosen concept:

1. The strengthened rail-ferry concept would require relatively limited investment, i.e. approximately **US$ 22.5** million for a new rail-ferry. With the block train and Georgian terminal capacity investment, total investment is approximately **US$ 100 million**.
2. The tanker-terminal concept would require an investment of **US$ 135 million** (tanker, terminals, see above), bringing the total phase 2 investments to **US$ 213 million**.

Based on above calculations, phase 2 LPG volumes would best be served through option 1, i.e. the strengthened rail-ferry concept. The extra investment (**US$ 113 million**) in case of the tanker-terminal option is worthwhile only if annual LPG volumes increase well beyond the phase 2 volumes, i.e. 600,000 tonnes.

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25 years and an discount rate of 7% is applied for calculations. Residual values are estimated at 20% of original investments.

[19] In this case the investment costs would need to be adjusted in order to provide sufficient capacity for the increased volumes, which is not considered in the simple calculation, the point being that at a certain volume the advantages of costs savings offset the disadvantages of additional investments.

Part of the phase 1 investment (one rail-ferry boat and the reconstructed rail-ferry terminals/ramps), worth more than **US$ 25 million**, would no longer be of use for the LPG transport chain in case of tanker-terminal option. However, the rail-ferry boat may serve other purposes.

3.4 Long-term investments

In phase 3 the long-term perspective is addressed; aiming at an annual throughput of 1.5-2.0 million tonnes of LPG along the TRACECA corridor. The key elements for phase 3 are summarised in the box below.

Volume: 1.5-2.0 million tonnes
Critical investment decisions: How to manage large volumes of LPG. At what levels does a pipeline option for landbridge transport become viable?
Critical parts of logistic chain: Capacity pressure throughout the logistic chain.

3.4.1 Around Caspian Sea[20]

At this throughput level, the concept of LPG tankers plus terminals would be more economic than the Rail ferries concept that was estimated to be more economic at the 600,000 tonnes p.a. volume (phase 2). Therefore this case may be elaborated as if the switch to the LPG tankers plus terminals concept were already made in phase 2 (investment of US$ 213 million).
Two (2) more LPG tankers for the Caspian Sea crossing would be needed (facilitating a potential annual transit capacity of 1.4 million tonnes LPG from Kazakhstan and Turkmenistan)—an investment sum of **US$ 50 million**. This could perhaps be reduced to one (**US$ 25 million**), in that case the three LPG tankers (two already working in phase 2) could transit around 1 million tonnes across the Caspian Sea with the balance of 0.5 million tonnes supplied from Azeri sources and fed into the TRACECA rail landbridge in Baku.

LPG terminal capacity at both sides of the Caspian Sea would need to be extended at an estimated investment sum of **US$ 65 million** (5xUS$ 30 million = US$ 150 million minus US$ 85 million already invested in phase 2).

3.4.2 Around Black Sea

Handling 1.5-2.0 million tonnes of LPG at the Georgian Black Sea coast (other than via pipeline) calls for four (4 train-to-ship) LPG terminals, at a total estimated investment sum of **US$ 120 million**, out of which some **US$ 40 million** would be invested already in phase 2 (Batumi terminal extension and a second, 300,000 T/yr throughput terminal)—therefore **US$ 80 million** in phase 3.

The TRACECA (Baku-Black Sea) rail 'landbridge' calls for twelve (12) typical LPG block trains—seven (7) additional to phase 2—for carrying about 1.5 million tonnes LPG—an investment sum of **US$ 70 million**.

The LPG pipeline alternative (Baku-Black Sea) that promises to become a competitive alternative at a TRACECA-corridor throughput level of 1.5 million tonnes—as will be shown in the following chapter—calls for an up-front investment estimated at **US$ 500 million**—to which the investments in various LPG (storage) terminals at Caspian and Black Sea ends have to be added (at least 6xUS$ 30 million = **US$ 180 million.**

[20] Also in this case the assumption is that Kazakhstan would provide any investments for the LPG-train transport (or otherwise, e.g. pipeline) to Aktau.

3.4.3 Summary phase 3: long-term investments

The phase 3 option with rail transport on the landbridge results in a total (minimum) phase 3 investment of **US$ 240 million,** i.e. one additional LPG tanker for cross Caspian (US$ 25 million); Black Sea terminal capacity (US$ 65 million); Georgian Coast LPG terminal capacity (US$ 80 million); and additional block train capacity (US$ 70 million).

The pipeline option still calls for Black Sea tanker and LPG terminal investment. Total investments would amount to **US$ 705 million**: one additional LPG tanker for cross Caspian (US$ 25 million); Georgian and Black Sea Coast LPG terminal capacity (US$ 180 million); and pipeline capacity (US$ 500 million).

The relatively high pipeline investment costs need to be 'earned back' through lower transportation costs; the extent to which transportation costs are lowered through pipeline transportation is dealt with in the next chapter.

4 LPG transportation costs

4.1 Introduction

This section focuses on LPG transportation costs and provides a major input in the assessment of the competitive position of LPG transport along the TRACECA corridor. The transportation costs in the base case, i.e. the Russian route (Section 4.2) are compared with those of the project case, i.e. transportation along the TRACECA corridor.

LPG Transportation Costs Calculation (TCC) model
In order to assess (future) LPG transportation costs, a dedicated LPG Transportation Costs Calculation (TCC) model has been developed. Specific features of the TCC-model are presented in the box below. More details are provided in Annex 4. It should be noted that the TCC-model is developed to compare transportation costs for various options, including the benchmark or project case, i.e. transportation of LPG via Russia. It is not meant to 'predict' future LPG prices, as market prices are determined by a range of factors, including transportation costs.

The TCC-model, which is made publicly available as part of this project, can be easily adjusted and used for alternative calculations, e.g. with new input values, which allows additional calculations and also sensitivity analysis on some of the critical parameters. There is still room for more precise assessment if additional data sources would be available, particularly more accurate cost data.

Box 4.1 TCC-model features

- Model made in Excel spreadsheet, user friendly, easy to work with;
- Allows for making updates, adjustments, own calculations, sensitive analysis;
- Presents transportation costs per phase, per O-D and per transport alternative (rail-ferry vs. tanker Cross Caspian);
- Aggregates calculations per section into overall transportation costs;
- Input values presented separately, including sources and assumptions.

4.2 Base case: the 'Russian' route

This section will include market prices and estimated transportation costs, which will serve as a benchmark for the project case. The based case will concentrate on the Russian route for LPG transported from Kazakhstan[21].

4.2.1 The current route

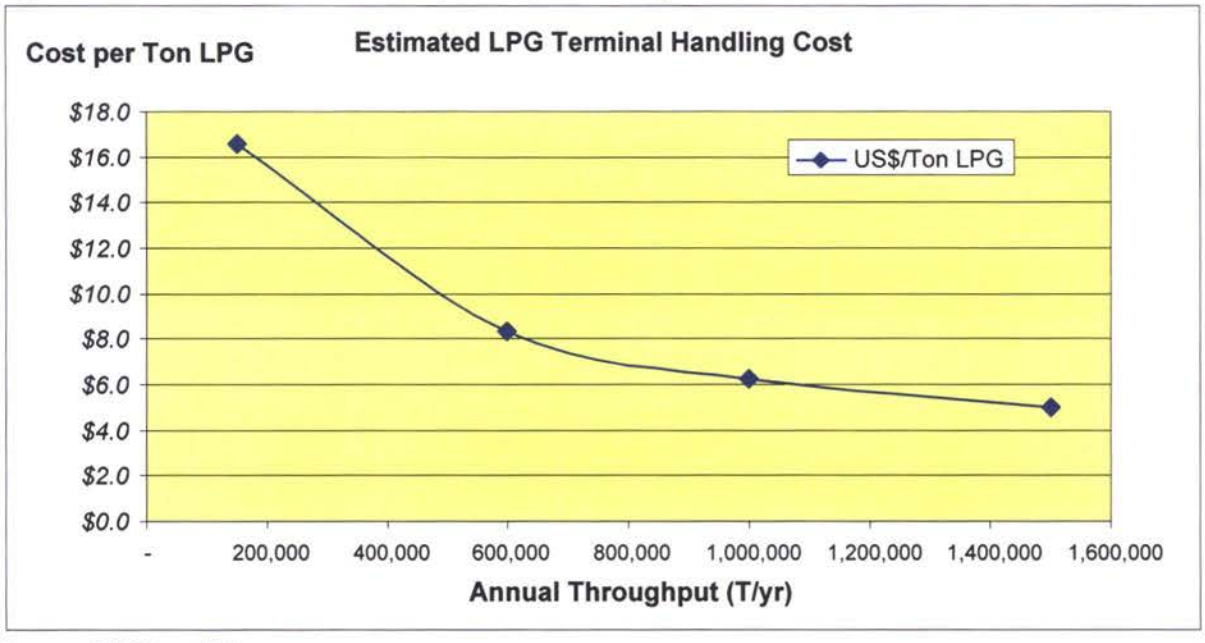
The present (2007) railway tariff for LPG transport for Kulsary-Odessa (distance: 2,482 kilometre) is **US$ 108/tonne.** This is based on following US$/100 tonne-km prices 2007:

- Kazakhstan: 3.38 US$/100 tonne-km
- Russian Federation: 5.14-5.42 US$/100 tonne-km
- Ukraine: 3.62-4.29 US$/100 tonne-km

The LPG handling costs (at the terminals from rail-to-ship or vice versa) are primarily (under 'normal' market conditions) a function of the size and annual throughput of the concerned LPG terminal, roughly estimated as shown in the Figure 4.1.

[21] Most LPG transported from Turkmenistan is currently going to Iran.

Figure 4.1 *LPG terminal handling costs (US$/tonne)*



Source: TCC-model

The handling cost per tonne at an 'average' LPG terminal of 500,000 tonnes annual throughput (capacity) are around US$ 10 (according to the relationship in the diagram, based on the more detailed estimations in the Transportation Costs Calculation (TCC) model, as described in Annex 4.

On the basis of these estimated figures, the 'benchmark' transportation costs for the current route, i.e. the route via Russian Federation to Odessa is estimated at **US$ 118/tonne**.

4.2.2 The route via Temryuk/Taman (Azov Sea/Russian Federation)

The anticipated railway tariffs for LPG transport at Temryuk and Taman are:

- Kulsary-Temryuk – distance: 1,818 km – **US$ 83.8/tonne** (small tankers only)
- Kulsary-Taman – distance: 1,840 km – **US$ 85/tonne**.

Thus, the (average) railway transport price advantage of Taman against Odessa is **US$ 23/tonne**[22].

On the basis of these estimated figures, the 'benchmark' (or base case) transportation costs, i.e. the cost level that the TRACECA alternative must meet to be competitive (under normal market conditions), is estimated at **US$ 95/ton**[23] (FOB Black Sea coast Georgia).

