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WEST AFRICA LPG MARKET DEVELOPMENT STUDY



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FOREWORD

Liquefied Petroleum Gas (LPG or LP Gas) is a clean and environmentally friendly source of energy and in order to protect the environment, LPG could be made accessible to all households as substitute to wood and biomass in many developing countries. The World Bank Oil and Gas Product Group and the World LP Gas Association representing industry, have agreed to jointly investigate LPG market development prospects in the world, starting with a study on West Africa.

There is a significant untapped LPG resource base in West Africa which could be made available to meet local market demand. Most market development capacity however, lays dormant mostly because of a lack of enabling environment. This is especially true in the institutional and regulatory field and potential for development needs to be stimulated with appropriate reforms and incentives, in order to be realized.

The World Bank pricing policy has consistently supported full economic cost recovery and transparent pricing mechanisms, with little or no subsidies, except for those properly targeted to the poor, limited in time and favoring investments over consumption.

Both the World Bank and the World LP Gas Association acknowledge the fact that in several developing countries, especially in Africa, LPG subsidies have been one of the elements improving the affordability of LPG to the end-user and accelerating market growth, particularly in the early stages of a market's development. Given the macro-economic constraints of developing countries in West Africa, national objectives such as access to modern energy services for the poor or mitigating deforestation, can only be achieved by way of multiple governmental and other incentives to attract foreign direct investment, allow fair returns on capital to industry and ensure accessible prices to end consumers.

Despite their diverging views on subsidies, the World Bank and the World LP Gas Association have decided to commission an independent study on LPG Market Development in West Africa, as a first step in a co-operative effort to promote LPG as a clean and multipurpose energy accessible to all consumers. The study's findings and conclusions do not totally reflect a few diverging views of the two co-sponsors, but they constitute a major step in bridging the knowledge gap that existed in this field and definitely pave the way in making LPG accessible to the poor of Africa and elsewhere. This study will contribute to the body of knowledge in the field and the region, serve as a key instrument in the debate on access to modern energy services and will foster the energy debate at large.

EXECUTIVE SUMMARY

Current LPG consumption in the major countries of West Africa is about 360,000 tonnes per year. However, if existing policy and commercial problems could be resolved, LPG consumption could be significantly increased in the region. This would reduce the use of wood fuel/charcoal and provide many environmental benefits, including reduced pollution and deforestation. This would also provide LPG to the people who need this fuel, to raise their standard of living and domestic comfort.

The recent expansion of the LPG industry in several countries in West Africa has demonstrated the long-term potential for the regional LPG markets. If LPG is made available at an attractive price to West African markets and additional investments are made in distribution and marketing infrastructure, utilization of LPG as household fuel would significantly rise.

The availability of LPG supply in West Africa is increasing sharply. Over the last several years, crude oil exploration and production activity has intensified in the region with the discovery of many new deepwater fields. Natural gas production associated with these new crude oil reservoirs is providing new gas processing opportunities, which lead to expanded LPG recovery. Additionally, there are several programs underway in West Africa to mitigate natural gas flaring from existing crude oil fields as well as new crude oil and condensate fields. This is also leading to significantly higher LPG production rates. LPG supplies in West Africa have already expanded from about 420,000 tonnes in 1995 to nearly 2.3 million tonnes in 2000. By 2005, regional LPG production is expected to increase by an additional 130% and reach 5.3 million tonnes per year.

This rapid rise of LPG production in West Africa is significantly expanding supply sources for the region and is providing an opportunity to reduce the landed cost of LPG to importing countries in West Africa. The Region's governments should seize this opportunity, strongly encourage the utilization of regional LPG supplies and work with importing companies to reduce import costs. Supply cost savings could then be passed on to consumers to further stimulate demand growth.

Of the countries reviewed in this study, LPG consumption is very heavily concentrated in the vicinity of capitals and major cities. Urban areas currently account for 65% to 90% of total national demand for the four countries (Cameroon, Côte d'Ivoire, Ghana and Senegal) analyzed in detail in this study. This suggests that a particularly large potential market for LPG remains in the rural areas of these countries. Specific programs appear to be needed to spur the development of LPG markets in outlying areas of each country.

The pricing of LPG in West Africa varies significantly among the various countries in the region, mainly due to the differences in government policies. The price of LPG is at least partially controlled in all markets reviewed, through control of the ex-refinery price and with a subsidy program in certain countries. LPG consumer prices vary from a low of US\$336 per tonne to a high of US\$652 per tonne in the four countries reviewed in detail in this analysis. Differences in subsidy levels are a large part of the spread in consumer prices across the region.

Governments in West Africa are urged to take advantage of this unique opportunity, to develop and adopt viable, proactive programs, preferably with a Regional view, to reap scale economies in encouraging the use of LPG as a domestic fuel. Each government should work together with industry to identify ways to increase public access and awareness of LPG.

A public awareness and educational program should be developed and implemented by each country in the region to inform potential consumers of the advantages of LPG to the individual and to the local community. LPG has the advantage of providing a healthy, convenient, portable fuel to the consumer while reducing deforestation in the region.

The affordability of LPG is a major public policy and market issue in each country in West Africa. Market size, government regulatory tax policies, market competition and private sector participation influence the affordability of LPG for the average consumer. In many developing countries, LPG subsidies have also been an important factor improving the affordability of LPG and accelerating demand growth, particularly in the initial stages of market development.

Strong, active participation by the private sector is essential to build an efficient, successful LPG distribution marketing system. Several conditions must exist in the market to attract private investment. The market must be of a suitable size to justify investments, future growth prospects must be evident, clear government policies and priorities should be in place, fair regulations should be enforced, and reasonable profit margins should exist.

To fully capitalize on the rapid rise in regional LPG availability, each government in West Africa needs to reevaluate their current market situation and policies on LPG and work with private industry to reform/liberalize the market. This should be accomplished as soon as possible in order to attract new entrants and investments into the marketplace. A joint industry/government task force should be formed in each country to identify specific actions that can be taken to stimulate private participation and investment in the LPG industry. If possible, this type of industry/government initiative should be undertaken on both a regional and country basis.

ACKNOWLEDGEMENTS

This study on West Africa LPG Market Development was jointly commissioned in 1999 by the World Bank's Oil & Gas Division and the World LP Gas Association, acting as co-sponsors.

The sponsors wish to particularly thank the Government of Denmark, who co-financed through its capable institution DANIDA, the cost of the study which will undoubtedly be read with great interest, and its recommendations implemented, by all parties concerned in Africa and elsewhere.

The sponsors retained Purvin & Gertz, Inc. and Frigo Consult as contractors for the study, which included a field visit in four focus countries of West Africa. The data, expertise, quality of analysis and professionalism demonstrated by Purvin & Gertz and Frigo Consult are gratefully acknowledged by the sponsors.

The sponsors and the contractors would like to express their great appreciation for the assistance provided by the National Authorities and the local representatives of Total Fina Elf and Exxon Mobil groups during the country visits.

This project was jointly coordinated by Mr. Mourad Belguedj, Lead Energy Specialist at the World Bank and Mr. Emmanuel Chantelot, Managing Director of the World LP Gas Association.

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I

INTRODUCTION

Current LPG consumption in West Africa is estimated to be about 360,000 tonnes per year. Utilization of LPG as household fuel has been expanding in several countries in West Africa since the early 1990s, but average per capita consumption in the region remains low by international standards.

The most common household fuels in West Africa are wood and charcoal. Heavy use of these fuels is contributing to the rapid rate of deforestation that is occurring in the region. Deforestation is seen as a long-term environmental threat that can probably only be effectively combated by substitution of wood and charcoal fuels with alternate fuels such as LPG, natural gas, or petroleum products (such as kerosene). LPG is a particularly attractive alternative to wood and charcoal, since it is a clean, efficient fuel that is relatively easy to transport, store, and distribute. It produces no toxic fumes and is considered by most consumers, the domestic fuel of choice.

The recent expansion of the LPG industry in several countries has demonstrated the long-term potential for the region. LPG has already made important contributions to the environment and quality of life for the people in West Africa that are using this fuel in their households.

The World Bank and the World LP Gas Association have retained Purvin & Gertz, Inc. (Purvin & Gertz) and Frigo Consult to conduct an analysis of the West African LPG market and make recommendations on how to further stimulate the LPG industry in the region and make improvements in operations and safety.

The consulting team visited the four focus countries in this study - Cameroon, Côte d'Ivoire, Ghana, and Senegal. Information was obtained on the local LPG market in each of these countries and key industry and government officials were interviewed during these visits. Limited plant visits were made in these four countries to review overall operations, bottle/valve distribution systems, major equipment ratings, and product specifications.

Purvin & Gertz and Frigo Consult conducted this analysis and prepared this report utilizing reasonable care and skill in applying methods of analysis consistent with normal industry practice. All results are based on information available at the time of review. Changes in factors upon which the review is based could affect the results. Forecasts are inherently uncertain because of events or combinations of events that cannot reasonably be foreseen including the actions of government, individuals, third parties and competitors.

Some of the information on which this report is based has been provided by others. Purvin & Gertz and Frigo Consult have utilized such information without verification unless specifically noted otherwise. Purvin & Gertz and Frigo Consult accept no liability for errors or inaccuracies in information provided by others.

II

SUMMARY

West Africa is a region of the world with a relative abundance of natural resources, but only limited economic development to date. The region has been a large producer and exporter of crude oil in the past, and it appears that petroleum exploration and production activity will continue to remain high in the foreseeable future. While the region has considerable potential for the recovery and utilization of natural gas and LPG in energy applications in West Africa, significant progress in development of these important resources is a relatively new phenomenon. Over time, LPG production in West Africa is expected to rise dramatically and this will provide an important resource which could be used to increase the quality of life in the region and retard deforestation.

Currently, the most common sources of household energy in most developing countries in West Africa are wood and charcoal. Heavy use of these fuels is contributing to the rapid rate of deforestation that is occurring in the region. Deforestation is seen as a long term environmental threat that can probably only be effectively combated by substitution of wood and charcoal fuels with alternate fuels such as LPG, natural gas, or petroleum products (such as kerosene). LPG is a particularly attractive alternative to wood and charcoal since it is a clean, efficient fuel that is relatively easy to transport and distribute.

1

West Africa Oil and Gas Activity

West Africa has been a significant crude oil producing region in the world for many years. Recently, oil-directed exploration and development activity has intensified even further with the discovery of many new deepwater fields in the region. This increased exploration and development activity will provide additional economic stimulus to the region and result in new opportunities to expand LPG recovery through gas processing.

Production of natural gas in West Africa has not been a particularly high priority in the past. Development of natural gas was constrained since there were very limited markets for natural gas in West Africa and gas export (LNG) economics from the region were not generally attractive. As a result, most of the gas produced in association with crude oil in West Africa has generally been flared. However, this situation is now changing and several steps are being taken to mitigate natural gas flaring and recover LPG and/or condensate.