4.3 Project case: the TRACECA route

This section presents transportation costs for the TRACECA route, based on the TCC-model, which was developed for this project. Results are presented in the next Section:

- per phase;
- per route (destination Kazakhstan, Turkmenistan, Azerbaijan);
- per mode of transport and means of transportation.

[22] US$ 108 – US$ 85
[23] US$ 85 + US$ 10 (Black Sea LPG terminal handling)

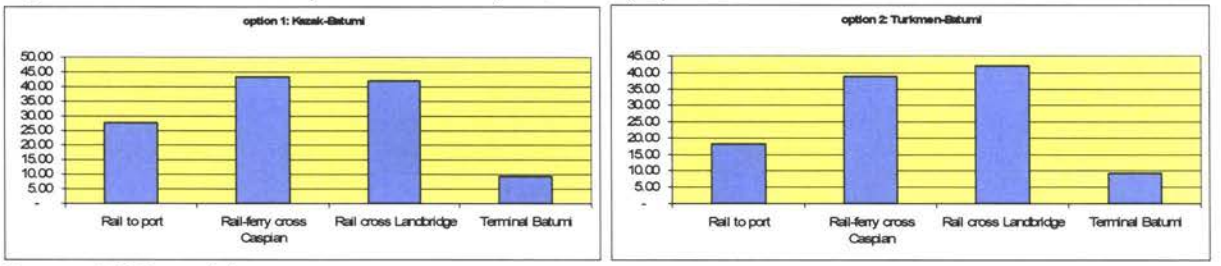
4.3.1 Phase 1: short-term transportation costs

The following three options (combination route-mode) are calculated in the TCC-model:

1. **Kazakhstan (Kulsary)-Batumi**: rail to port, rail ferry terminal, ferry cross Caspian, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 122.24**. (Note: The 'precision' of this and all following figures is somewhat deceptive—they represent the 'exact' TCC model outcomes, but the cost 'input' assumptions to get to these results are rather 'global' with considerable margins of uncertainty)
2. **Turkmenistan-Batumi:** rail to port, rail ferry terminal, ferry cross Caspian, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 108.26**.
3. **Baku-Batumi**: costs to terminal/terminal costs[24], rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 60.54**.

The breakdown of the transportation costs of LPG coming from Kazakhstan and Turkmenistan is presented in Figure 4.2.

Figure 4.2 *LPG transportation costs (US$/tonne)-option 1 and 2*



Source: TCC-model

Remarks based on Figure 4.2:

- Transportation costs of Kazak LPG (left side) is slightly higher than that of Turkmen LPG (right side), caused by higher transportation costs to the port and across the Caspian Sea.
- Transportation costs breakdown patterns are rather similar.
- If transportation costs savings are to be realised the cross-Caspian and cross-TRACECA Landbridge sections provide the best opportunities.
- Azeri/Baku-originated LPG production provides a very interesting opportunity (low cost advantage).

4.3.2 Phase 2: medium-term transportation costs

The following five options (combination route-mode) are calculated in the TCC-model:

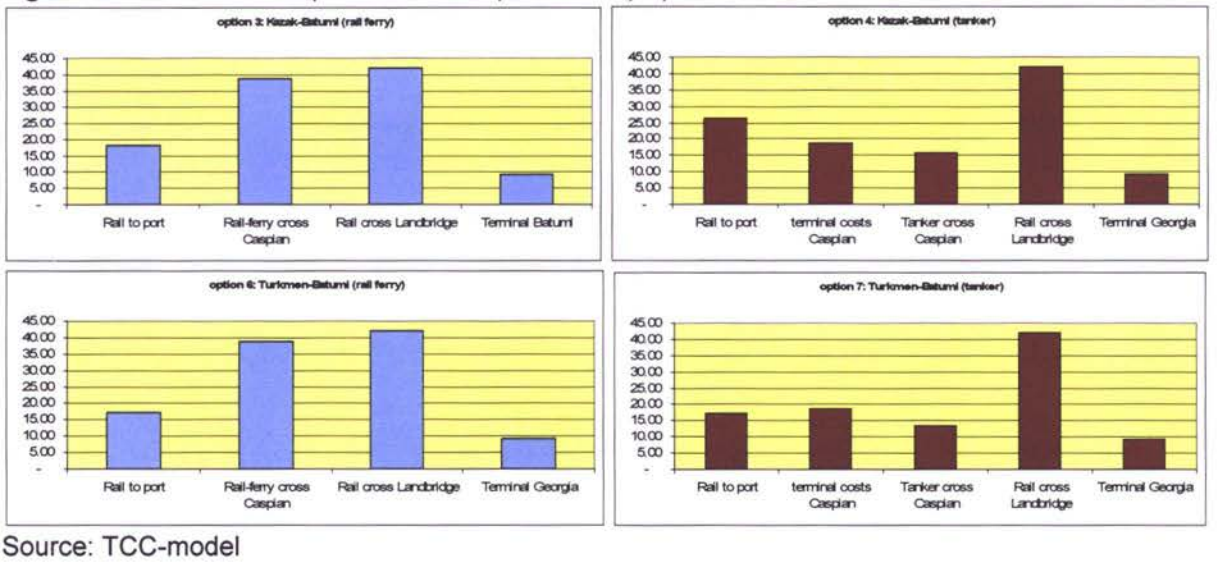
4. **Kazakhstan (Kulsary)-Batumi**: rail to port, rail ferry terminal, ferry cross Caspian, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 120.86**.
5. **Kazakhstan (Kulsary)-Batumi**: rail to port, terminal, tanker cross Caspian, terminal, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 111.65**.
6. **Turkmenistan-Batumi:** rail to port, rail ferry terminal, ferry cross Caspian, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 107.42**.
7. **Turkmenistan-Batumi:** rail to port, terminal, tanker cross Caspian, terminal, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 100.46.**

[24] The costs to terminal and terminal costs at Batumi were in the model assumed to equal the terminal costs at Batumi.

8. **Baku-Batumi**: costs to terminal/terminal costs[25], rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 54.98**.

The breakdown of the transportation costs of LPG coming from Kazakhstan and Turkmenistan is presented in Figure 4.3, both for the rail ferry and the tanker-terminal option.

Figure 4.3 *LPG transportation costs (US$/tonne)-option 1*



Source: TCC-model

Remarks based on Figure 4.3:

- Transportation costs of Kazak LPG (upper two graphs) are slightly higher than that of Turkmen LPG (lower graphs), caused by higher transportation costs to the port and across the Caspian Sea.
- Also for options 4-7, transportation costs breakdown patterns are rather similar.
- Transportation costs based on cross-Caspian transport via tanker-terminal (presented in red) are lower at the presented volumes, as indicated in Section 3.3.3.
- Azeri/Baku-originated LPG production provides a very interesting opportunity (low cost advantage).

4.3.3 Phase 3: long-term transportation costs

The following five options (combination route-mode) are calculated in the TCC-model:

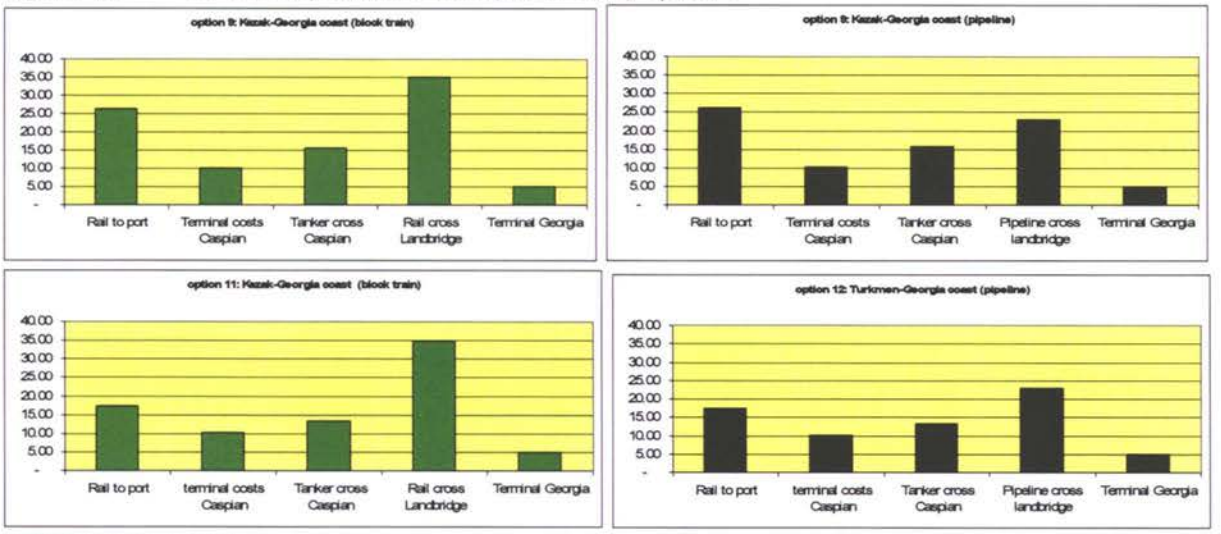
9. **Kazakhstan (Kulsary)-Batumi**: rail to port, terminal, tanker cross Caspian, terminal, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 91.86**.
10. **Kazakhstan (Kulsary)-Batumi**: rail to port, terminal, tanker cross Caspian, terminal, pipeline cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 79.93**.
11. **Turkmenistan-Batumi:** rail to port, terminal, tanker cross Caspian, terminal, rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 80.66**.
12. **Turkmenistan-Batumi:** rail to port, terminal, tanker cross Caspian, terminal, pipeline cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 68.74**.

[25] The costs to terminal and terminal costs at Batumi were in the model assumed to equal the terminal costs at Batumi.

13. **Baku-Batumi**: costs to terminal/terminal costs[26], rail cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 46.40**.
14. **Baku-Batumi**: costs to terminal/terminal costs[27], pipeline cross Azerbaijan-Georgia landbridge, Batumi terminal. Total transportation costs are calculated at **US$ 34.48**.

The breakdown of the transportation costs of LPG coming from Kazakhstan and Turkmenistan is presented in Figure 4.4, both for the block train and the pipeline option.

Figure 4.4 *LPG transportation costs (US$/tonne)-option 1*



Source: TCC-model

Remarks based on Figure 4.4:

- Also here transportation costs of Kazak LPG (upper graphs) are slightly higher than that of Turkmen LPG (lower two graphs), again caused by higher transportation costs to the port and across the Caspian Sea.
- Transportation costs breakdown patterns are rather similar.
- Transportation costs cross landbridge via pipeline (options 10, 12, presented in dark green) are lower than the transportation costs via block trains (options 9 and 11, light green colour).

4.4 Summarised results and verification

Summarised results

Table 4.1 summarises the above presented aggregated LPG transportation costs.

[26] The costs to terminal and terminal costs at Batumi were in the model assumed to equal the terminal costs at Batumi.

[27] The costs to terminal and terminal costs at Batumi were in the model assumed to equal the terminal costs at Batumi.

Table 4.1 *LPG Transportation costs per option (US$/tonne)*

Option	Transportation costs
Phase 1(150-200 kT):	
1. Kazak/Kulsary-Batumi	122.24
2. Turkmenistan-Batumi	108.26
3. Azerbaijan-Batumi	60.54
Phase 2 (600 kT):	
4. Kazak/Kulsary-Georgia – rail-ferry	120.86
5. Kazak/Kulsary-Georgia – tanker-terminal	111.65
6. Turkmenistan-Georgia – rail-ferry	107.42
7. Turkmenistan-Georgia – tanker-terminal	100.46
8. Azerbaijan-Georgia	54.98
Phase 3 (1.500 -2.000 kT):	
9. Kazak/Kulsary-Georgia –block trains	91.86
10. Kazak/Kulsary-Georgia – pipeline	79.93
11. Turkmenistan-Georgia – block trains	80.66
12. Turkmenistan- Georgia – pipeline	68.74
13. Azerbaijan-Georgia – block trains	46.40
14. Azerbaijan-Georgia – pipeline	34.48

Source: TCC-model

Verification
The extent to which the above figure are accurate is 'tested' against market developments in crude oil and against stated expected prices.

Crude oil
Crude oil transportation costs Kulsary-Batumi along the 'TRACECA' route (Kulsary-Aktau-Baku-Batumi) are currently about US$ 56/tonne. LPG railway tariffs per tonne are (currently) estimated at roughly 1.8 times those of crude oil[28]. If the 1.8 'multiplier' would be valid for the rail-ferry transport as well, this would translate in LPG transportation costs of US$ 101/tonne. Based on this, US$ 105/tonne would represent a plausible (target) cost level—slightly lower than the Odessa-price (US$ 108/tonne). In both cases the LPG terminal costs (US$ 10-15/tonne) need to be added to obtain a FOB Black Sea LPG transportation cost, i.e. in the range **US$ 115-120/tonnes.** This cost level is 'in line' with the calculated phase 1 level (**US$ 122.1/tonne**) and phase 2 level (**US$ 120.9/tonne** and **US$ 111.7/tonne** for rail-ferry and tanker option respectively).

Near future market prices
Estimations made by local forwarding professionals in the TRACECA region, indicate that the 'near future' transport price FCA Kazakhstan (Kulsary) – FOB Batumi (Black Sea) would be higher, notably **US$ 130/tonne** (Kulsary – Aktau by rail US$ 28, Aktau port charges US$ 3, Aktau- Baku US$ 45, Baku port charge US$ 3, Baku Batumi by rail US$ 40, Batumi terminal charge US$ 11) than the calculated (TCC model) short-term transportation costs (**US$ 122.2/tonne**).

With regard to the 'near future' transport price FCA Turkmenistan (Nebiddag) – FOB Batumi (Black Sea) at an estimated price level of **US$ 113/tonne** (Nebiddag –TMB US$ 16, TMB port charges US$ 3, TMB- Baku US$ 40, Baku port charge US$ 3, Baku Batumi by rail US$ 40, Batumi terminal charge US$ 11), this level is also somewhat higher than the calculated (TCC model) short-term transportation costs (**US$ 108.3/tonne**).

The above indicates that the TCC-model provides outputs that are reasonably in line with verifications from another commodity, i.e. Crude Oil, and the market.

[28] See Section 5.3 for further elaboration.

4.5 Competitive analysis

4.5.1 Kazakhstan

In the short-run the target price for being competitive would be **US$ 118/tonne** (transportation costs Kulsary-Odessa, as outlined in Section 4.2.1). This would leave a price gap of **US$ 4.2/tonne**, compared to the short-term costs calculations. This could be considered a premium if a producer would be interested in diversifying transportation routes.

In the medium-long run the target price FCA Kulsary-FCA Batumi to be competitive for LPG produced in Tengiz and future LPG productions to be sourced in the same area will be in the range of **US$ 95/tonne**, equivalent to transportation costs to Temryuk/Taman[29]. The gap with calculated transportation costs is then widening to some **US$ 25/tonne**, which is substantial.

The long-term scenario, with substantial investments along the TRACECA corridor, would reduce transportation costs substantially to levels of **US$ 92/tonne**[30], making LPG TRACECA transport potentially competitive, under strict conditions, as indicated in the next chapter.

4.5.2 Turkmenistan

The bulk of LPG export from Turkmenistan is transported to Iran. To obtain the same LPG netbacks FCA Turkmenbashi while exporting FOB Batumi, the maximum transportation cost FCA Turkmenbashi-FOB Batumi should be **US$ 83/tonne** for the period 2006-2007.

In comparison with Kazakh-produced LPG, however, the TRACECA route to the Black Sea could come closer to a competitive level, at an estimated price level of US$ 108.3/tonne in the short term and US$ 100.5/tonne in the medium term (see calculated transportation costs-section 4.3). The viability of Turkmen LPG export through the TRACECA corridor will depend on the transportation costs by Azeri ferry, rail tariffs through Azerbaijan and Georgia and transhipment costs in Batumi.

4.5.3 Azerbaijan

Competitive pricing for Azeri produced LPG is less an item, as the TRACECA landbridge provides the only export route. Obviously, the transportation costs do provide an important input in decision making regarding the production of LPG.

Currently, it is not clear whether SOCAR or ACG or Shah Deniz oil and gas fields will recover LPG. It is understood that SOCAR does not plan to produce LPG nor to develop a new LPG terminal at Kulevi. ACG (Azeri Lt) and Shah Deniz (Gas) consortia led by BP would be able to recover 500,000 to 600,000 tonnes per year of propane and 300,000 tonnes of butane. BP is currently reviewing whether or not producing LPG can be economically justified. The estimations made with the help of the TCC model indicate significant competitive advantages vis-á-vis Turkmenistan and Kazakhstan, due to lower transportation costs.

4.5.4 Ukraine

In 2007 Odessa LPG terminal is expecting to export 500,000 tonnes of LPG (mostly TCO LPG from Kazakhstan), out of an overall LPG transit through Ukraine of about 1 million per year, indicating a substantial market share of Kazak origin LPG.

[29] As described above: US$ 85/tonne rail tariff and US$ 10/tonne transhipment surcharge at Temryuk/Taman.
[30] LPG transportation via pipeline would further decrease LPG transportation costs and consequently increase the competitiveness of LPG TRACECA corridor transportation.

In order to maintain this position, a decrease LPG transportation cost on the Ukrainian territory will be required for Odessa to compete with the new Temryuk/Taman LPG terminals on the Russian Black Sea (with 1 million tonnes per year throughput capacity and vessels up to 20,000 tonnes) due to be commissioned by end of 2008.

5 Reference case: transport of Crude Oil

5.1 Introduction

Transport of crude oil by rail, particularly across the Caspian, is a recent phenomenon which has evolved in terms of organization, efficiency and pricing over the past 5 to 7 years. Transport of LPG along the same corridor is in its infancy. A similar evolution can be expected in terms of organization, efficiency. As for pricing, transport of dangerous goods is expected to maintain a premium over transport of crude.

Characteristics of transport elements Kulsary-Batumi applied to both Crude and LPG::

- Multi mode of transport rail-ferry-rail-terminal –shipping and empty RTCs return
- Three Countries applying same FSU rail rules, procedures, documentations
- Multi number of organizations intervening on a single voyage (more than 10), as each segment of the voyage is handled by at least two organizations
- Large number of documents for a single block train (exceeding 1,000 pages)

Both organisation and tariffs are paramount for achieving efficiency, competitive transport and minimize transport cargo transit losses. For example, (i) major Transport Service Companies can issue all computerized documents for a block train within less than 2 hours; (ii) have agents along the route at main points like border crossings to assist in coordination with local Authorities and minimize delays; (iii) keep tracking railcars and coordinate with the oil producer and the loading terminals to plan arrivals, date of return of RTCs in real time.

These Services are difficult to be achieved when contracting transport with the Individual Organizations.

5.2 Transportation costs

Aktau-Batumi

For crude oil, major service companies can now offer oil producers transport arrangements on a larger span of the route, such as FOB Aktau-FOB Batumi with a single tariff for the whole route of about US$ 37/tonne, as illustrated in Figure 5.1, or about US$ 56/tonne FCA Kulsary-FOB Batumi:

Figure 5.1 *Oil tariff (US$/tonne)*

Source Argus April 2007

For LPG on the same route FOB Aktau-FOB Batumi, several organizations would need to be involved with a total Transportation cost of US$ 99/tonne (as mentioned in Section 4.4 under Near future market prices) or 2.7 times the price for crude oil, besides longer transport time.

It must be recognized that substantial organization and tariffs improvements have been realized as the volume of Oil being transported on a single route has been substantially increased

The target of US$ 95/tonne FCA Kulsary-FOB Batumi required to make this LPG route competitive means that the transportation of LPG along this corridor could be approximately 1.7 times the transportation costs of Crude Oil on that same route. Based on these figures there seems to be a perspective for LPG transport. Key to this are the conditions that need to be met, such as:

- Major transport organizations will need to adopt a similar work approach for LPG as is achieved already for Crude Oil transport;
- Main components as rail tariffs, shipping across the Caspian, transhipment costs at Batumi need to be comprehensively reviewed.

5.3 Rail tariffs

While all FSU railway organizations apply the same operating rules, railway organisations in each country applies its own tariff policy. Table 5.1 provides an overview of rail tariffs for both LPG and Crude Oil in Kazakhstan, Russian Federation, Ukraine and Azerbaijan.

Table 5.1 *Rail tariffs, LPG vs. Crude Oil*

	Distances, Km	**Railway Tariff, $/T**	**Railway Tariff, US$/T/100 km**				**Source**
LPG	Total	Total	Kazak	Russia	Ukraine	Azerbaijan	
• Kulsary (Tengiz) to Odessa	2,482	108.27	3.38	5.42	3.62	-	Ministry of Transport of Ukraine Aug 2007
• Kulsary (Tengiz) to Taman	1,840	84.92	3.38	5.14	-	-	Ministry of Transport of Ukraine Aug 2007
• Atyrau (Refinery) to Odessa	2,263	94.09	3.64	4.22	4.29		Tamanneftegas Web site 2006
• Atyrau (Refinery) to Taman	1,621	71.47	3.64	4.60			Tamanneftegas Web site 2006
• Tobolsk-Taman	1,406	49.33		1.44			Tamanneftegas Web site 2006
• Baku- Garbadini	499	25				5.0	Meeting Baku Nov 2006
CRUDE OIL							
• Kulsary (Tengiz) to Odessa	2,482	60.0	2.40	2.67	2.10		Oteko Dec 2006
• Atyrau (Refinery) to Odessa	2,263	56.0		2.49	2.06		Tamanneftegas Web site 2006
• Baku- Garbadini	499	12				2.4	Meeting Baku November 2006
Average Tariff coefficient LPG vs. Crude		**1.8**	**1.4**	**2.0**	**1.7**	**2.1**	

Based on Table 5.1 the following comments can be made:

1. Differences in railway tariffs in US$/100 km for crude oil for the routes indicated above are limited between the various countries.
2. LPG tariffs in US$/100 km present much larger variations between the indicated countries and in Russia vary significantly between different export routes. Azeri tariffs, as reported above, appears to be on the high side.
3. Russian tariffs are favouring Russian supply sources exporting through Russian ports with railway tariffs about halved.