The program underway to reduce gas flaring will greatly increase the availability of LPG in West Africa over time. As this occurs, additional supplies will become available for the expansion of regional LPG markets as well as the export markets.

2

West Africa LPG Market Analysis

LPG markets in most countries in West Africa are in the early stages of development, and consumption rates have not reached high levels by international standards. However, West African LPG demand has expanded fairly significantly during the 1990s, and it appears that regional LPG demand might be poised for a period of rapid expansion in the future.

There has already been considerable development of LPG markets in a few countries in West Africa during the decade. This recent expansion of the LPG industry has demonstrated the long-term potential for the West Africa region. Additionally, LPG has already made important contributions to the environment and the quality of life of the people using this fuel in their households in several countries in the region.

Regional LPG Supply/Demand

During the 1990s, LPG production has increased rapidly in West Africa and the region is becoming a very prolific exporter of LPG to international markets. Several additional new large LPG recovery projects in West Africa are underway or in planning, and the supplies of LPG in the region are expected to continue to rise rapidly over the next 5 to 10 years. This buildup in supply is large enough to support the simultaneous expansion of regional LPG markets and significantly higher export sales.

The regional LPG supply/demand balance is summarized in the following table:

	1995	1996	2000	2002	2005
Supply					
Nigeria	169	620	1,647	2,106	4,449
Congo	4	404	404	404	404
Angola	184	190	191	191	422
Other Countries	64	68	71	73	73
Total Supply	421	1,282	2,313	2,774	5,348
Demand	247	336	381	422	516
Regional Surplus	174	945	1,932	2,352	4,832

The total regional LPG surplus is now around 1.9 million tonnes per year and is expected to continue to rise in the short to medium term. Even with the provision for continued growth in LPG consumption in West Africa, the regional LPG surplus is expected to more than double over the next five years. Thus, there is more than ample LPG supply to fuel new market development in West Africa.

The recent increase in regional LPG supplies and the prospect for an increasingly larger surplus in the region are providing an opportunity to reduce the landed cost of LPG to importing countries in the region. The accomplishment of this supply objective would be to effectively replace European-referenced supplies (FOB Med or European ports) with regional supplies. The regional governments should strongly encourage the utilization of regional LPG supplies and work with importing companies to reduce import costs. These savings, once achieved, could be passed on to consumers to further stimulate demand.

LPG production has been accelerating particularly fast in Nigeria since 1995. LPG production in Nigeria is now over 1.6 million tonnes per year and represents around 85% of the total LPG supply in West Africa. The Congo is now the second largest producer of LPG and has assumed a very important role in supplying small butane cargoes for regional markets. Angola is the third largest producer, and its LPG production is expected to significantly expand as projects to reduce gas flaring in Angola are implemented.

Market Size/Characteristics

The general structure of the LPG industry in West Africa includes both private and public participation in varying degrees in the supply, distribution, and marketing of the product. In countries with a local refinery, the refinery is normally responsible for LPG imports as well as domestic supplies. Most LPG is distributed and marketed by private oil marketing companies in the region, but there are also government-owned companies active in LPG marketing in some countries. LPG prices are generally controlled by the government, at least at the ex-refinery level. Distribution and marketing margins are typically either controlled or heavily influenced by government agencies.

The size of the LPG market in West Africa has been fairly modest historically, both on an absolute basis and in terms of average consumption per capita. This is still the case for the region as a whole, but there has been significant growth in LPG consumption in a few countries in the region during the 1990s.

Total LPG sales in West Africa are currently estimated to be about 361,000 tonnes per year as detailed in the following table:

WEST AFRICA LPG CONSUMPTION					
	Total LPG Consumption (M Tonnes)	Percent Res/Comm (%)	Res/Comm LPG Cons. (M Tonnes)	Population (MM People)	R/C LPG Cons. Per Capita (Kg/Year)
Cameroon	28	95%	27	14.9	1.8
Côte d'Ivoire	50	85%	43	15.7	2.7
Ghana	40	85%	34	19.2	1.8
Senegal	100	98%	98	9.5	10.3
Subtotal	218	92%	201	59.3	3.4
Angola	50	90%	45	11.7	3.8
Congo, Dem. Rep.	1	90%	1	49.6	0.0
Congo, Rep.	4	90%	4	2.7	1.3
Gabon	17	90%	15	1.2	12.8
Nigeria	58	40%	23	125.1	0.2
Other Countries	13	90%	12	65.8	0.2
TOTAL WEST AFRICA	361	83%	301	315.4	1.0

About 60% of current LPG consumption in West Africa is concentrated in four countries, which are the focus countries for this analysis—Cameroon, Côte d'Ivoire, Ghana, and Senegal. The only other countries in the region with significant consumption of LPG are Angola, Gabon, and Nigeria.

Most of the LPG consumed in West Africa is used for household cooking. As a result, around 83% of total LPG consumption is used in the residential and commercial sector.

In the case of some countries, the proportion of total LPG demand concentrated in the residential and commercial sector is even higher. This is the case in Senegal, where over 98% of all LPG consumption occurs in the residential and commercial sector.

One common characteristic of all the West African markets analyzed in detail in this study is that LPG consumption tends to be very highly concentrated in, and near, capitals and other major cities. The proportion of LPG in the major urban centers in the four countries highlighted in this study is estimated in the following table:

LPG CONSUMPTION IN MAJOR URBAN CENTERS					
	Cameroon	Côte d'Ivoire	Ghana	Senegal	Total -4 Countries
Total Country					
Res/Com LPG Demand (M Tonne)	27	43	34	98	202
Population (MM People)	14.9	15.7	19.2	9.5	59.3
Avg. Consumption (Kg/Yr./Capita)	1.8	2.7	1.8	10.3	3.4
Major Urban Centers					
Res/Com LPG Demand (M Tonne)	22	39	22	78	161
Population (MM People)	3	3	4	3	13
Avg. Consumption (Kg/Yr./Capita)	7.2	12.9	5.5	26.1	12.4
Rest of Country					
Res/Com LPG Demand (M Tonne)	5	4	12	20	41
Population (MM People)	11.9	12.7	15.2	6.5	46.3
Avg. Consumption (Kg/Yr./Capita)	0.5	0.3	0.8	3.0	0.9

It should be noted that many estimates are required to generate the above table. However, it does clearly indicate the approximate split between LPG consumption rates in major urban centers versus the rest of the country for the four countries analyzed.

The combined average per capita consumption in the four countries is estimated to be around 12.4 Kg per year for the major urban centers. This is well above the estimate of 0.9 Kg per person average LPG consumption for the rest (outside of the major urban centers) of the four countries.

In the case of the four countries visited, LPG demand in the major cities represents between 65% and 90% of the total national demand. This suggests that a particularly large potential market for LPG remains outside of the capital/major cities in each country. It further suggests that specific programs will probably be required in order to spur development of LPG markets in outlying areas of each country.

The average consumption of LPG as fuel in residential and commercial markets in West Africa is currently estimated to be only around 1.0 kilogram per year per capita. This is very low by world standards and serves to highlight the large potential for expanding the role of LPG as a domestic fuel in West Africa in the future. Average per capita consumption of LPG in worldwide residential and commercial markets is currently about 15.8 kilograms per year. Thus, current LPG consumption in West Africa has only reached about 6% of average per capita world consumption rates.

Market Growth

The development of the LPG market in West Africa is reviewed in the table below for the four country LPG markets examined in detail in this study:

	LPG Consumption (M Tonnes)				
	Cameroon	Côte d'Ivoire	Ghana	Senegal	Total
1990	23.0	23.0	17.0	33.5	96.5
1995	23.2	29.0	39.6	53.1	144.9
1999(E)	28.0	50.0	40.0	100.0	218.0
Average Growth (%/Year)	2.2%	9.0%	10.0%	12.9%	9.5%

Taken together, LPG consumption in these four countries has expanded by an average rate of about 9.5% per year during the 1990s. This represents fairly strong growth over this period and a significant acceleration in growth rates compared to the previous decade.

LPG demand increased fairly well in Ghana during the first half of the 1990s, but the market expansion has since slowed. In 1996, the government of Ghana removed a price subsidy, which led to a temporary decline in LPG consumption. Autofuel LPG consumption continues to decline, while use of LPG as a household fuel has resumed some level of growth.

In Côte d'Ivoire, market growth has been stronger since 1995 (compared to the first half of the decade) due to the positive effects of the CFA devaluation in 1994 on the local economy and the positive impact of aggressive marketing practices of a new entrant on domestic consumption.

Cameroon has experienced the lowest LPG demand growth of the four countries during the 1990s. One reason for this appears to be the lack of any significant government policy promoting the use of LPG. Another is the apparent impact that a new market entrant has had on the local market. While this new entrant has been successful in garnishing market share away from other marketers, total LPG consumption in Cameroon has not changed appreciably over the past decade, and most other marketers do not appear to have much interest in making additional investments in LPG distribution and marketing until the industry is reformed.

The highest growth market of these countries is Senegal. This is an important example of LPG market development in the region, and lessons learned in Senegal might be successfully applied in other countries in the region.

Senegal has undergone dramatic growth during the 1990s for several reasons. LPG has been available at competitive prices in small-sized bottles since the mid-1980s. The competitive pricing has resulted, to a great degree, from the sizeable subsidy that is available for LPG sold in small bottles.

The government program to subsidize LPG in small bottles has made it more affordable to lower-income customers and accelerated the rate of new customer additions during the 1990s. As the LPG market experienced strong growth in Senegal, private marketing companies elected to make sizeable new investments in LPG storage, bottling, and distribution facilities. These types of investments were essential for an orderly expansion of the market. The strong growth pattern that became evident in Senegal during the early 1990s had the effect of drawing new participants into the market, who adopted aggressive marketing strategies and have helped to stimulate further growth in an already successful and expanding market.

A key feature of the success story in Senegal appears to be the impact of the government program promoting LPG on consumer preferences and private investment. The program significantly enhanced the competitive position of LPG and was maintained for a long enough period of time to allow the market to expand to its present size.

Currently, the government of Senegal is in the initial phase of a five-year program to completely eliminate the existing subsidy on LPG sold in small bottles. While the government has generally been pleased with the success of the LPG program, it wants to reduce the financial burden of this subsidy on the state. The complete elimination of the subsidy is expected to significantly reduce future LPG demand growth rates and may ultimately result in some erosion of existing LPG use in the country.

Supply Cost Evaluation

The cost of LPG supplies is an important element in LPG pricing in West Africa, as it is in any developing market. The LPG acquisition cost can have a significant influence on the product cost to the consumer and the ability of the consumer to afford LPG as a household cooking fuel. Additionally, the LPG acquisition cost is particularly important to those countries where significant imports are required and LPG is subsidized by the government.