Based on the above, a similar approach could be considered by the railway Authorities of Kazakhstan, Turkmenistan, Azerbaijan, Georgia, Ukraine, together reviewing railway tariffs on the TRACECA corridor accordingly.

Also on the railway routes shown in Table 5.1, the ratio LPG/Crude oil rail tariffs is averaging 1.8, whereas the TRACECA corridor would benefit if this ratio would be aligned at the lower ratio level of for example Kazakhstan (1.4).

Kazakhstan LPG exports from Odessa will have to compete with the forthcoming new LPG Temryuk/ Taman terminal and all the transportation cost elements on the Ukrainian territory will need to be reviewed to maintain competitive.

6 Conclusions

6.1 Potential for TRACECA LPG

The size of the potential market of LPG which is transported along the TRACECA corridor is first of all determined by LPG supply from (potential) LPG producing counties, i.e. Kazakhstan, Turkmenistan and Azerbaijan, and LPG demand in the regional markets, i.e. Turkey, the Balkans and Europe beyond.

LPG-supply from Kazakhstan, Turkmenistan and Azerbaijan is potentially abundant. LPG production, triggered by high energy prices and flaring restrictions, is not likely to pose a constraint for project feasibility under the condition that produced LPG quality will conform to EU-standards. Notably Kazakhstan (1,350 kT in 2006), and to a lesser extent Turkmenistan (400 kT in 2006) and Azerbaijan (160 kT in 2006[31]) are LPG producing counties. The aggregate production volume in those countries is expected to triple in 2015 to some 5.6 million tonnes of LPG. The vast majority of produced LPG (>80 percent) will be exported.

LPG consumption in target markets, i.e. Turkey, the Balkans and Ukraine, thus in Countries neighbouring the Black Sea, is growing, particularly in consumption of autogas. The aggregate LPG consumption of Turkey, Ukraine, Moldova, Romania, Bulgaria and Serbia in 2006 was some 5.4 million tonnes of LPG with close to 900 KT of LPG imports in 2006. The LPG imports in these Countries are forecast to grow to a conservative amount of 1.7 by 2015 . LPG demand growth rates can be accelerated with tax incentives and investments in infrastructure. LPG demand in the Black Sea region can be expanded to the Danube regional countries if adequate infrastructure and a new LPG barge fleet can be developed.

The potential for LPG transported along the TRACECA corridor is estimated at a range of 1.0 to 2.3 million tonnes of LPG per year. The extent to which this volume can be captured is heavily depending on meeting some critical criteria, i.e. the competitive position in terms of transportation costs against alternative routes; the (political) willingness to invest in the TRACECA LPG logistic chain (and by doing so lowering transportation costs) and the ability to co-operate between parties involved (producers, transport authorities). These aspects are dealt with below.

6.2 Competitive position

The geographical location of the TRACECA route provides opportunities for Kazakh, Turkmen and Azeri produced LPG. It should be realised that notwithstanding the above potential, the current volume of LPG transported along the TRACECA corridor to the above-mentioned markets is negligible and there is no history in LPG transportation along this route. The current LPG flow along the TRACECA corridor (Baku-Batumi) is less than 20,000 tonnes per year.

Low volumes are explained by high transport prices desired by the (transport) parties in TRACECA compared to alternative routes. Kazakhstan is exporting via Russia, as well as East bound, and Turkmenistan to Iran and other countries. Other factors influencing the development of LPG transport along the TRACECA corridor:

- There is currently lack of a well structured overall competitive organisational set-up for LPG transport on the TRACECA corridor.
- The existing Russian route has functioned for decades; infrastructure and rolling stock (for TRACECA) have to be (partly) developed and acquired.
- Return on investments may indicate lower results than in the oil sector, thus all decisions and preparations will require an optimal business approach.

[31] It should be noted that uncertainties still remain in LPG production forecasts, especially in Azerbaijan where potential LPG recovery from gas and oil fields are not clear.

- Waiting times for LPG transported come at twice the costs of waiting times for transportation of diesel. Consequently, the speed of transportation is for LPG transport of high importance.

LPG from Kazakhstan for the Black Sea market is currently transported via the Russian Federation and Ukraine to Odessa. Transportation costs per tonne are calculated at **US$ 118**, which can be considered a target for TRACECA transported LPG from Kazakhstan. Important in this respect is the near future completion of LPG terminals at Temryuk/Taman at Russian territory at the Black Sea. Anticipated LPG transportation costs per tonne are **US$ 95**, providing the more appropriate benchmark for (future) transportation costs of TRACECA transported LPG.

Turkmen LPG is now exported via Iran. Export via the TRACECA corridor can be made viable and competitive, provided the transport cost chain can get closer to a benchmark of 83 $/T.
Turkmen crude is exported both to Iran and in the TRACECA Corridor illustrating that this can be achieved for LPG

The transportation costs are calculated using a Transportation Costs Calculation (TCC) model, resulting in a wide range of outcomes, varying with the chosen options, which are based on volumes and mode of transportation applied. The complexity of the TRACECA logistic chain, with Caspian Sea crossing handling costs and multi country rail transport, does provide a competitive disadvantage, which is translated in high transportation costs. Calculated LPG transportation costs for Kazakh and Turkmen LPG transported along the TRACECA corridor can be competitive with above benchmarks only at high volumes (>1.5 million tonnes LPG per year). For Azeri LPG this is different as it can be transported to the Georgian coast at relatively low costs.

It should be noted, however, that if proven to be a reliable and reasonably priced, the TRACECA corridor could:

- Entice Oil and Gas Companies to recover LPG, leading to increased LPG exports via the TRACECA route . In turn, increased LPG exports leads to lower transportation costs.
- Provide an alternative for existing transportation routes. LPG producers could limit their dependency on a single Russian export route and might consider to absorb slightly higher transportation costs as a (risk) diversification premium.

6.3 The need to invest

For development of LPG transportation along the TRACECA corridor a phased approach is foreseen:

1. Short term, i.e. within the next three years (2008-2010)->some 150,000-200,000 tonnes
2. Medium term, i.e. 3-5 years from now (2011-2012)->some 600,000 tonnes
3. Long term, i.e. more than five years from now (>2012)-> some 1.5-2.0 million tonnes of LPG

Each phase has its own dynamics, determined by factors such as capacity, investment needs and most feasible modes of transportation. In the short run LPG volumes are restricted through terminal capacity limits of some 150,000-200,000 tonnes at Batumi. If this volume is to be captures, investments in Caspian Sea rail ferry connections (terminals and vessels) and rolling stock are needed. Total investments are estimated at **US$ 35 million** (minimum—up to US$ 56.5 in case of investments in Kazakh railway rolling stock, and extra rail-ferry terminals' investment). At these volumes and with rail ferry cross Caspian transport, transportation costs are evaluated as relatively high, e.g. some US$ 122 per tonne from Kulsary, Kazakhstan. The premium over transportation costs to Odessa and in the near future Temryuk/Taman is considerable.

The gap in transportation costs on that same stretch would decrease in the second phase, with increased volumes. For the transportation of some 600,000 tonnes investments are then needed in cross Caspian transport (either through strengthening of the rail ferry system or through a LPG tanker system with LPG terminals at both sides of the Caspian); LPG block train capacity and LPG terminal capacity at the Georgian coast. Total investment needs are approximately **US$ 100 million** for the

improved rail ferry concept and **US$ 213 million** in case of a tanker-terminal concept. (on top of the phase 1 investments).

The transportation costs savings through tanker-terminal operations compared to rail ferry transport are substantial, i.e. 27 percent. However, additional investment costs of LPG tankers and dedicated LPG terminals (some US$ 113 million), as compared to the improved rail ferry option, do not provide a positive Net Present Value. However, with further increased LPG volumes, starting at levels of some 1.2 million tonnes, the tanker-terminal option becomes feasible. If a rapid volume expansion is foreseen, investment in he tanker-terminal option is therefore advised, especially to avoid investments in rail ferries that have only limited economic lifetime.

With volumes increasing to 1.5-2.0 million tonnes levels additional investments throughout the logistic chain are needed to facilitate the transportation of LPG. This would amount to some **US$ 240 million**[32]**.** With further increasing volumes a pipeline option for cross landbridge transport (Azerbaijan – Georgia) could be considered. Investment costs are high and a dedicated analysis would be required to determine the economic and financial feasibility of such investment.

6.4 Recommended next steps

The need to get organised

Kazakhstan and Turkmenistan, with flaring reduction, are developing an array of new LPG productions sites with yearly capacities of 50,000-200,000 tonnes, which aggregated would reach volumes exceeding 500,000 tonnes per year.

It is recommended that a "Consortium LPG Transport Company" be established in Kazakhstan and in Turkmenistan, in cooperation with Azerbaijan and Georgian transport companies to develop similar strategies as major LPG exporters like TCO to offer transport, railcars, documentation services on the whole export route in order to:

- Negotiate transportation costs on the Traceca corridor due to larger volumes.
- Organize planning, leasing railcars, operations and monitoring of transport along the route from the LPG producer loading site till FOB Batumi in an effective and cheaper manner as already realized for Crude oil from Aktau and Turkmenbashi on the same TRACACA corridor.

It should be noted that in Russia this is what has been done by having Gazexport the exclusive export role for LPG export from Russia, and using CITCO in Vienna for this trading role[33].

The commitment of LPG producers to supply LPG via the TRACECA corridor is a crucial step in the above joint approach. Important in this respect is to support the production of LPG in Azerbaijan. This LPG would be exported via the TRACECA route. By doing so a basic LPG transportation volume is established and facilitated, paving the way for LPG exports from Kazakhstan and Turkmenistan via the TRACECA route.

Additional factors towards harmonisation must be considered as well, e.g. the formulation of the overall handling unit.

The role of the countries

- Ukraine: for Odessa to compete with Taman new LPG terminal for Kazakhstan LPG exports, reduced transportation costs incurred on the Ukrainian territory are recommended to be reviewed. Also to develop feasibility and investment requirements to develop transhipments on LPG barges to navigate on the Danube in order to foster the LPG transit potential.

[32] These costs are on top of the phases 1 and 2 investments—therefore accumulated investment level about US$ 490-510 million.

[33] Still some exceptions to the rule exists as SUIC, Tatneft, Orensal, ...!)

- With Kazmunaigas expected to become the owner of the Batumi terminals, including the LPG terminal, reducing the LPG transportation costs FOB Aktau and across Caspian Sea are recommended to favour export from Batumi.
- There is currently no clear view on Azerbaijan LPG production forecast, it would be recommended to provide an incentive by Azerbaijan Authorities to BP ACG and Shah Deniz consortia to recover up to 900 kT/Year of LPG—taking advantage of the relatively low transportation costs Baku-Black Sea.
- Azerbaijan and Georgia to reduce transport costs cross Caspian and on their territories so as to entice Azeri, Kazakh and Turkmen LPG potential producers to recover LPG for export on the Traceca Corridor

Continue the debate and trigger the process

The potential of LPG transported along the TRACECA corridor is there. The case of Crude Oil transportation has proven that (energy) markets can generate strong and rapid development trends. Investments are needed along the corridor, as well as a well-coordinated, joint approach. This calls for a continued debate with stakeholders involved, i.e. producers, transport authorities, banks, Governments.

Ingredients for this debate could be:

- How to set-up the above joint approach.
- How to trigger LPG producers, notably in Azerbaijan, to produce LPG and transport it via the TRACECA route.
- How to organise the required feasibility studies.
- How to start phase 1, with limited investments.
- How to increase volumes of LPG transported along the TRACECA corridor and how to organise cross-Caspian transport, e.g. to quickly develop towards a LPG volume that justifies investment in LPG tankers with LPG terminals at both sides of the Caspian.

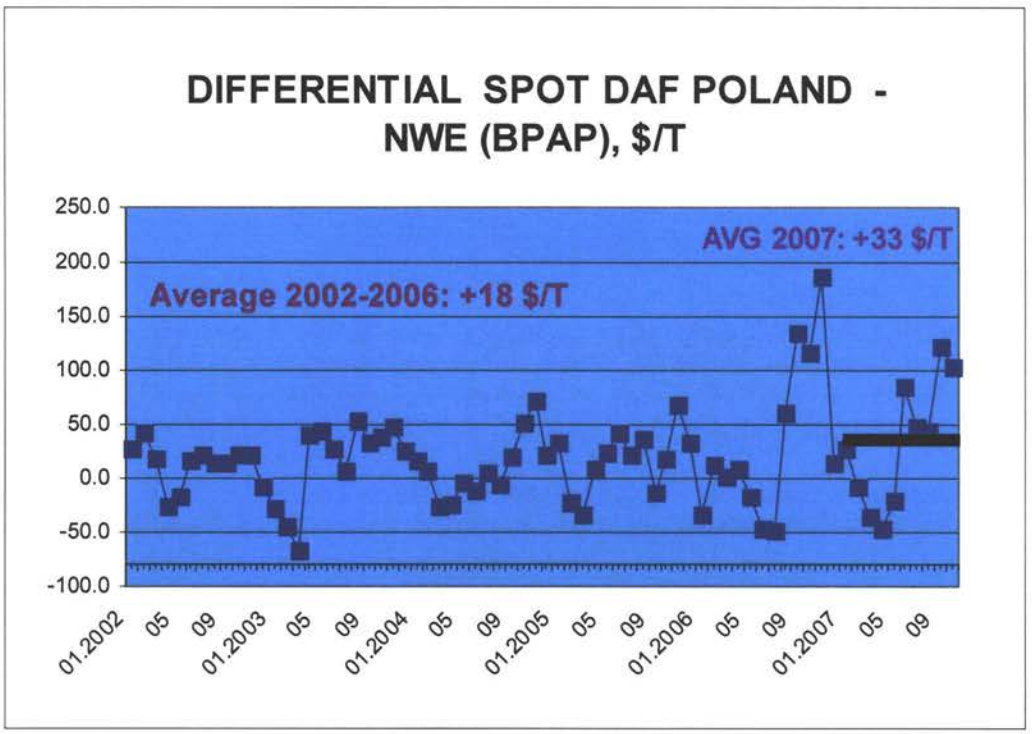
ANNEX-1 LPG price analysis

LPG export prices follow International market price quotations prevailing in each of the three export regions from TRACECA region, i.e. North West Europe (NWE), Mediterranean (MED), and Arabian Gulf (AG) .

In Section 2 of the main report actual market prices for the main LPG export routes and their implications for the Traceca Corridor producers (Kazakhstan, Turkmenistan, Azerbaijan) on the Traceca corridor export route were determined.

Hereto, actual market price differentials between regional pricing quotations are analyzed. This will allow a better understanding of the ways LPG is currently exported. Furthermore, it will allow to identify pitfalls and benefits from the different practices used by different LPG producers which can benefit the Traceca Corridor producers.

East Europe-Poland
The graph below reflects spot sale prices DAF Polish border vs. International NWE prices



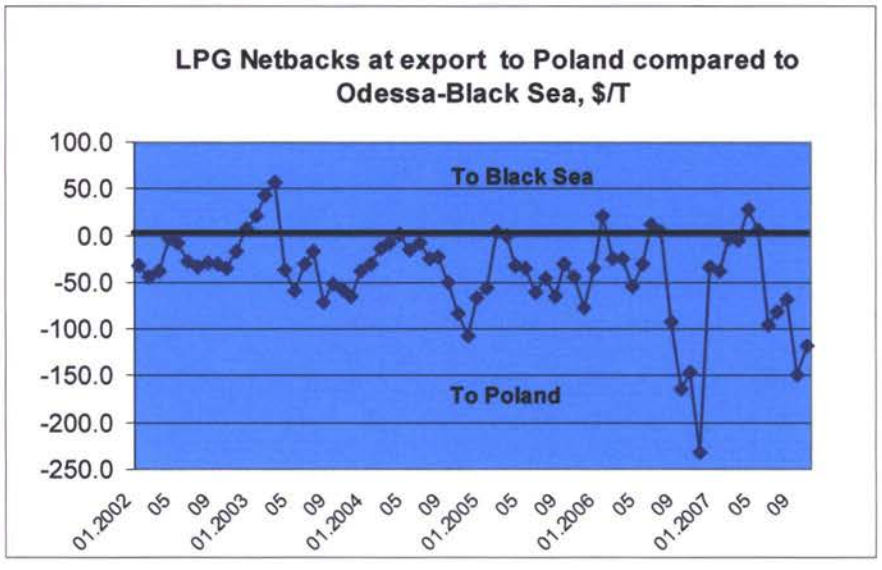
For 10 months In 2007 DAF Poland LPG prices were monthly posted prices North West Europe plus US$ 33/T (equivalent to freight costs from Rotterdam). The spot pricing volatility has increased substantially from +/- US$ 50/T to + US$ 100/-50/T in 2007.

What does this mean?

Source Primagaz-Central Europe

LPG sellers from Russia (SUIC, Orensal, Tatneft,...) and from Kazakhstan (Uzen, ,.) with export avails less than 100,000 tonnes per year are attempting to optimize sale prices almost for each train load and are selling mostly on fix price to Poland, mostly to an array of local independents, thus in a buyer market. Pricing depends on the strength of the buyer's demand and vary widely from the ongoing International market price.

The graph below compares netbacks for LPG producer selling at fix prices to Poland vs. export to Black Seam via Odessa.



Poland destination is most of the time preferred to export to Black Sea. Indeed LPG producers with less than 100,000 T/year export avails, either from Russia or from Kazakhstan were preferentially exporting to Poland rather than in Black Sea via Odessa.

The sellers from Russia (CITCO-Gazexport) and from Kazakhstan (TCO) with export avails exceeding 500,000 T/Year diversify export routes to NWE, East Europe, Black Sea to avoid to dependency on any single export route and sell mostly under price formula (which for the Black Sea may include a NWE pricing component) to hedge on the price fluctuations between different regional markets. Still, from Kazakhstan 28 % was exported to Black Sea-Turkey while the Bulk was supplied to NWE or East Europe.

What does it tells for the TRACECA Corridor ?
Kazakhstan and Turkmenistan, with flaring reduction, are developing an array of new LPG productions sites with yearly capacities of 50,000-200,000 tonnes, which aggregated would reach avails exceeding 500,000 T per year.

Consequently, it is recommended that a "Consortium LPG trading Company" be established both In Kazakhstan and in Turkmenistan, gathering export avails from small and medium size LPG producers so as to be able to develop similar strategies as major LPG exporters like TCO:

- Diversify export routes
- Develop pricing formulae
- Select Buyers

NOTE: In Russia this is what has been done by having Gazexport the exclusive export role for LPG export from Russia, and using CITCO in Vienna for this trading role. Still some exceptions to the rule exist, e.g. SUIC, Tatneft, Orensal.

This Project is funded
by the European Union

ANNEX-2 Ukraine LPG Transit potential

1 Current LPG transit through Ukraine

Origin of LPG transit through Ukraine are from Kazakhstan (Tengiz propane and butane to Odessa, and East Europe, LPG mix from Pavlodar and Uzen to East Europe), from Russia to Odessa and East Europe. The figure below indicates the LPG transit through Ukraine in 2006. The following table provides details on sources of LPG.

Source: Argus Moscow Conference April 2007

LPG Transit through Ukraine 7 months 2007 vs. 7 months 2006, **kT**

Main Sources	2007 (7 months)	2006 (7 months)	2007 vs. 2006, %
Kazakhstan			
Kulsary (Tengiz)	323	279	+ 16
Pavlodar	55	29	+ 90
Others (Uzen, Tekesy, Aksaraiska,	23.8	21	+ 16
Russia			
Tobolsk	143	124	
Kargala	112	45	
Novokybichev	23	19	
Limbey	13	0	
Others			
TOTAL	730	561	+ 30

Source: Ukraine Ministry of Transport- August 2007

LPG transit from Kazakhstan and Russia through Ukraine to East Europe and to Black Sea have substantially increased in 2007.

However new elements like more restrictive Quality norms applicable in EU Countries, new LPG Black Sea terminals in Russia (Temryuk, Taman), Growing Ukraine LPG consumption and import requirements. Potential new LPG transit possibilities from the Traceca corridor is expected to change the above picture.

Quality wise, LPG mix from Kazakhstan Tengiz propane and butane productions are meeting E-589 Euro specifications. Also it is expected that all new LPG Kazakhstan productions will meet E-589 norms.

From Russia propane, butane manufactured in Tobolsk, Novokybishev, Tchaikovsky plants, are also meeting Euro specs. Currently Orenbourg LPG mix, which exceeds sulphur limits is still exported to Poland via Ukraine at a discount of about 20 $/T to on-specs LPG.

Romania, Bulgaria can still accept GOST LPG. However, by 2009 all EU East Europe Countries will be restricted to Euro norms. Consequently, LPG manufactured in about all oil refineries in FSU will need to be treated and require additional refinery investments. Ukraine, Albania, Serbia LPG norms are still following GOST norms.