In general, the largest parcel size that can be reasonably accommodated in onshore LPG storage should be used in order to minimize shipping costs. However, the optimization of LPG supply costs in developing markets typically involves reaching a balance between potential savings achieved with larger parcel sizes and the cost of providing additional storage.

The limiting factor on import parcel size in West Africa appears to be the capacity of the storage facilities in the various countries. Currently, most countries in West Africa import LPG on a 'single port discharge' basis. This requires small ship movements from the source to the importing country. In theory, the countries with small parcel sizes could reduce freight costs by combining orders and using multi-port deliveries in larger ships. However, there are many practical considerations which currently limit these opportunities. As the markets expand and the involvement of private companies in supply acquisition increases, more opportunities for supply optimization will likely develop.

The overall size of the local market served by import facilities drives the economical throughput of the storage facilities. The larger markets in West Africa are most likely to benefit from the greater parcel sizes, as the import and storage facilities will have a higher overall utilization rate. Senegal is a good example. Over the last several years, the average parcel size of imports has increased from around 1,000 tonnes to approximately 4,000 tonnes, with a corresponding decrease in the freight rates.

Some representative LPG shipping costs for various size parcels are summarized below for West African trade:

Origin	Destination	Ship Class (Tonnes)			
		12,000	4,000	2,000	1,000
Point Noire	Dakar	35.1	48.3	73.4	104.3
Point Noire	Abidjan	21.8	29.7	44.5	67.0
Point Noire	Tema	21.8	29.7	44.5	67.0
Point Noire	Doula	17.3	23.5	37.3	57.7

As illustrated in the table above, larger parcel sizes can provide a significant reduction in freight rates. This is particularly true for very small parcels—for example, comparing shipping costs for 2,000 tonne parcels with 1,000 tonne parcels. As we move up in parcel size, the benefit of continuing to increase parcel size gradually diminishes.

Recent actions taken in Senegal appear to have achieved much of the potential cost reduction benefits available to this market. This does not appear to be the case yet in the other countries reviewed and some potential remains to further optimize product acquisition costs. Multi-port discharge may provide an alternative to the current import strategy if the appropriate parties are able to coordinate such actions.

Côte d'Ivoire typically imports LPG in 1,500 tonne parcels and import requirements are currently around 20,000 tonnes per year. Ghana currently imports around 35,000 tonnes per year and averages around 2,000 tonne parcel sizes. Both countries might be candidates for increasing LPG storage capacity to lower freight cost. The economics of these potential projects will be enhanced in either country if import levels continue to rise.

Due to the low LPG import levels in Cameroon, there does not seem to be much economic merit in expanding LPG storage at this location unless the market and import requirements expand significantly.

If the storage facilities were adequate to handle larger parcel sizes and the freight rates could be decreased, inland countries might also be able to benefit from lower LPG acquisition costs. The larger import facilities may be able to function as trans-shipment terminals, providing economies of scale to help make the importation of LPG viable in other inland markets. Currently, the inland markets of Burkina Faso, Mali, Chad and the Central African Republic receive LPG via truck transport from the coastal import facilities in Côte d'Ivoire, Senegal and Cameroon. The decrease in import costs may provide additional economic incentive for the expansion of markets in the inland countries.

Pricing/Competitiveness of LPG

The pricing of LPG in the various countries studied in West Africa differs widely, mainly due to the differences in government policies. The price of LPG is at least partially controlled in all the markets, mainly through control of the ex-refinery price and with the help of a subsidy program in certain countries.

The pricing of LPG in the four West African countries analyzed in this study is summarized below:

WEST AFRICA LPG PRICING (\$US/Tonne)						
	Cameroon 12.5 Kg	Côte d'Ivoire		Ghana 14.5 Kg	Senegal	
		6 Kg	12.5 Kg		6 Kg	12.5 Kg
Ex-Refinery Price	150.0	235.0	235.0	264.2	306.8	306.8
Shipping	9.2					
Port Charges	6.0	2.0	2.0			
Taxes and Duties	1.7	4.7	4.7	39.6		
Stabilization (Tax)						81.8
Storage and Filling Margin	207.6			103.8	134.7	183.5
Distribution Margin	89.0	268.8	218.6		52.8	30.4
TVA					44.1	49.0
Transport Equalization Subsidy	29.8	6.4 (100.2)	6.4		(202.0)	
Consumer Price	493.3	416.7	466.7	407.5	336.4	651.5

As demonstrated in the table above, the ex-refinery price of LPG varies widely among the countries studied. Côte d'Ivoire, Ghana, and Senegal have been slowly moving towards import parity in their ex-refinery pricing structure over several years. The ex-refinery price in Cameroon differs the most from international import parity prices. However, it should be noted that imports of LPG into Cameroon account for only approximately 10% of the total supply.

The storage, filling and distribution margins available to marketers and dealers in the countries studied also varied considerably, affected strongly by government policy and market structure. Ghana had the smallest overall margin (\$US 103.8 per tonne) due to the fact that the marketers are just involved with LPG cylinder filling and not distribution. The highest distribution and filling margin occurs in Cameroon, at approximately \$US 297 per tonne, which represents over 60% of the end-user price.

The subsidies for LPG are explicitly detailed in the price structure in Côte d'Ivoire and Senegal. However, there are often "hidden" subsidies in the other countries through the government control of the ex-refinery price. While Senegal has a large direct subsidy of \$US 202 per tonne for LPG in 6 Kg cylinders, it must be pointed out that Senegal also charges a TVA tax of \$US 44 per tonne on this LPG. In effect, the government is partially offsetting the cost of the subsidy by taxing the LPG sales.

LPG prices in the principal markets of West Africa range from a low of \$US 336 per tonne in small cylinders in Senegal to a high of \$US 652 per tonne, also in Senegal. In markets with no subsidy program, the price of LPG ranges from approximately \$US 408 per tonne to \$US 493 per tonne at the consumer level.

Surprisingly, the retail selling prices of LPG in the various countries are not as dissimilar as might be expected. Additionally, consumer prices in the West African countries studied are not particularly high when compared to other developing markets around the world.

The comparative prices of various fuels on an energy equivalent basis in West Africa are summarized below:

Fuel	Cameroon	Côte d'Ivoire	Ghana	Senegal
LPG				
6 kg	22.6	19.1		15.4
6 Kg (w/o subsidy)		24.7		29.9
12.5 Kg		21.4	18.7	24.7
Electricity	35.8	49.1		
Charcoal	74.4	21.3	17.1	20.2
Kerosene	21.1	25.4	17.3	22.2

In the countries included in this study, LPG appears to be a reasonably competitive fuel. However, its competitive position varies from country to country and is noticeably effected by the presence or lack of subsidies. LPG appears to have the strongest competitive position in Senegal due to the high subsidy applied to 6 Kg bottles. If this subsidy is removed as planned, LPG will no longer be the most attractive household fuel on an energy equivalent cost basis.

In Ghana, LPG appears to be slightly higher than either charcoal or kerosene on an energy equivalent cost basis.

In Côte d'Ivoire, LPG has a competitive advantage versus charcoal and kerosene if the existing subsidy is maintained. However, even without the subsidy, LPG still appears to be a competitive fuel.

In Cameroon, LPG is priced slightly higher than kerosene on an energy equivalent cost basis. Reported data indicated that LPG was priced below charcoal on this basis. However, there is some doubt about this conclusion since the use of charcoal is wide spread in the country.

The initial equipment costs for LPG cooking appliances in the West African countries studied in this report are summarized below:

	Cameroon 6 Kg	Côte d'Ivoire 6 Kg	Ghana 14.5 Kg	Senegal 6 Kg
Bottle Deposit	13	13	32	10
Burner	10	10	38	5
Cooker/Stand	5	13		5
Total	28	37	70	21

In order to use LPG, the consumer has a higher initial investment cost over using other household fuels. The initial cost includes the deposit on or the purchase of the LPG cylinder and the purchase of a cooking appliance or stove. This becomes an affordability issue to low income potential consumers. The initial investment cost for LPG can be a barrier for users. The minimum equipment cost in the countries reviewed ranged from a low of \$US 21 in Senegal to a high of \$US 70 in Ghana. The cost in Ghana is particularly high because the typical consumer practice is to purchase a cylinder outright (versus payment of a bottle deposit which is the case in other countries) and prevalence of a larger (14.5 Kg) bottle size. The burner cost in Ghana is higher than the other countries because reportedly, consumers in Ghana prefer to purchase a stove instead of an open burner and cooking stand.

Recommendations

Each local government in West Africa should adopt a strong, proactive program to encourage the use of LPG as a domestic fuel and work together with industry to identify ways to increase public access to LPG and increase public awareness of this clean fuel.

A public education program should be developed and implemented to inform potential consumers of the advantages of LPG to the consumer and local community. LPG has the benefit of reducing deforestation while providing a healthy, convenient and portable fuel to the consumer. Thus, both the regional environment and the individual household benefit from conversion from wood and charcoal to LPG fuel.

The LPG business and regulatory structure needs to be strengthened and liberalized in most West African countries in order to stimulate market development and attract new market entrants. This requires the establishment and enforcement of transparent and fair regulations that are equally applied to all companies engaged in the distribution and marketing of LPG and the manufacturing of cylinders (where applicable) in each country.

Strong participation by private industry is essential to build an efficient and robust LPG distribution marketing system. In order to attract investment by private industry, several conditions must exist in the LPG market. The market must be of a suitable size to justify investments, there must be a reasonable prospect for future growth, clear government policies and priorities should be in place, adequate and fair regulations should exist, and reasonable profit margins should be evident.

Each government in West Africa needs to reevaluate their current position and policies on LPG and work with private industry to reform/liberalize the market in order to attract new investments and new entrants into the marketplace. A joint industry/government task force should be formed to review the current LPG business/regulatory environment in each country and identify specific actions that can be taken to stimulate private participation and investment in LPG distribution and marketing facilities. This industry/government initiative should be undertaken on both a regional and a country level.

In most countries in West Africa, government initiatives will be required to stimulate LPG consumption, particularly in the outlying areas of each country. While LPG consumption has already experienced sizeable growth in several major urban centers in the region, utilization of LPG in smaller cities and rural areas remains relatively low. Consumer education and awareness programs should be developed and utilized to promote the use of LPG in household applications to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG. These programs need to target consumers in outlying areas and address access to LPG supply and equipment as well as the affordability of LPG to the consumer.

The affordability of LPG for the average consumer is a major market and public policy issue in each country in West Africa. Market size, governmental regulatory and tax policies, private sector participation and market competition are all elements that influence the affordability of LPG. In many developing countries, LPG subsidies have also been a key factor improving the affordability of LPG to the end-user and accelerating market growth, particularly in the early stages of a market's development.

Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. If subsidies are used to stimulate LPG consumption and increase the affordability of the fuel, the subsidies should be established in an explicit and transparent manner. Subsidies/equipment rebates and/or low interest loans to new customers might be considered in order to overcome the affordability issue and increase access to modern fuels.

The plan to completely eliminate the subsidy on LPG consumed in 6 Kg bottles in Senegal should be re-evaluated against the price elasticity of existing markets. Additionally, the impact of the loss of the subsidy on future prospects of developing additional LPG consumption in the outlying areas of the country should be reviewed. Over the long term, some reduction in the subsidy is probably unavoidable considering the size of the market, the magnitude of the existing subsidy and fiscal constraints on the government of Senegal. However, it is possible that the program to completely eliminate the subsidy may damage a very successful program to utilize LPG and retard deforestation in the country. At a minimum, the planned subsidy elimination is expected to sharply reduce future growth of LPG consumption in Senegal and threaten the viability of existing and future investments by private industry.

Significant progress in a regulatory system governing LPG appears to be needed in Cameroon, where the lack of clear and equitable regulations appears to have provided an unfair advantage for one marketer/cylinder manufacturer and discouraged other marketers from making additional investments.

Several LPG operational and safety issues appear to need attention in Ghana. Standards for LPG marketing and distribution facilities should be developed as soon as possible and uniformly applied across the country. Such standards should be a mandatory part of the licensing procedure for new facilities. Cylinder testing programs need to be established and the marketers given the opportunity and right to remove/replace unsafe cylinders. While these particular safety issues were evident in Ghana, safety issues also exist in most other countries in the region.

There have been considerable efforts by several countries in recent years to increase LPG import parcel sizes to reduce the product acquisition cost. This has been particularly apparent in Senegal, and freight costs have significantly declined for this country. We recommend that the parties responsible for LPG acquisition continue to look for opportunities to reduce import freight costs in the future. In the near term, opportunities for break bulk facilities may be limited by market size and other geographic and commercial issues. However, over time, as the regional market expands, we would expect many new import cost reduction opportunities to materialize.

3**Bottle/Valve Distribution Review**

The system for distributing, recycling, inspecting and filling LPG cylinders is a key element of the safety system utilized by the LPG industry throughout the world. The bottle/valve distribution systems in West Africa vary across the region due to differences in consumer preferences and government regulation.

In three of the four countries visited in West Africa, the filling plants are centralized, enabling the facilities to provide economies of scale through high filling capacities, and allowing for comprehensive testing and checking of cylinders. Many of these filling plants are automated, minimizing the impact of human error in the process. Cylinder testing and re-qualification facilities are often established in conjunction with the filling plant, allowing cylinder transportation cost for maintenance to be minimized.

In Ghana, the distribution system is quite different than in the other countries in the study. Due to the consumer preference for bottle ownership, the marketing companies do not have the responsibility for maintenance of the cylinders.

Regulations and standards across the region are not standardized, but there are similarities in some of the countries visited. The international oil marketing companies operating in the region have specific regulations and standards demanded by corporate bodies. The regulation and enforcement of safety practices across the region vary depending upon government oversight of the industry.

The overall conclusions drawn from observations at selected LPG distribution facilities in the countries visited during this study is that safety improvements are needed in several segments of the LPG industry in West Africa.

Local cylinder fabrication takes place in three of the four countries visited, but only one of the manufacturing companies appears to produce cylinders of international standard. The other companies produce either cylinders of substandard quality or have had quality problems in their production in the past. It is a severe problem for the entire LPG industry if cylinders of substandard quality are circulated. Therefore, we strongly recommend that the governments strengthen and enforce cylinder-manufacturing standards in each country with manufacturing plants in operation. These manufacturing standards should also be standardized across the region, as transportation of bottles across country boundaries currently occurs. The standardization of bottle specifications across the region will enable conforming bottles to be safely utilized in each country. Standardization of bottle specifications will also expand sales opportunities for locally produced bottles (vs. imported bottles).

There was a general observation that the majority of the filling plants did not perform check weighing and leak testing of all the filled cylinders. We strongly recommend that there must be complete check weighing carried out, since over-filled cylinders can be very dangerous if they are exposed to heat. Additionally, a thorough leak-testing program should be a standard procedure. An automatic system would alleviate the possibility of human error and greatly improve safety.

The overall safety condition of the filling plants observed varied from very good conditions to very poor. Those plants that had very poor conditions typically lacking the following features: emergency plans, remotely-located plant shutdown systems, water spray over the filling area, gas detection systems, breakaway devices at the tank truck discharge or loading facility, fire hoses, emergency plans integrated with the local fire brigade, etc.

Generally, the distribution mode of customer-owned cylinders with no exchange system tends to compromise safety. Under this system, it is more difficult to improve safety standards and enforce the criteria for cylinder rejection. In Ghana, the filling plant operators need formal government regulatory support for the rejection of filling the customer's cylinder. However, this system depends on the filling plant operator to be trained and responsible for checking the cylinders, a weakness inherent in the system. While it would be ideal to operate a cylinder exchange program, the practical implementation of such a system in Ghana would be near impossible based on the current consumer ownership of cylinders.

It is recommended that management at the filling plants start collecting data on over and under-filled cylinders, a practice that is not used at any of the plants visited by the consulting team. This data will help control the operations, ensure that the filling machines and cylinder valves are in good condition, and may also prove helpful in the remediation of claims against equipment manufacturers, if needed.

4**Technical Specifications/Equipment Rating**

Technical specifications and equipment rating are important factors that influence the operability and safety of LPG distribution systems at any location in West Africa, or elsewhere. In this analysis, LPG specifications and equipment ratings were reviewed for the four countries visited to evaluate the potential for increasing the propane content of LPG in the future.

During the plant visits, it was found that more detailed information must be obtained from all the marketing companies before it can be decided which components of the infrastructure and equipment can be used to handle a higher propane content product and which must be replaced.

Most of the cylinders seem to be designed for propane use, but a more comprehensive check is needed before any changes are made.

The storage tanks appear to be mostly butane rated, so they would have to be replaced by tanks designed for propane use, or, alternatively, new propane-rated tanks have to be added.

Since only a few installations have been visited, we do not know explicitly whether the condition of the other marketing companies' installations and cylinders differ from the visited companies. The individual industry professionals interviewed, however, assured us that the total industry picture was very similar to their specific infrastructure and operations.

Most likely a pre-condition for handling a higher propane content product is that investments are made in new propane rated storage tanks, a rather expensive component, but other components might be required to be replaced as well. Before any changes in the product specifications are made in the countries in West Africa, a much more comprehensive assessment of the existing infrastructure and equipment would need to be completed.

III STUDY RECOMMENDATIONS

The recommendations contained throughout the West Africa LPG Market Development Study report are reproduced in this section for the convenience of the reader and for easy referral. The order of the recommendations included in this summary section follows the overall outline of the full report.

1

Summary

Overall Recommendations

Each local government in West Africa should adopt a strong, proactive program to encourage the use of LPG as a domestic fuel and work together with industry to identify ways to increase public access to LPG and increase public awareness of this clean fuel.

A public education program should be developed and implemented to inform potential consumers of the advantages of LPG to the consumer and local community. LPG has the benefit of reducing deforestation while providing a healthy, convenient and portable fuel to the consumer. Thus, both the regional environment and the individual household benefit from conversion from wood and charcoal to LPG fuel.

The LPG business and regulatory environment should be strengthened and liberalized further in most West African countries in order to stimulate market development and attract new market entrants. This requires the establishment of transparent and fair regulations that are equally applied to all companies engaged in the distribution and marketing of LPG and the manufacturing of cylinders (where applicable) in each country.

Strong participation by private industry is essential to build an efficient and robust LPG distribution marketing system. In order to attract investment by private industry, several conditions must exist in the LPG market. The market must be of a suitable size to justify investments, there must be a reasonable prospect for future growth, clear government policies and priorities should be in place, adequate and fair regulations should exist, and reasonable profit margins should be evident.

Each government should reevaluate their current position and policies on LPG and work with private industry to reform/liberalize the market in order to attract new investments and new entrants into the marketplace. A joint industry/government task force should be formed to review the current LPG business/regulatory environment in each country and identify specific actions that can be taken to stimulate private participation and investment in LPG distribution and marketing facilities. This industry/government initiative should be undertaken on both a regional and country level.

In most countries in West Africa, government initiatives will be required to stimulate LPG consumption, particularly in the outlying areas of each country. While LPG consumption has already experienced sizeable growth in several major urban centers in the region, utilization of LPG in smaller cities and rural areas remains relatively low. Consumer education and awareness programs should be developed and utilized to promote the use of LPG in household applications to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG. These programs need to target consumers in outlying areas and address access to LPG supply and equipment as well as the affordability of LPG to the consumer.

The affordability of LPG for the average consumer is a major market and public policy issue in each country in West Africa. Market size, governmental regulatory and tax policies, private sector participation and market competition are all elements that influence the affordability of LPG. In many developing countries, LPG subsidies have also been a key factor improving the affordability of LPG to the end-user and accelerating market growth, particularly in the early stages of a market's development.

Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. If subsidies are used to stimulate LPG consumption and increase the affordability of the fuel, the subsidies should be established in an explicit and transparent manner. Subsidies/equipment rebates and/or low interest loans to new customers might be considered to overcome the affordability issue and increase access to modern fuels.

The plan to completely eliminate the subsidy on LPG consumed in 6 Kg bottles in Senegal should be re-evaluated against the price elasticity of existing markets. Additionally, the impact of the loss of the subsidy on future prospects of developing additional LPG consumption in the outlying areas of the country should be reviewed. Over the long term, some reduction in the subsidy is probably unavoidable considering the size of the market, the magnitude of the existing subsidy and fiscal constraints on the government of Senegal. However, it is possible that the program to completely eliminate the subsidy may damage a very successful program to utilize LPG and retard deforestation in the country. At a minimum, the planned subsidy elimination is expected to sharply reduce future growth of LPG consumption in Senegal and threaten the viability of existing and future investments by private industry.

Significant progress in regulatory system governing LPG appears to be needed in Cameroon, where the lack of clear and equitable regulations appears to have provided an unfair advantage for one marketer/cylinder manufacturer and discouraged other marketers from making additional investments.

Several LPG operational and safety issues appear to need attention in Ghana. Standards for LPG marketing and distribution facilities should be developed as soon as possible and uniformly applied across the country. Such standards should be a mandatory part of the licensing procedure for new facilities. Cylinder testing programs need to be established and the marketers given the opportunity and right to remove/replace unsafe cylinders. While these particular safety issues were evident in Ghana, safety issues also exist in most other countries in the region.

There have been considerable efforts by several countries in recent years to increase LPG import parcel sizes to reduce the product acquisition cost. This has been particularly apparent in Senegal, and freight costs have significantly declined for this country. We recommend that the parties responsible for LPG acquisition continue to look for opportunities to reduce import freight costs in the future. In the near term, opportunities for break bulk facilities may be limited by market size and other geographic and commercial issues. However, over time, as the regional market expands, we would expect many new import cost reduction opportunities to materialize.