Overall it appears that the main quality bottleneck could appear for Russian supplies. However with large plants already manufacturing LPG at Euro norms, as Tobolsk and off-specs LPG acceptable for blending and priced at discounts to on-specs LPG, it not clear that any significant changes in the current LPG export routes to East Europe will occur.

2 Ukraine Forecast of LPG production, Consumption, Import requirements.

Ukraine LPG Production

Source: Argus Moscow Conference April 2007

Source: Argus Moscow Conference April 2007

LPG Production in Ukraine originates from stabilization at fields (Ukrnafta, Ukrgazvydobuvannaya) and Oil refineries (Kremenchug, Lisichansk). No major increase in LPG production is forecast, unless new field production is developed and LPG recovered.

Quality wise, all LPG produced in Ukraine will need additional treatment to reach E-589 quality level and require additional investment at LPG plants.

6.1.2 Ukraine LPG Consumption

COUNTRIES	Ha	Consumpt. ,000 T/Y 2004	Consumpt. ,000 T/Y 2006	Consumpt. Kg/Hab. 2006 Total/Auto	IMPORT ,000 T/Y 2004	IMPORT ,000 T/Y 2006	Forecast Kg/Hab 2015	Forecast ,000 T/Y 2015	Forecast IMPORTS ,000 T/Yr 2015	Forecast Kg/Hab 2015	Forecast ,000 T/Y 2015	Forecast IMPORTS ,000 T/Yr 2015
UKRAINE	47.3	610	836	**17.7** / 2.0	- 30	62	**20**	946	**310**	**40**	1890	**1250**
MOLDAVA	4.45	50	50	**11** / N.A	50	50	**20**	90	90	**40**	180	180
ROUMANIA	22.4	317	400	**17.9** / 6.5	- 25	20	**20**	450	100	**40**	890	540
BULGARIA	7.5	330	345	**46** / 40	210	220	**50**	380	260	**50**	380	260
SERBIA	10.8	65	186	**17.2** / 9.2	- 8	85	**20**	220	150	**40**	430	350
TURKEY (1)	68.9	3755	3580	**54.5**/ 20	350/2900	450/2680	Unchanged	3750	800/2700	Unchanged	3750	800/2900
TOTAL					550	887			**1710**			**3380**

Source WLPGAS 2005,2007
(1) TURKEY: Imports from Black Sea / Total imports

The table above provides a comparison of LPG consumption of Ukraine with neighbouring countries along with two different consumption forecast scenarios.

Ukraine, as most East European Countries, is facing growing LPG consumption, particularly autogas in major cities where the distribution infrastructure has been developed.

Two consumption forecast scenarios have been made:

- A very modest LPG consumption growth in Ukraine of 20 Kg/ha by 2015 vs. current 17.7 Kg/ha. Under this scenario, a 310 kT/Year net import is forecast by 2015.
- As GDP is growing in above Countries and with ongoing infrastructure developments, an LPG consumption growth of 40 Kg/ha can be anticipated (still inferior to current consumption levels in Poland, Turkey and Bulgaria). This would result in 1250 kT/Year net LPG imports to Ukraine. Further Investment in LPG Distribution infrastructure will favour the LPG consumption rate of Growth in Ukraine as well as tax incentive for using a cleaner fuel.

Most of the required Ukraine LPG imports quantities could be supplied via the Traceca corridor, as well as to countries bordering Danube and in Turkey.

3 Ukraine Potential Transit, Import

With Ukraine having already four LPG Sea port terminals for LPG exports (Odessa, Reni, Illichevsk, Kerch), Kazakhstan transit through Ukraine could be maintained, provided transport economics remain competitive, and in addition LPG imports could be developed by specializing LPG ports to either exports like Odessa meeting international standards or imports. Reni Port recently operated LPG imports to Moldova and is keen to develop transit to the Danube by transhipping incoming ships into LPG barges.

Kazakhstan: Taman Competition with Odessa

	Distances, Km				Railway Tariff, $/T				Taman Advantage to Odessa
	Kazak	Russia	Ukr	Total	Kazak	Russia	Ukr	Total	
LPG TRANSIT # 1									
	Base Case								
Base Case 32 T RTC'S									
Kulsary (Tengiz) to Odessa	547	1094	841	**2482**	18.51	59.30	30.46	**108.27**	
Kulsary (Tengiz) to Odessa					16.70	46.12	36.04	98.86	
Kulsary (Tengiz) to Odessa	547	1094	979	2620	19.17	61.9	35.92	**116.99**	
Competitive case									
Kulsary (Tengiz) to Taman	547	1293	-	**1840**	18.51	66.41	-	**84.92**	23.35
					16.70	59.54		76.24	22.62
Taman Rail Tariff advantage to Odessa, $/T									**22.9**

Sources: Ukraine Ministry of Transport, Oteko

A current advantage of 23 $/T is calculated for Taman vs. Odessa. Indeed Distances are shorter to Taman. Taman, being a new terminal requiring investments exceeding 200 $ million with a 1.8 km jetty, 1 million tons per year LPG terminal and 5 million tons per year terminal, Taman is expected to offer a throughput fee in the order of 30 $/T to recover some of the transport benefits that Kazakhstan and Russian producers will obtain in going to Taman, as opposed to 20 $/T in Odessa.

once Taman LPG terminal will be commissioned (now postponed to 2009), It would be recommended that transport costs on the Ukrainian territory (LPG railway tariffs, LPG terminal throughput fee, port costs and other service costs) be reviewed so as to decrease the total transport costs on the Ukrainian territory by about **13 $/T** to remain competitive.

Traceca Corridor: Land transit

The next table simulates a comparison between LPG from Traceca corridor at its price market value FOB Batumi and transit costs through Ukraine to Izov (Poland) with current Izov import Prices. Thus shipping from Batumi to say Odessa. Transhipment in Odessa and land transport to Izov. One case is considering LPG vessels and transhipment in Odessa in railcars. A second case simulates transport from Batumi to Odessa and on to Izov in LPG containers.

Note: Numbers in the grey cells below are Consultant estimates. Other numbers have been obtained from Ukraine Ministry of transport, Odessa Port, Odessa terminal, ship brokers.

LPG Ukraine Transit	Shipping			T/S	Rail Tariff	33 T RTC Lease			FOB Batumi -DAF Izov	PRICE DAF IZOV, SP +	PRICE DAF IZOV- SP, AVG 07 +23 $/T or PROFIT, $/T
	R/T Days	$/day	$/T	$/T	$/T	$/T/day	R/T Days	$/T			
FOB Batumi: LPG = SP - 20 $/T											
Batumi- Odessa-Izov, Vessel 3000 T+RTC'S	5	7000	11.67	18	38.52	1	10	10	**78.19**	58.19	**-35.19**
Batumi- Odessa-Izov, 40 ft Containers	5	5000	8.333	10	25.43	2	24	48	**67.77**	47.77	**-24.77**

The last column indicates that current LPG transit land route to Izov-Poland (land transit through Ukraine from Kazakhstan or Russia or Belarus) is more attractive than LPG Traceca corridor transit through Ukraine to Poland. Same result both for LPG railcars and LPG Containers which have a leasing fee per ton/per day about double than for LPG railcars.

While above does not provide accurate results, still the magnitude tells that current land transit routes to East Europe is expected to remain competitive.

Traceca Corridor: Ukraine transit to Danube

The table below simulates a comparison between LPG from Traceca corridor FOB Batumi supplied by 3000 T to Reni for transhipment into LPG barge and delivery North on the Danube to Ruse (Bulgaria) and a delivery from Odessa to Constanta for Transhipment into Railcars delivered to Ruse.

LPG Prices FOB Batumi and FOB Odessa have been considered at International market values or at a 5$/T discount FOB Batumi vs. FOB Odessa.

Note: Numbers in the grey cells below are Consultant estimates. Other numbers have been obtained from Ukraine Ministry of transport, Reni Port, Reni Terminal, Ship brokers.

	Shipping			Danube Canal	T/S	LPG Barge			FOB Batumi-DAF Ruse R/T	PRICE DAF Ruse, SP +	PRICE DAF Ruse, Transit via Reni, Profit $/T
LPG TRANSIT to DUNAU	R/T Days	$/day	**$/T**	**$/T**	**$/T**	R/T Days	**$/T/D**	**$/T**	**$/T**		
Batumi To Ruse (Bulgaria) via Reni and Danube, FOB Batumi SP-20 $/T	7	7000	16.33	5	30	8	7	56	107.33	**87.33**	**-17.33**
						Rail Constanta-Ruse			FOB Odessa-DAF Ruse	PRICE DAF Ruse, SP +	
						Km	$/T/100km	$/T	**$/T**		
Alternative Odessa-Constanta-Ruse: FOB Odessa SP-15$/T	3	7000	7	0	30	600	4	48	85	**70**	

The last column indicates that LPG transit via Constanta would be preferred to transit via Reni.
One puzzling cost element is that the above considers transport cost in $/T/Day for LPG barges exceeding LPG railcar. Also transhipment cost in Reni exceeds transhipment costs in many other LPG Black sea terminals .

It is recommended that Reni Port and Ukraine Ministry of Transport review all cost elements for the Reni transit route to Danube in comparison to actual LPG supply routes, so as to assess what investment and tariffs are required to make such a route workable and competitive.

4 Conclusions

- Ukraine LPG transit represents 1 million tons in 2006 and first seven months of 2007 indicate a growing amount of LPG transit. Several new elements will affect LPG transport in Ukraine:
  - More restrictive Quality norms applicable in EU Countries,
  - New LPG Black Sea terminals in Russia (Temryuk, Taman),
  - Growing Ukraine LPG consumption and import requirements,
  - Potential new LPG transit possibilities from the Traceca corridor

- No significant change in LPG Ukraine transit to East Europe expected as a result of more restrictive quality norms in East Europe.

- Ukraine becoming a growing LPG net importer. No major increase in LPG production is forecast, unless new field production is developed and LPG recovered. A very modest LPG consumption growth in Ukraine of 20 Kg/ha by 2015 (vs. current 17.7 Kg/ha) will result in a net LPG import of a **310 kT/Year**, while with growing GDP and current LPG distribution infrastructure development a rate of 40 kg/ha can be anticipated (still inferior to current consumption levels in Poland, Turkey, Bulgaria). This would result in **1,250 kT/Year** net LPG imports to Ukraine. Further Investment in LPG Distribution infrastructure will favour the LPG consumption rate of Growth in Ukraine as well as tax incentive for using a cleaner fuel. It would be recommended that activities of Ukrainian LPG Sea ports be as LPG export or as LPG imports be assessed.