Bottle/Valve Distribution Review

The system for distributing, recycling, inspecting and filling LPG cylinders is a key element of the safety system utilized by the LPG industry throughout the world. The bottle/value distribution systems in West Africa vary across the region due to differences in consumer preferences and government regulation.

Local cylinder fabrication takes place in three of the four countries visited, but only one of the manufacturing companies appears to produce cylinders of international standard. The other companies produce either cylinders of substandard quality or have had quality problems in their production in the past. It is a severe problem for the entire LPG industry if cylinders of substandard quality are circulated. Therefore, we strongly recommend that the governments strengthen and enforce cylinder manufacturing standards in each country with manufacturing plants in operation. These manufacturing standard should also be standardized across the region, as transportation of bottles across country boundaries currently occurs. The standardization of bottle specifications across the region will enable conforming bottles to be safely utilized in each country, and expand sales opportunities for locally produced bottles.

There was a general observation that the majority of the filling plants did not perform check weighing and leak testing of all the filled cylinders. We strongly recommend that there must be complete check weighing carried out, since over-filled cylinders can be very dangerous if they are exposed to heat. Additionally, a thorough leak-testing program should be a standard procedure. An automatic system would alleviate the possibility of human error and greatly improve safety.

It is recommended that management at the filling plants start collecting data on over and under-filled cylinders, a practice that is not used at any of the plants visited by the consulting team. This data will help control the operations, ensure that the filling machines and cylinder valves are in good condition, and may also prove helpful in the remediation of claims against equipment manufacturers, if needed.

2**Cameroon**

The LPG business and regulatory environment in Cameroon should be liberalized in order to stimulate market development and facilitate the entrance of new LPG marketers. This will require the establishment of transparent and fair regulations that are equally applied to all companies engaged in the distribution and marketing of LPG and the manufacturing of cylinders.

The government should reevaluate its current position and policies on LPG and work with private industry to reform/liberalize the market to attract new entrants into the marketplace. A joint industry/government task force should be formed to review the current LPG business/regulatory environment in each country and identify specific actions that can be taken to stimulate private participation and investment in LPG distribution and marketing facilities. This industry/government initiative should be undertaken on both a regional and country level.

As in many developing countries in West Africa, it appears that government initiatives may be required in order to stimulate LPG consumption in Cameroon, particularly in outlying areas of the country. Consumer education and awareness programs could be developed and utilized to promote the use of LPG in domestic markets to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG.

As noted, some government action may be needed to accelerate LPG consumption growth in outlying rural areas in Cameroon. These programs could take several forms, but need to address the affordability of LPG for the average consumer in these regions of the country. Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. Subsidies/equipment rebates and/or low interest loans to new customers might be considered in order to overcome the affordability issue.

3**Côte d'Ivoire**

Government initiatives to stimulate LPG consumption appear to be needed in the outlying rural areas in Côte d'Ivoire. These programs could take several forms, but need to address the affordability of LPG for the average consumer in Côte d'Ivoire. Selective subsidies might be beneficial if the development of the LPG market is to be accelerated and the deforestation to be retarded. Consumer education and awareness programs might be instrumental in increasing user interest in LPG.

The government needs to take steps to open the market to potential new competitors. This requires clear standards and license regulations.

4**Ghana**

As in many other developing countries in West Africa, it appears that government initiatives may be required in order to stimulate LPG consumption in Ghana, particularly in outlying areas of the country. Consumer education and awareness programs could be developed and utilized to promote the use of LPG in domestic markets to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG.

As noted, some government action may be needed to accelerate LPG consumption growth in outlying rural areas in Ghana. These programs could take several forms, but need to specifically address the affordability of LPG for the average consumer in these regions of the country. Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. Subsidies/equipment rebates and/or low interest loans to new customers might be considered in order to overcome the affordability issue.

Several LPG operational and safety issues appear to need attention in Ghana. Standards for LPG marketing and distribution facilities should be developed as soon as possible and uniformly applied across the country. Such standards should be a mandatory part of the licensing procedure for new facilities. Cylinder testing programs need to be established and the marketers given the opportunity and right to remove/replace defective cylinders.

5**Senegal**

The plan to completely eliminate the subsidy on 6 Kg LPG bottles should be re-evaluated against the price elasticity of existing LPG markets. Additionally, the impact of the loss of the subsidy on the prospects of adding additional LPG consumption in the outlying areas of the country in the future should be reviewed. Over the long-term, some reduction in the subsidy is probably unavoidable considering the size of the market, the magnitude of the existing subsidy and fiscal constraints on the government of Senegal. However, it is possible that the program to completely eliminate the subsidy will do irreparable damage to a very successful program to utilize LPG and retard deforestation in the country. At a minimum, the planned subsidy elimination is expected to sharply reduce future growth of LPG consumption and threaten the viability of existing and future investments by private industry.

Alternatives to the planned complete elimination of the subsidy should be reviewed and considered. Possible alternatives might include a gradual scale-back of the subsidy to levels that preserve some competitive advantage for LPG, while reducing the fiscal burden to the government. Cross-subsidies with gasoline or other fuels might be considered if the government wishes to continue to promote LPG use, while minimizing the cost of this program to the government.

Bottle deposits in Senegal are quite low compared to the cost of the cylinder. While this has the positive effect of increasing the affordability of LPG for the new consumer, it also results in loss of LPG bottles to neighboring countries. Therefore, the deposit structure should be reviewed and possibly increased to mitigate this problem.

6**Bottle/Valve Distribution System Review**

The United Nations Environment Program and the World LPG Gas Association jointly issued a booklet entitled "Guidelines for Good Safety Practice in the LPG Gas Industry" in 1998. This document should be used as a reference in the establishment of safety guidelines, as it incorporates information from both industry and government in other LPG consuming areas.

Cameroon

The substandard domestic cylinder fabrication in Cameroon should be ceased as soon as possible and the use of such cylinders prohibited. Also, the Government should tighten the control and inspection of cylinders to prevent the circulation of severely dented and corroded cylinders.

In the filling operations observed in Cameroon, not all the filled cylinders are check weighed. Check weighing of all cylinders is imperative to assure a safe operation. Furthermore, it is recommended that automatic leak testing of the filled cylinders be introduced in order to improve safety. The overall safety system at the filling plant observed in Cameroon appeared to be good.

Côte d'Ivoire

Much of the cylinder stock at the filling plant observed in Côte d'Ivoire appeared to be in poor condition. It is recommended, therefore, that the government tightens-up on the control and inspection of cylinders to prevent the circulation of unsafe cylinders. Furthermore, the filling plants should carry out a 100% check weighing to improve safety. It is also recommended that the plants introduce automatic leak testing of all the filled cylinders.

There is no palletization in the truck transport of filled and empty cylinders by any of the operators in the industry. The introduction of palletization would improve cylinder handling, reducing damage and increasing cylinder life.

Ghana

In the case of the plant observed in Ghana, the filling operation is below safety standards in all aspects of operations. Cylinders, which have passed the re-qualification date, are not removed, but are filled. Cylinders are not check weighed and leak tested, and there is no effective evacuation system for cylinders that are found to be leaking. There are not adequate safety measures to control unauthorized personnel from site access, minimum spacing/clearance standards were not observed, and there was no equipment such as water sprays, fire hoses and emergency stops in the truck discharge set-up.

In the case of another filling plant observed in Ghana, the facility appeared to have good site control, layout and spacing. However, the plant will always suffer from inherent difficulties with this mode of mini-plant operation. There appears to be a lack of an effective system of rejecting cylinders, manual leak testing, and evacuation of leaking cylinders. The plant appeared to have a definite investment program underway to remedy safety deficiencies in terms of water sprays, fire hoses, etc.

Cylinders are owned by the customers in Ghana. In general the observed cylinders seem to be in poor condition, but only extremely bad/dented cylinders are rejected. The safety at the filling plants does not meet international standards, and should be brought up to these standards. We strongly recommend that the government establish regulations and procedures to resolve these safety issues.

Senegal

The filling plant observed in Senegal appears to be operated in a safe and efficient manner. We do recommend that management verify that 100% check weighing and leak testing are always carried out at this facility.

Regarding the cylinder fabrication in Senegal, we strongly recommend that the government tightens-up control and inspection of the cylinders produced.

Shell was the only operator with palletization in the truck transport of filled and empty cylinders. The introduction of palletization by all operators would improve cylinder handling, reducing damage and increasing cylinder life.

7

Technical Specifications/Equipment Rating

During the visits it was found that more detailed information must be obtained from all the marketing companies before it can be decided which components of the infrastructure and equipment can be used to handle a higher propane content product and which must be replaced. We recommend that higher propane mixes should not be introduced before all specifications of the tanks and cylinders are checked 100% in order to maintain essential safety standards.

A consistent set of product specifications would greatly enhance LPG safety in the region. Governments and industry should work together to establish product specifications for the region. The standardization of product specifications will allow infrastructure and equipment specifications to be set to ensure safe transport and use of LPG. This will further allow equipment, such as bottles and truck transports to be utilized across country boundaries and allow for safe transport of product.

IV

WEST AFRICA LPG MARKET OVERVIEW

Africa is a region of the world with a relative abundance of natural resources, but the region has experienced only limited economic development to date. There has already been considerable exploitation of the oil and gas resource base in Africa, but significant potential remains across the continent. As a result, Africa is expected to become an even larger producer of energy in the future.

While Africa has a relative abundance of natural resources, most of the economies on the continent have been fairly slow to develop. It has not generally kept pace with economic growth in other developing regions, such as Southeast Asia and Latin America. Africa currently accounts for around 13% of total world population with an estimated population of around 780 million people. However, its combined GNP is only about 2% of total world economic activity. Additionally, the rate of population growth in Africa is relatively high compared to other developing regions of the world. This high rate of population growth continues to exert economic pressures on the region.

The most common source of household energy in most developing countries in Africa remains wood and charcoal. Heavy use of these fuels is contributing to the rapid rate of deforestation that is occurring in the region. Deforestation is seen as a long term environmental threat that can probably only be effectively combated by substitution of wood and charcoal fuels with alternate fuels such as LPG, natural gas, or petroleum products (such as kerosene). LPG is a particularly attractive alternative to wood and charcoal since it is a clean, efficient fuel that is relatively easy to transport and distribute.

At the present time, LPG consumption levels in West Africa are relatively low compared to most other regions of the world. However, several markets in West Africa have already experienced significant growth during the 1990s, demonstrating the high remaining potential for LPG in the region.

1 Regional Economic Characteristics

For this study, West Africa is defined to include the countries located on the west coast of Africa from Senegal to Angola and most of the neighboring inland countries. However, the majority of the analysis included in this study focuses on the four most highly developed LPG markets in the region : Cameroon, Côte d'Ivoire, Ghana, and Senegal.

West Africa, as defined in this study, includes 21 countries with a combined population of around 315 million people. The region has a land area of about 11.4 million square kilometers, which is about 25% larger than the United States. The combined gross national product (GNP) of the countries included in the region was reported to be about \$US 98 billion in 1997, which represents an average GNP per capita of about \$US 330 per year. Key macroeconomic statistics for the countries included in West Africa are summarized in the following table:

WEST AFRICA ECONOMIC INDICATORS				
Country	1999 Population (MM)	1997 GNP (\$US MMM)	1997 GNP/Capita (\$US/Year)	Land Area (M SQ KM)
Cameroon	14.9	9.1	650	465
Côte d'Ivoire	15.7	10.2	690	318
Ghana	19.2	6.6	370	228
Senegal	9.5	4.9	550	193
Subtotal	59.3	30.8	550	1,204
Angola	11.7	3.8	340	1,247
Benin	5.8	2.2	380	111
Burkina Faso	11.4	2.6	240	274
C. African Rep.	3.4	1.1	320	623
Chad	6.1	1.6	240	1,259
Congo, Dem. Rep.	49.6	5.1	110	2,267
Congo, Rep.	2.7	1.8	660	342
Equatorial Guinea	0.4	0.2	360	28
Gabon	1.2	6.4	4,230	258
Gambia	1.1	0.3	360	11
Guinea	7.2	3.9	570	246
Guinea-Bissau	1.2	0.3	240	28
Liberia	3.5	1.2	364	99
Mali	10.6	2.7	260	1,220
Niger	10.6	2.0	200	1,267
Nigeria	125.1	30.7	260	911
Togo	4.5	1.4	330	54
Total	315.4	98.1	329	11,449

As shown in the table above, the country with the largest population and economy in West Africa is Nigeria. However, Nigeria's GNP per capita is lower than the regional average and considerably lower than the four countries reviewed in detail in this study.

The four countries detailed in this study (Cameroon, Côte d'Ivoire, Ghana, and Senegal) have a combined population of slightly over 59 million and a combined GNP of about \$US 31 billion. Among these countries, the GNP per capita ranges from a low of about \$US 370 to a high of \$US 690 per year, with the average of all four countries being about \$US 550 per year. This compares with an overall average GNP per capita of \$US 329 per for West Africa. Thus, all of these countries are more prosperous than the whole West Africa region. Côte d'Ivoire has the highest GNP per capita in West Africa with the exception of Gabon, which has a particularly high GNP per capita due to large oil export earnings and a comparatively small population base.

2

Oil and Gas Activity

West Africa is already a significant crude oil producing region in the world, and exploration and development activity has intensified further in recent years due to the discovery of many new deepwater fields in the region. The region already accounts for crude oil production of about 3.7 million barrels per day as illustrated in the following table:

Angola	726
Benin	3
Cameroon	120
Congo, Dem. Rep.	28
Congo, Rep.	238
Côte d'Ivoire	10
Equatorial Guinea	83
Gabon	360
Ghana	5
Nigeria	2,080
Total	3,653

Nigeria has been the top oil producer in West Africa for many years. This should continue in the future, but production is rising in both Angola and the Republic of the Congo (Congo-Brazzaville).

Production of natural gas in West Africa has not been a particularly high priority in the past. This is because the exploration and production activity in the region was very export-orientated, and export economics generally favor crude oil development over gas. Additionally, there have been very limited markets for natural gas in West Africa up to now. As a result, most of the gas produced in association with crude oil in the region has generally been flared. However, this situation is now changing and several steps are being taken to mitigate natural gas flaring and recover LPG and/or condensate.

The program underway to reduce gas flaring should greatly increase the availability of LPG in West Africa over time. This will provide additional supplies for expansion of regional LPG markets as well as the export markets.

An example of the impact of the reduction in gas flaring on LPG production rates can be found in Nigeria. In 1997, more than 25 million cubic meters of natural gas were flared in Nigeria. The LPG content of this flared gas was estimated to be about four million tonnes. However, several projects have been developed, or are under development, to recover LPG. These projects include the Escravos, Oso, Cawthorne Channel, Funiwa, and Nigerian LNG projects. Together, these projects are expected to add around three million tonnes per year of additional LPG production over the period between 1997 and 2005. Some of these projects are already on line, and LPG production has increased significantly in Nigeria since the mid 1990s. Most of this product is destined for export markets initially, but this could change if, and when, domestic markets required additional LPG supplies.

Other examples of increased LPG recovery from natural gas in West Africa include the Republic of Congo and Angola. Production of LPG from the N'Kossa crude oil field in the Congo was begun in 1997. LPG production from this field is already about 400,000 tonnes per year. Since this new source of LPG supply has been brought on line, it has become a frequent source of imports for several West African countries such as Côte d'Ivoire, Ghana, and Senegal.

Angola has been a net exporter of LPG from the Cabinda field to international LPG markets for many years. There are plans to expand gas-processing facilities in Angola to reduce gas flaring and facilitate increased crude oil and condensate production in the future. As this occurs, LPG production from gas processing in Angola is expected to rise from current levels of about 170,000 tonnes per year to around 800,000 per year. This increase is anticipated over the next seven to eight years if companies currently involved in the exploration and development of crude oil proceed with planned projects.

3

Regional LPG Supply/Demand

Since 1995, the West Africa (Gulf of Guinea) region has been increasing its net exports of LPG. A number of significant new gas processing projects in the region have increased local LPG supply to levels above current regional demand. The table below illustrates the supply/demand balance in the region:

	1995	1998	2000	2002	2005
Supply					
Nigeria	169	620	1,647	2,106	4,449
Congo	4	404	404	404	404
Angola	184	190	191	191	422
Senegal	5	5	5	5	5
Côte d'Ivoire	18	21	25	26	26
Cameroon	21	21	21	21	21
Ghana	12	12	12	12	12
Gabon	8	8	8	8	8
Other	0	0	0	0	0
Total	421	1,282	2,313	2,773	5,347
Demand	247	336	381	422	516
Regional Surplus	174	946	1,932	2,351	4,831
Note: 'Other' includes Benin, Burkina Faso, Central African Rep., Chad, Dem. Rep. Congo, Eq. Guinea, Gambia, Guinea-Bissau, Liberia, Mali, Niger, and Togo.					

The largest increase in the region supply has come from Nigeria, where supply has increased from approximately 170,000 tonnes in 1995 to over 1.5 million tonnes in 1999. Purvin & Gertz forecasts that LPG production from Nigeria will increase to around 3.5 million tonnes by 2005. The large increase from 1995 to present is due to the Escravos and Oso LPG plants. The Escravos facility was commissioned in 1997 and the Oso facility was started-up in 1998. Both of these gas-processing projects have added significant amounts of LPG production capacity in Nigeria. In addition, both of these projects were intentionally developed to provide export opportunities for LPG, versus domestic consumption.

Even with the start-up of these significant LPG production projects, Nigeria continues to flare much of the gas produced in association with crude oil. The reduction of gas flaring in the country is an often stated goal of the Nigerian National Petroleum Company and the Nigerian government, as Nigeria has significant environmental problems that need to be addressed.

The Cawthorne Channel (Nigeria) gas processing facilities are expected to come on-stream in 2001, while the Funiwa (Nigeria) gas processing facility is expected to be commissioned in late 2002. Additionally, Nigerian LNG has been in the process of building a two train LNG plant for commissioning in 1999. In the first phase of this project, no LPG is expected to be recovered as the gas stream has a fairly low propane/butane content. However, approval for a third train is expected to occur, and such a train would be expected to have a higher liquids content gas as the feedstream. The third liquefaction train could be brought on-line in 2003.

With construction of additional gas processing and LPG recovery projects anticipated in the early years of the current decade, the Nigerian LPG surplus is expected to increase to over 3.0 million tonnes by 2005, as Nigeria remains by far the largest supply source and exporter in the region.

Both Angola and Congo are also significant LPG producers in the Gulf of Guinea region. In 1995, Angola had a base surplus of approximately 160,000 tonnes. Purvin & Gertz expects this to grow to over 470,000 tonnes by 2005. The majority of the LPG exported from Angola currently comes from the Cabinda field. The gas processing facilities at Cabinda have been in operation for several years, but planned expansions over the next several years are expected to occur. In addition, plans for additional facilities to reduce gas flaring via the Sanha Project are expected to increase LPG available for export.

The Congo started exports of LPG in 1997 as the N’Kossa field was brought on stream. Much of the LPG exports from Congo are supplied to other coastal African countries as the butane is exported in small cargoes. LPG fractionation is available at N’Kossa, and the butane is sold into regional markets, while all of the propane is destined for other world markets outside the region.

As regional supply builds, there is LPG available in the region to supply both domestic demand growth and export sales. The regional governments and LPG marketers should capitalize on this development by working together to develop and implement programs that will take advantage of these local supply sources for LPG import needs and domestic demand.

The recent increase in regional LPG supplies and the prospect for an increasingly larger surplus in the region is providing an opportunity to reduce the landed cost of LPG to importing countries in the region. The accomplishment of this supply objective would be to effectively replace European-referenced supplies (FOB Med or European ports) with regional supplies. The regional governments should strongly encourage the utilization of regional LPG supplies and work with importing companies to reduce import costs. These savings, once achieved, could be passed on to consumers to further stimulate demand.

4

LPG Market Structure/Development

The general structure of the LPG industry in West Africa includes both private and public participation in varying degrees in the supply, distribution, and marketing of the product. In countries with a local refinery, the refinery is normally responsible for LPG imports as well as domestic supplies. Most LPG is distributed and marketed by private oil marketing companies in the region, but there are also government-owned companies active in LPG marketing in some countries. LPG prices are generally controlled by the government at least at the ex-refinery level. Distribution and marketing margins are typically either controlled or heavily influenced by government agencies.

5

West Africa LPG Market Size/Characteristics

The size of the LPG market in West Africa has been fairly modest historically, both on an absolute basis and in terms of average consumption per capita. This is still the case for the region as a whole, but there has been significant growth in LPG consumption in a few countries in the region during the 1990s. This recent expansion of the LPG industry has demonstrated the long-term potential for the region. Additionally, it has already made important contributions to the environment and the quality of life of the people using LPG in several countries in the region.