- Once Taman LPG terminal will be commissioned (now postponed to 2009), It would be recommended that transport costs on the Ukrainian territory (LPG railway tariffs, LPG terminal throughput fee, port costs and other service costs) be reviewed so as to decrease the total transport costs on the Ukrainian territory by about US$ **13/T** for Odessa to remain competitive.

- LPG Traceca corridor in transit through Ukraine to Poland East Europe, be by railcars, be by LPG containers do not appear competitive to current export routes.

- Reni could develop LPG transit on Danube. It is recommended that Reni Port and Ukraine Ministry of Transport review all cost elements for the Reni transit route to Danube in comparison to actual LPG supply routes, so as to assess what investment and what tariffs are required to make such a route workable and competitive.

ANNEX-3 NPV calculations for tanker-terminal vs. rail ferry

Inputs:
Project duration: 25 years
Discount rate: 7 percent
Annual volume of LPG transported: 600,000 tonnes, out of which 2/3 from Kazakhstan and 1/3 from Turkmenistan.
Residual values estimated at 20% of original investment.

A simple Cost-Benefit Analysis is carried out based on above input values in which the base case is defined as cross Caspian LPG transport by rail-ferry and the project case is defined as cross Caspian LPG transport by tanker and LPG terminals at both sides of the Caspian. Investment costs are the estimated investment costs for the tanker and terminal combination (as compared to the rail ferry investments). Benefits are the lower transportation costs per tonne through tanker LPG transport, multiplied by the volumes transported. The values are presented in chapter 3 and 4.

year	Present value
-	112,500,000-
1	4,743,925
2	4,433,575
3	4,143,528
4	3,872,456
5	3,619,118
6	3,382,353
7	3,161,078
8	2,954,278
9	2,761,008
10	2,580,381
11	2,411,571
12	2,253,805
13	2,106,360
14	1,968,560
15	1,839,776
16	1,719,417
17	1,606,932
18	1,501,805
19	1,403,556
20	1,311,735
21	1,225,920
22	1,145,720
23	1,070,766
24	1,000,716
25	5,080,855
NPV	49,200,805-

ANNEX-4 Transportation Costs Calculation (TCC) model

In order to assess (future) LPG transportation costs, a dedicated LPG Transportation Costs Calculation (TCC) model has been developed. Specific features of the TCC-model are presented in the box below. It should be noted that the TCC-model is made available together with this report. The TCC-model can be easily adjusted and used for alternative calculations, e.g. with new input values, which allows additional calculations and for example sensitivity analysis on some of the critical parameters.

- Model made in Excel spreadsheet, user friendly, easy to work with
- Allows for making updates, adjustments, own calculations, sensitive analysis
- Presents transportation costs per phase, per O-D and per transport alternative (rail-ferry vs. tanker Cross Caspian)
- Aggregates calculations per section into overall transportation costs
- Input values presented separately, including sources and assumptions

The Transportation Costs Calculation (TCC) model calculates aggregated transportation costs of LPG along the TRACECA corridor.

The model consists of an output sheet, presenting the aggregated transportation costs of 14 options and a range of input sheets:

0. General input data
1. Transportation costs to the port in origin country, i.e. Aktau or TMB (1A en 1B)
2. Transportation costs of cross Caspian transport by rail ferry (2A) and by LPG tanker (2B)
3. Transportation costs of terminal
4. Transportation costs of cross landbridge by pipeline
5. Transportation costs of cross landbridge by rail

An additional worksheet is included with graphs for all selected options. The graphs present the build-up of the transportation costs for each selected option.

The options are combinations of volumes (phase 1,2 and 3) and different modes of transport. The 14 calculated options, together with costs of transportation (US$/tonne) are presented in the table below (which is the above-mentioned output sheet).

Phase 1(150-200 kT):	
1. Kazak/Kulsary-Batumi (rail to port, rail ferry terminal, ferry X Caspian, rail Cross Landbridge, Batumi terminal)	**122.24**
2. Turkmenistan-Batumi (rail to port, rail ferry terminal, ferry X Caspian, rail Cross Landbridge, Batumi terminal)	**108.26**
3. Azerbaijan-Batumi (costs to terminal/terminal costs, rail Cross Landbridge, Batumi terminal)	**60.54**
Phase 2 (600 kT):	
4. Kazak/Kulsary-Georgia (rail to port, rail ferry terminal, ferry X Caspian, rail Cross Landbridge, Georgia terminal)	**120.86**
5. Kazak/Kulsary-Georgia (rail to port, terminal, tanker X Caspian, terminal, rail Cross Landbridge, Georgia terminal)	**111.65**
6. Turkmenistan-Georgia (rail to port, rail ferry terminal, ferry X Caspian, rail Cross Landbridge, Georgia terminal)	**107.42**
7. Turkmenistan-Georgia (rail to port, terminal, tanker X Caspian, terminal, rail Cross Landbridge, Georgia terminal)	**100.46**
8. Azerbaijan-Georgia (rail Cross Landbridge, Georgia terminal)-see option 3 with higher volumes	**54.98**
Phase 3 (1.500 -2.000 kT):	
9. Kazak/Kulsary-Georgia (rail to port, terminal, tanker X Caspian, rail Cross Landbridge, Georgia terminal)	**91.86**
10. Kazak/Kulsary-Georgia (rail to port, terminal, tanker X Caspian, pipeline Cross Landbridge, Georgia terminal)	**79.93**
11. Turkmenistan-Georgia (rail to port, terminal, tanker X Caspian, rail Cross Landbridge, Georgia terminal)	**80.66**
12. Turkmenistan- Georgia (rail to port, terminal, tanker X Caspian, pipeline Cross Landbridge, Georgia terminal)	**68.74**
13. Azerbaijan-Georgia (rail Cross Landbridge, Georgia terminal)-see option 3 with higher volumes	**46.40**
14. Azerbaijan-Georgia (pipeline Cross Landbridge, Georgia terminal)- – or pipeline to destination, e.g. Turkey	**34.48**

The general input parameters are presented below. In all input sheets the dimensions and sources or assumptions are included.

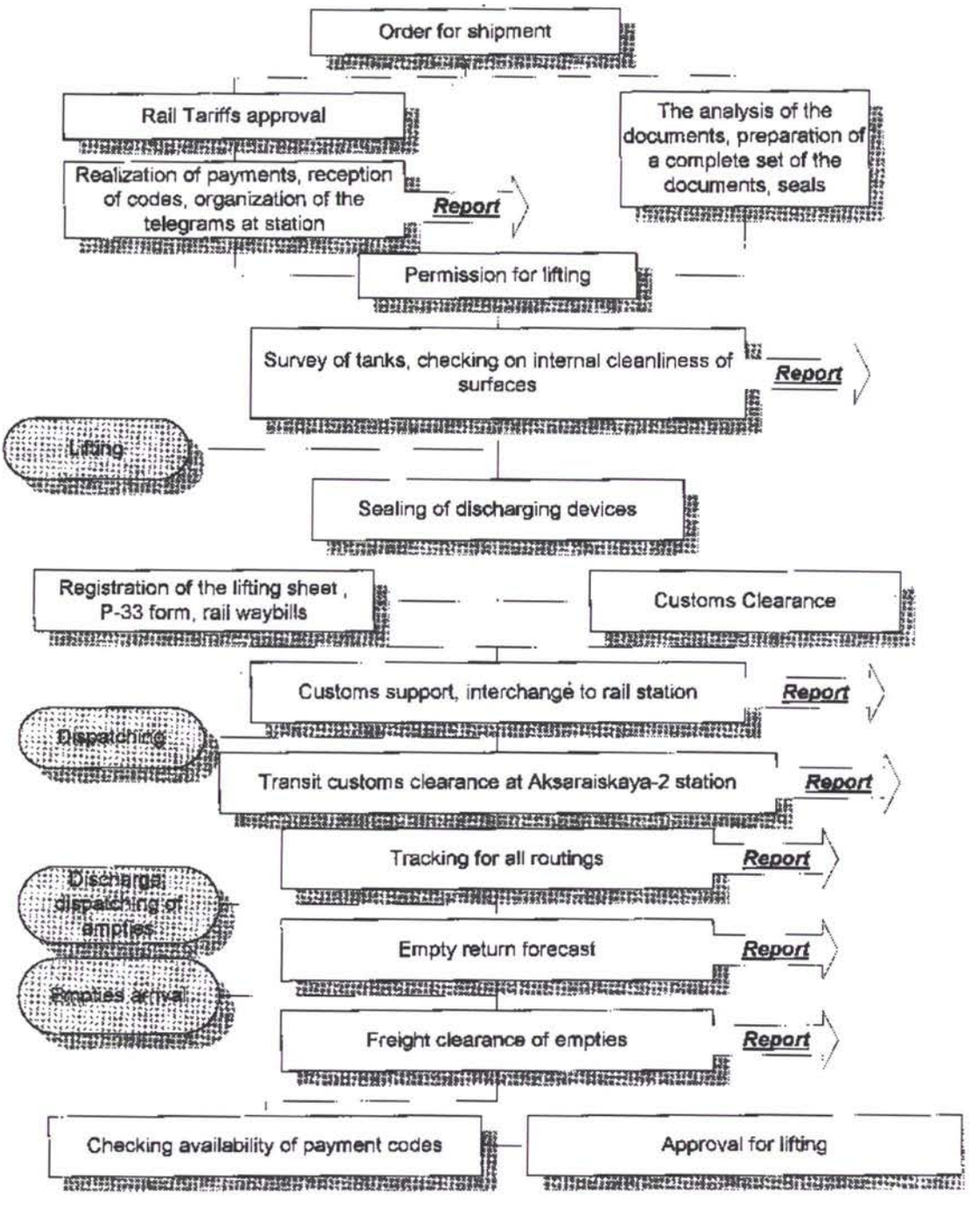
Item	amount	dimension	source-assumption
Capacity RTC (type A)	29	tonnes	CIS standard/confirmed by local railways
Capacity RTC (type B)	40	tonnes	Planned/needs technical approval
RTC operational days/year	360	days/year	Fact/confirmed by local railways
Purchase price RTC (type A)	70,000	US$	estimated price from Azovmash
Purchase price RTC (type B)	90,000	US$	estimated price from Azovmash
Locomotive	5,000,000	US$	Consultants' estimate
interest rate	7%	%	Consultants' estimate
nr years payback	25	years	Consultants' estimate
operating profit per tonne rail	1.5	USD/tonne	minimum figure as per industry practise
LPG Terminal Investment	$30,000,000	500 KT p.a.	Temryuk costs minus estimated possible savings
Terminal operating costs LPG	$750,000		Consultants' estimate
LPG Tanker Investment	$25,000,000	DWDT 10'	assumption/6' DWT Product Tanker is 18 Mio.
Tank Container		20 ft	Fact
Tank Container		40 ft	Fact
Ferry Boat	$25,000,000	US$	Reference Safinat
FOB TMB-DAF Gardabani	$84.0	tonnes	Aztranspetrol Quote TMB-Gardabani