Total LPG sales in West Africa are currently estimated to be about 361,000 tonnes per year as detailed in the following table:

WEST AFRICA LPG CONSUMPTION					
	Total LPG Consumption (M Tonnes)	Percent Res/Comm (%)	Res/Comm LPG Cons. (M Tonnes)	Population (MM People)	R/C LPG Cons. Per Capita (Kg/Year)
Cameroon	28	95%	27	14.9	1.8
Côte d'Ivoire	50	85%	43	15.7	2.7
Ghana	40	85%	34	19.2	1.8
Senegal	100	98%	98	9.5	10.3
Subtotal	218	92%	201	59.3	3.4
Angola	50	90%	45	11.7	3.8
Congo, Dem. Rep.	1	90%	1	49.6	0.0
Congo, Rep.	4	90%	4	2.7	1.3
Gabon	17	90%	15	1.2	12.8
Nigeria	58	40%	23	125.1	0.2
Other Countries	13	90%	12	65.8	0.2
Total West Africa	361	83%	301	315.4	1.0

About 60% of current LPG consumption in West Africa is concentrated in four countries, which are the focus countries for this analysis—Cameroon, Côte d'Ivoire, Ghana, and Senegal. The only other countries in the region with significant consumption of LPG are Angola, Gabon, and Nigeria.

Most of the LPG consumed in West Africa is used for household cooking. As a result, around 83% of total LPG consumption is used in the residential and commercial sector.

In the case of some countries, the proportion of total LPG demand concentrated in the residential and commercial sector is even higher. This is the case in Senegal where over 98% of all LPG consumption occurs in the residential and commercial sector.

The majority of LPG consumption in West Africa currently occurs in the general vicinity of the major cities in each country. In the case of the four countries analyzed in detail in this study, LPG demand in the major cities represents between 65% and 90% of the total national demand. This suggests that a particularly large potential market for LPG remains outside of the capital/major cities in each country.

The proportion of LPG demand in the major urban centers in the four countries highlighted in this study is estimated below:

LPG CONSUMPTION IN MAJOR URBAN CENTERS					
	Cameroon	Côte d'Ivoire	Ghana	Senegal	Total - 4 Countries
<u>Total Country</u>					
Res/Com LPG Demand (MTonne)	27	43	34	98	201
Population (MMPeople)	14.9	15.7	19.2	9.5	59.3
Avg. Consumption (Kg/Yr./Capita)	1.8	2.7	1.8	10.3	3.4
<u>Major Urban Centers</u>					
Res/Com LPG Demand (MTonne)	22	39	22	78	161
Population (MMPeople)	3	3	4	3	13
Avg. Consumption (Kg/Yr./Capita)	7.2	12.9	5.5	26.1	12.4
<u>Rest of Country</u>					
Res/Com LPG Demand (MTonne)	5	4	12	20	41
Population (MMPeople)	11.9	12.7	15.2	6.5	46.3
Avg. Consumption (Kg/Yr./Capita)	0.5	0.3	0.8	3.0	0.9

It should be noted that many estimates are required to generate the above table. However, it does clearly indicate the approximate split between LPG consumption rates in major urban centers versus the rest of the country for the four countries analyzed. The combined average per capita consumption in the four countries is estimated to be around 12.4 Kg per year for the major urban centers. This is well above the estimate of 0.9 Kg per person average LPG consumption for the rest (outside of the major urban centers) of the four countries.

6

Comparison to Other LPG Markets

Per capita LPG residential and commercial consumption rates vary significantly around the world depending on the availability of LPG supplies, availability and economics of alternate fuels, affordability of LPG, government policies or restrictions on LPG use, and consumer fuel preferences. Over the past 20 years, LPG demand has increased significantly in many developing countries around the world. Thus, it is useful to compare current consumption levels in West Africa with other developing countries and regions. Regional per capita LPG consumption rates are contrasted in the following table:

RESIDENTIAL AND COMMERCIAL LPG CONSUMPTION (Kg/Year/Capita)	
West Africa (Overall)	1.0
West Africa - 4 Countries	
Overall	3.4
Only Urban Centers	12.4
Rest of Country	0.9
Indonesia	2.9
India	5.4
China	7.5
Africa (Whole)	8.3
Southeast Asia	9.2
North Africa	39.1
Latin America	42.6

The average consumption of LPG as fuel in residential and commercial markets in West Africa is currently estimated to be only around 1.0 kilograms per year per capita. This is very low by world standards and serves to highlight the large potential for expanding the role of LPG as a domestic fuel in West Africa in the future. Average per capita consumption of LPG in worldwide residential and commercial markets is currently about 15.8 kilograms per year. Thus, current LPG consumption in West Africa has only reached about 6% of average world consumption rates.

LPG consumption has been increasing fairly rapidly in the developing countries of Indonesia, India, and China for many years. Per capita consumption rates now range from 2.9 to 7.5 kilograms per capita in these three populous countries in Asia. The average consumption in West Africa is well under this range, and only Gabon and Senegal have exceeded these LPG penetration levels to date.

The LPG industry has developed differently in the various regions of Africa. This is shown to be the case when the LPG markets in West Africa are compared to LPG markets in North Africa. In the case of North Africa, LPG has developed into a very common household energy source over the past 20 years. This has occurred for several reasons including stronger economic development in North Africa as well as quicker and more extensive development of natural gas/LPG resources than has been the case in West Africa. North Africa has one of the world's largest LPG exporters (Algeria), and three countries in the region (Algeria, Egypt, and Morocco) have over one million tonnes per year of LPG consumption.

The LPG market in West Africa has developed slower than its counterpart in North Africa due to many factors, included those cited above. However, LPG has gained popularity as a source of household energy supply in West Africa in recent years, and there are indications that regional markets might expand even quicker in the future with strong government support and private investment.

The average per capita LPG residential and commercial consumption rate in Africa, taken as a whole, is currently around 8.3 kilograms per year. North African consumption rates are considerably higher at around 39.1 kilograms per year per capita. Latin America also has significantly higher per capita LPG consumption levels.

As shown in the preceding table, the average consumption of LPG as fuel in the residential and commercial sector in West Africa is estimated to be around 1.0 kilograms per year per capita. However, there is considerable variation in this index of LPG market development throughout the region. At the upper end of per capita consumption in West Africa are Gabon and Senegal. Gabon has the advantage of having a fairly small population, high economic development for the region, and access to local supplies. Senegal has the distinction of having the largest LPG market in the region and the largest per capita consumption of LPG of the medium and large countries in West Africa.

As noted in the previous section, the estimated per capita LPG consumption in the urban centers in West Africa is well above the overall consumption for the region. For the four countries highlighted in this study, the average per capita LPG consumption in the residential and commercial sector is estimated to be around 12.4 Kilograms per year. This compares more favorably with some of the examples of LPG consumption on other developing regions in the world and illustrates the upside potential of the West African region.

LPG Market Growth in West Africa

The development of the LPG market in West Africa is reviewed in the table below for the four country LPG markets examined in detail in this study:

GROWTH IN LPG CONSUMPTION IN WEST AFRICA					
	LPG Consumption (M Tonnes)				
	Cameroon	Côte d'Ivoire	Ghana	Senegal	Total
1990	23.0	23.0	17.0	33.5	96.5
1995	23.2	29.0	39.6	53.1	144.9
1999(E)	28.0	50.0	40.0	100.0	218.0
Average Growth (%/Year)	2.2%	9.0%	10.0%	12.9%	9.5%

Taken together, LPG consumption in these four countries has expanded by an average rate of about 9.5% per year since 1990. This represents fairly strong growth during the 1990s when compared with the rate of expansion of LPG markets in other developing countries and regions of the world during this period. It also represents a significant acceleration in market growth in West Africa compared to the previous decade.

Overall, LPG demand appears to be growing reasonably well in Côte d'Ivoire and Ghana. However, there are some differences in growth patterns in these two countries. LPG demand increased fairly well in Ghana during the first half of the 1990s, but the market expansion has slowed since. In 1996, the government of Ghana removed a price subsidy which led to a temporary decline in LPG consumption. Autofuel LPG consumption continues to decline while use of LPG as a household fuel has resumed some level of growth. In the case of Côte d'Ivoire, market growth has been stronger since 1995 (compared to the first half of the decade) due to the positive effects of the CFA devaluation in 1994 and the impact of aggressive marketing practices of a new entrant on domestic consumption.

Of the four countries covered in detail in this study, Cameroon has experienced the lowest LPG demand growth during the 1990s. The reasons for this are probably manifold. One reason appears to be the lack of any significant government policy promoting the use of LPG. Another is the apparent impact that a new market entrant has had on the local market. A local company previously involved only in the manufacture of LPG cylinders has embarked on an aggressive marketing program to take existing LPG sales away from traditional marketers. While this company has been successful in garnishing market share, total LPG consumption in Cameroon has not changed appreciably over the past decade and most other marketers do not appear to have much interest in making additional investments in LPG distribution and marketing until the industry is reformed.

The highest growth market of the four countries visited is Senegal. This is an important example of LPG market development in the region, and lessons learned in Senegal might be successfully applied in other countries in the region. The market in Senegal has undergone dramatic growth during the 1990s for several reasons. LPG has been available at competitive prices in small-sized bottles since the mid-1980s. The competitive pricing has resulted, to a great degree, from the sizeable subsidy that is available for LPG sold in small bottles. The subsidy is currently around \$US 202 per tonne and reduces consumer prices by around 38% below the calculated price without the subsidy.

The government program to subsidize LPG in small bottles has made LPG more affordable to lower-income customers and accelerated the rate of new customer additions during the 1990s. As the LPG market experienced strong growth in Senegal, private marketing companies elected to make sizeable new investments in LPG storage, bottling, and distribution facilities. These types of investments were essential for an orderly expansion of the market. The strong growth pattern that became evident in Senegal during the early 1990s had the effect of drawing new participants into the market. Elf entered the market in 1994 and Mobil entered in 1997. Both companies pursued aggressive marketing strategies and have helped to stimulate further growth in an already successful and expanding market.

A key feature of the success story in Senegal appears to be the impact of the government program promoting LPG on consumer preferences and private investment. The program significantly enhanced the competitive position of LPG and was maintained for a long enough period of time to allow the market to expand to its present size.

Currently, the government of Senegal is in the initial phase of a five-year program to completely eliminate the existing subsidy on LPG sold in small bottles. While the government has generally been pleased with the success of the LPG program, it wants to reduce the financial burden of this subsidy on the state. The complete elimination of the subsidy is expected to significantly reduce future LPG demand growth rates and may ultimately result in some erosion of existing LPG use in the country.

8 Supply/Distribution System Characteristics

The supply and distribution system for LPG in West Africa has many similarities among the countries examined in this study. In all four countries reviewed, imports of LPG are controlled via the government through control of the import facilities. The import facilities for LPG are typically located at the refineries in the various countries. The local refinery plays a vital part in the supply and distribution system, as the refinery is the major source of LPG in each country. In all the countries, LPG supply transits through common bulk storage facilities located at or near the refineries.