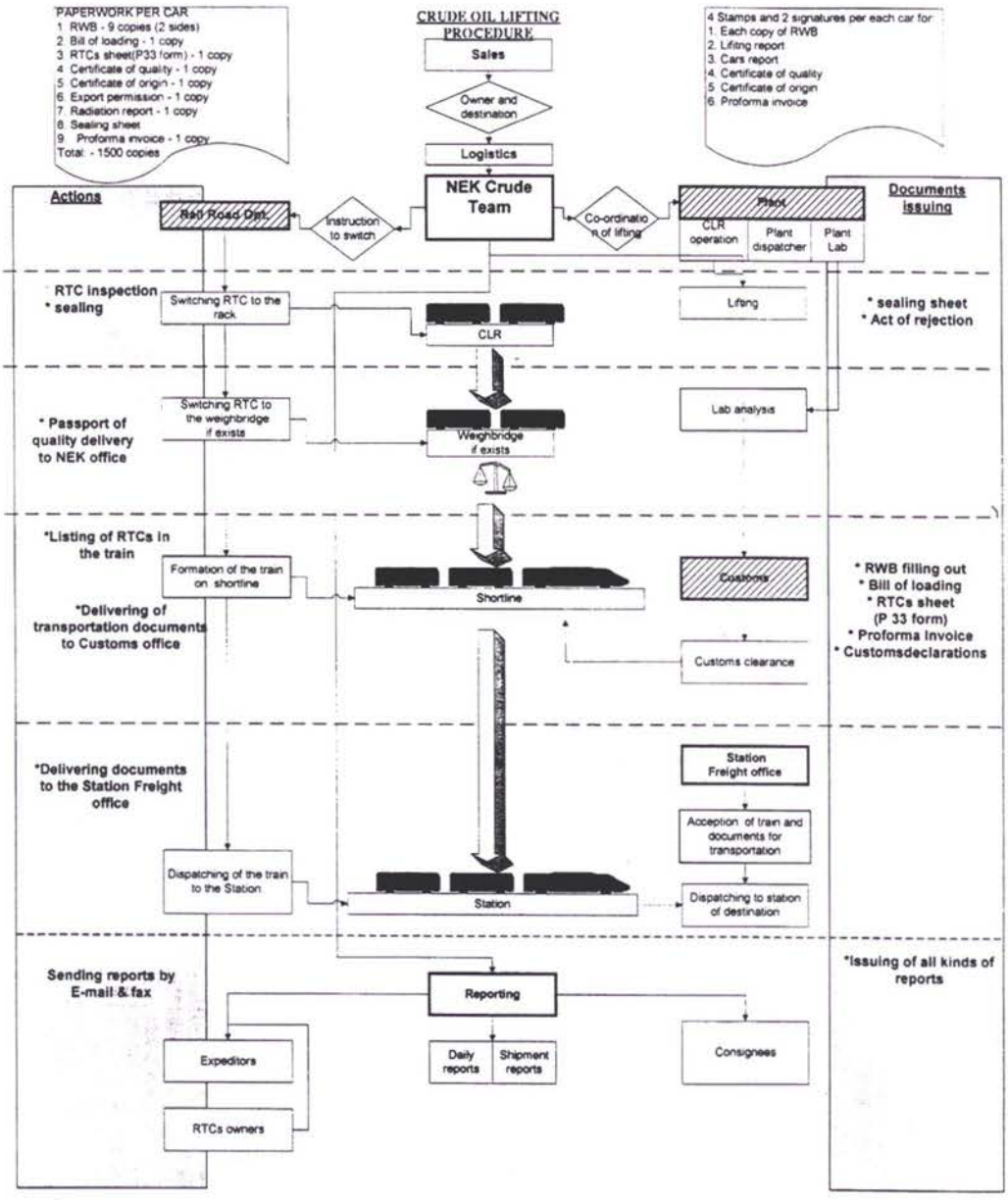
The input sheets 1-5 together form the elements of the logistic chain from source to Georgian coast. The transportation costs of all these input sheets together form the 'puzzle pieces' from which aggregated chain costs can be produced.

Besides the yellow marked input values, the input sheets also include a green marked calculation area. In this part of the inputs sheet relevant calculations are carried out. The nature of the TCC model makes it easy to follow input values (sources and assumptions) and the calculations carried out. As a consequence, the TCC model can be further used and adjusted according to the needs of the user.

ANNEX-5 Rail transport procedures in FSU

Railway transport in most countries in the region have (to a large extent) retained similar procedures as in the former Soviet Union. As an example the successive steps for rail transport from Kulsary to Odessa and back to Kulsary are as follows:

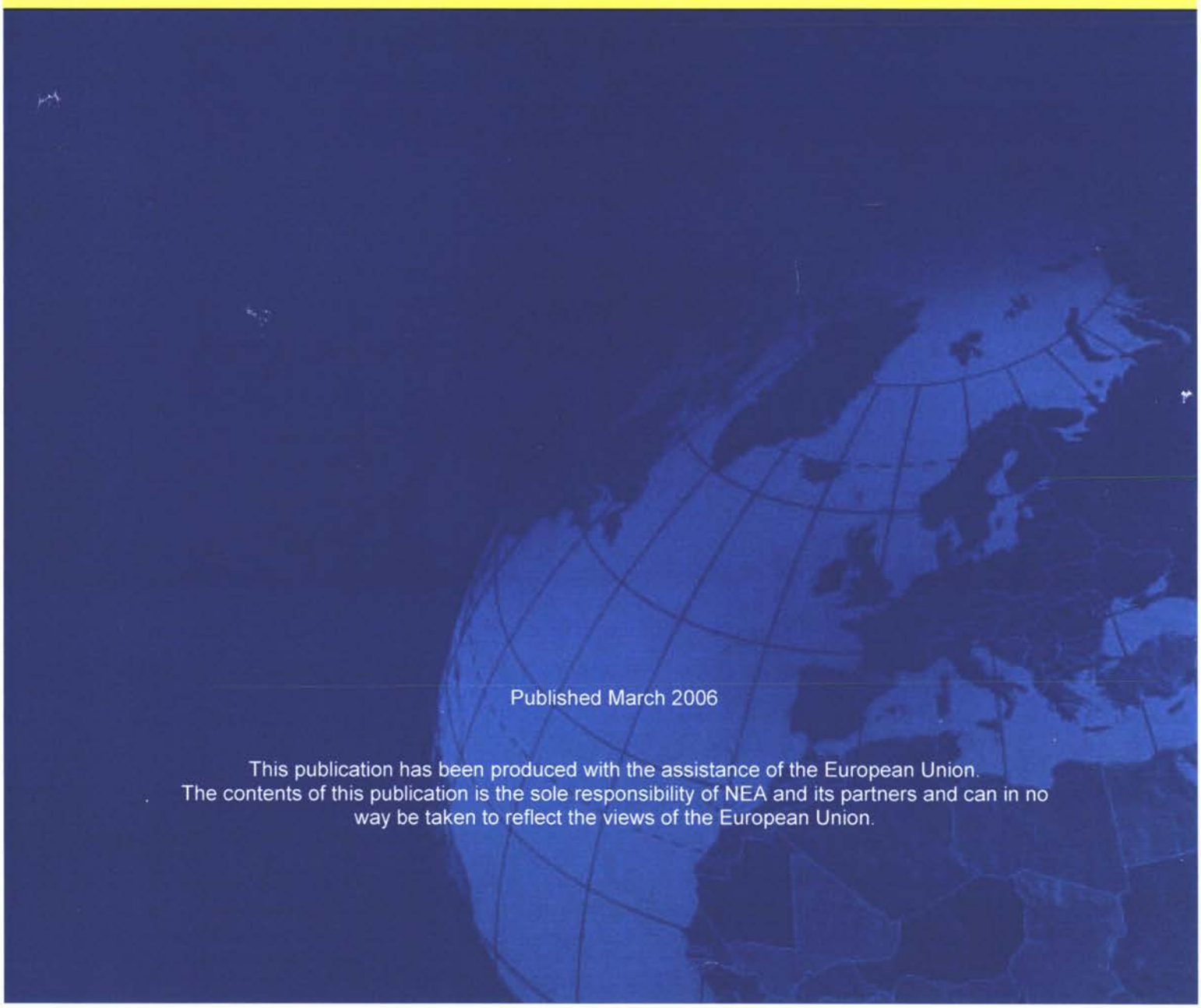



PAPERWORK PER CAR
1 RWB - 9 copies (2 sides)
2 Bill of loading - 1 copy
3 RTCs sheet(P33 form) - 1 copy
4 Certificate of quality - 1 copy
5 Certificate of origin - 1 copy
6 Export permission - 1 copy
7 Radiation report - 1 copy
8 Sealing sheet
9 Proforma invoice - 1 copy
Total: - 1500 copies
CRUDE OIL LIFTING PROCEDURE
Sales
Owner and destination
Logistics
NEK Crude Team
4 Stamps and 2 signatures per each car for:
1. Each copy of RWB
2. Lifting report
3. Cars report
4. Certificate of quality
5. Certificate of origin
6. Proforma invoice
Actions
Rail Road Dpt.
Instruction to switch
Co-ordination of lifting
Plant
CLR operation
Plant dispatcher
Plant Lab
Documents issuing
RTC inspection
* sealing
Switching RTC to the rack
Lifting
* sealing sheet
* Act of rejection
CLR
* Passport of quality delivery to NEK office
Switching RTC to the weighbridge if exists
Lab analysis
Weighbridge if exists
*Listing of RTCs in the train
Formation of the train on shortline
Shortline
Customs
* RWB filling out
* Bill of loading
* RTCs sheet (P 33 form)
* Proforma invoice
* Customsdeclarations
*Delivering of transportation documents to Customs office
Customs clearance
*Delivering documents to the Station Freight office
Station Freight office
Acception of train and documents for transportation
Dispatching of the train to the Station
Station
Dispatching to station of destination
Sending reports by E-mail & fax
Reporting
*Issuing of all kinds of reports
Expeditors
Daily reports
Shipment reports
Consignees
RTCs owners

The above provides in more details the lifting procedures as performed in Kulsary. The overview illustrates the complexity of what needs to be done, the large amount of papers involved; the need for coordination to make each individual step fulfilled and synchronized.

It should be realized that in case one of the document is not properly filled or properly signed for one railcar, it will cause problem and delay along the route and will need to be corrected. While these incidents seldom happen on the route Kulsary-Odessa which is used continuously, it may still happen especially for return of empty railcars where a new set of documents is issued at the discharge location.

Major forwarding companies have developed computerized software to issue documentations. The computer link up for coordinating with the various organizations involved in the process, monitoring the lifting process, and on the transport process till destination for each railcar, including at cross border points. Also experienced staff is located at all major stops along the route like cross border points, to alert in case of problem .



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