Location of LPG storage facilities in or near the refinery allows access to port facilities and the availability of waterborne LPG imports. The typical size of waterborne import parcels for the countries in the region are summarized below:

Country	Import Storage Capacity (Tonnes)	Imports (M Tonnes/Year)	Average Storage Turnover (Number of Turnovers/Year)	Typical Parcel Size (Tonnes)
Cameroon	1,500	3	2.0	800
Côte d'Ivoire	2,600	20	7.7	1,500
Ghana	3,700	35	9.5	2,000
Senegal	6,680	93	13.9	4,000

The total available import storage capacity ranges from 1,500 tonnes for Cameroon to around 6,680 tonnes in the case of Senegal. Required imports in Cameroon are relatively low and this results in a particularly low storage utilization level of only 2.0 storage turnovers (annual imports divided by storage capacity) per year. Senegal has the largest import storage capacity and also has the largest LPG import requirement in the region. As a result of the large import requirement, the import storage capacity utilization is the highest in Senegal at around 13.9 storage turnovers per year.

Every LPG import terminal operation in the world is somewhat unique due to its particular storage configuration, dock access, operating cost structure and access to domestic markets. However, in general, pressurized LPG terminals such as the facilities located in West Africa are expected to have a target utilization of 15 to 20 turnovers per year to ensure economic operation. The utilization of LPG storage capacity in Senegal is reasonably close to this general benchmark, but is noticeably lower in Côte d'Ivoire and Ghana. Utilization levels are extremely low in Cameroon and it would probably be very difficult to justify additional storage capacity in this location on economic grounds unless imports increased significantly.

In the region, shipping economies of scale could be achieved by bringing in larger LPG parcels. However, the potential savings in freight rates varies considerably among the various countries and storage capacity often limits the potential parcel size.

With the exception of Ghana, local distribution companies, often with government ownership, then take over distribution of the LPG product to the bottling facilities. Ownership and operatorship of bottling facilities varies by country, with various levels of private ownership of bottling facilities evident in the region.

Cameroon is the only country in the region that relies on rail for LPG transport, and even there, it plays a fairly small part in the overall distribution network. In the other countries, LPG is transported almost exclusively by road tanker. Pipeline infrastructure to transport LPG more than a few miles from the refineries is not available.

As the consumption of LPG is concentrated in the large metropolitan areas in all the countries, the distribution infrastructure tends to be concentrated in areas near the refineries. As the LPG markets in West Africa grow over time, the distribution infrastructure should expand as LPG is delivered further inland.

With the exception of Ghana, centralized LPG bottling facilities are used by the marketing companies, and the companies maintain ownership and control of the cylinders. In Ghana, the consumer ownership of bottles and the number of mini-filling plants dramatically changes the distribution system when compared to other countries. The retail distribution channels in Ghana are also very different than the other West African countries as a result of the mini-filling plants.

The LPG cylinders used in West Africa vary quite substantially from country to country. While most cylinders in circulation in West Africa are rated for propane use, this is not always the case. The specifications for cylinders between countries also vary quite considerably, and there is not a common standard in use in the region. This may potentially pose a safety concern as cylinders are moved between countries.

In three of the four countries reviewed in West Africa, cylinders are manufactured locally. The quantity and quality of locally produced cylinders varies significantly by country in the region. Quality control standards in the region are a major concern of some of the oil marketing companies, as the international oil marketing companies often have more stringent quality and safety standards than the countries have established. While some local cylinder manufacturers purport to meet internationally established quality guidelines, external verification is weak or nonexistent.

The differing and often unique cylinder specifications often pose a challenge for the marketing companies, as they cannot import cylinders for use in the local market. Also, the duties and taxes placed on imported cylinders are often high and make the importation of cylinders unattractive for the marketing companies.

In Senegal, Cameroon, and Côte d'Ivoire, the oil marketing companies own the cylinders and the consumer places a deposit on the cylinder. As the cylinders are returned for refilling, the companies have the ability to inspect the cylinder to ensure that the cylinder is in a safe and usable condition. If the condition of the cylinder warrants replacement, the marketing company is able to either refurbish or replace the cylinder as needed.

In Ghana, the consumer ownership of the cylinder raises some safety concerns. Since the consumer owns the cylinder and the marketer simply fills the cylinder with LPG, the marketer is limited in the safety actions that can be taken. If the marketer deems the cylinder unsafe for use, their only alternative is to refuse to fill it. The marketer does not currently have the ability or the obligation to remove the cylinder from circulation.

The retail distribution channels in West Africa are typically free from government control, other than the government ownership in some marketing companies. The oil marketing companies use a combination of direct selling via service stations and distribution at the retail level through dealers and storefront operators. LPG is readily available in the larger cities, with spotty distribution further inland.

9**Regulatory Structure**

The LPG markets in West Africa vary quite substantially in their regulatory structure as they are in differing states of privatization, liberalization, and deregulation.

The regulation of the LPG industry varies substantially from country to country. In all of the countries, the government continues to have some significant involvement in the LPG market, mainly through a presence in the storage and importation of LPG, and through government ownership stakes in one or more companies in the LPG marketing sector of the industry.

The licensing procedures for LPG installations are quite diverse, ranging from fairly transparent to virtually nonexistent. In many countries, there appears to be a clear need for additional clarification of licensing standards. Additionally, all licensing standards and regulations need to be applied consistently to all marketers. Licensing standards are needed to facilitate the entry of new companies into the market.

The privatization of government owned entities is an ongoing process in West Africa. In most countries, the government either owns or controls a significant stake in the local refinery. The refineries are often one of the first government companies in the energy sector to be privatized. The pace of privatization varies considerably among the countries.

The regulation of LPG safety is an area of concern to many marketers in the region. Enforcement of existing regulations and the development of additional regulations, where needed, are both issues that need attention in West Africa, as in many other developing markets.

10**LPG Supply Cost Evaluation**

The cost of LPG supplies is an important element in LPG pricing in West Africa. This can have a significant influence on the product cost to the consumer and the ability of the consumer to afford LPG as a household cooking fuel. Additionally, the LPG acquisition cost is particularly important to those countries where significant imports are required and LPG is subsidized by the government.

In general, LPG shipping costs are affected by several factors, including parcel size, the distance from source of supply and the size of the vessel. Vessels may be chartered on a per voyage rate or a time charter rate. Due to the relatively small volumes of LPG that are imported in most of the West African countries, the product is often purchased on a delivered cost basis, whereby the seller of the product bears the responsibility and the cost of freight.

LPG freight rates can generally be reduced on a per tonne basis by increasing the parcel size. Currently, most countries in West Africa import LPG on a 'single port discharge' basis. This requires small ship movements from the source to the importing country. It is more economical to bring in larger ships to accommodate larger parcel sizes, but the ship must be fully utilized in order to make use of the more economical mode of transport. For some cases, multi-port discharge is a necessity in order to fully utilize the larger cargo carrying ability of the ships. Average freight rates per tonne of LPG are actually higher for a multi-port discharge than a single port discharge for the same class of ship. However, freight savings are achieved by bringing in larger sized ships than would be needed by each single facility on its own, thereby achieving economies of scale in shipping. As freight rates are quoted on average cost per tonne of product shipped, an equitable distribution of the costs must be made for each size parcel that is off-loaded at each port for a multi-port discharge.

In order to minimize shipping costs, the largest parcel size that can be adequately accommodated in the onshore LPG storage should be used. In the countries visited, port facilities were represented as adequate to handle larger size vessels than were currently used in the delivery of LPG. The limiting factor on import parcel size in West Africa appears to be the capacity of the storage facilities in the various countries.

While larger parcel sizes allow lower delivered freight rates to be achieved, the cost of storage must also be factored into the economic analysis. The capital cost required to construct additional LPG storage provides an incentive to minimize the storage capacity, thereby reducing the parcel size allowable for import. The overall size of the local market served by import facilities drives the economical throughput of the storage facilities.

The larger markets in West Africa are most likely to benefit from the greater parcel sizes, as the import and storage facilities will have a higher overall utilization rate. Senegal is a good example. Over the last several years, the average parcel size of imports has increased from around 1,000 tonnes to approximately 4,000 tonnes, with a corresponding decrease in the freight rates.

In order to optimize total cost of service, importers of LPG need to determine freight rates for a variety of parcel sizes and shipping configurations (one or two port discharge) and use these to calculate the most economical solution for their needs.

Some representative LPG shipping costs for various size parcels are summarized below for West African trade:

Origin	Destination	Ship Class (Tonnes)			
		12,000	4,000	2,000	1,000
Point Noire	Dakar	35.1	48.3	73.4	104.3
Point Noire	Abidjan	21.8	29.7	44.5	67.0
Point Noire	Tema	21.8	29.7	44.5	67.0
Point Noire	Doula	17.3	23.5	37.3	57.7
W. Med.	Dakar	34.3	47.1	71.7	100.2
W. Med.	Abidjan	43.2	65.7	93.3	137.4
W. Med.	Tema	47.7	65.7	100.5	146.7
W. Med.	Doula	52.1	78.1	114.9	165.3
Tema	Doula	17.3	23.5	30.1	57.7
Lavera	Abidjan/Tema	51.9	71.2	108.4	161.6
Point Noire	Abidjan/Tema	26.0	35.3	52.4	81.9
Lavera	Tema/Doula	56.4	83.6	122.8	180.2
Point Noire	Tema/Doula	25.2	34.0	50.7	77.8

As illustrated in the above table, larger parcel sizes can provide a significant decrease in freight rates. This is particularly true for 2,000 tonne parcels compared to 1,000 tonne parcels. As we move up in parcel size, the benefit of continuing to increase parcel size gradually diminishes. Recent actions taken in Senegal appears to have achieved much of the potential cost reduction benefits available to this market. This does not appear to be the case yet in the other countries reviewed, and some potential remains to further optimize product acquisition costs.

Two port discharge cargoes may provide an attractive option for LPG importation. As demonstrated in the table, two-port discharge, sourcing LPG from Point Noire and delivering product to Abidjan and Tema, would provide freight costs savings of approximately 50% of the cost of freight from Point Noire to either single individual destination. The two-port discharge cargoes would lessen the need for additional storage to be constructed, but would still provide freight savings. However, this method requires additional coordination between the buyers of the LPG, and may prove to be difficult in practice. Given the small parcel sizes acquired by Cameroon, and the substantial savings already achieved by Senegal due to market growth, a two-port discharge cargo would be attractive for LPG imports into Côte d'Ivoire and Ghana. Given their geographical proximity, this may prove to be the most attractive option for these LPG importers.

If the storage facilities were adequate to handle larger parcel sizes and the freight rates could be decreased, inland countries might also be able to benefit from lower LPG acquisition costs. The larger import facilities may be able to function as trans-shipment terminals, providing economies of scale to help make the importation of LPG viable in other inland markets. Currently, the inland markets of Burkina Faso, Mali, Chad and the Central African Republic receive LPG via truck transport from the coastal import facilities in Côte d'Ivoire, Senegal and Cameroon. The decrease in import costs may provide additional economic incentive for the expansion of markets in the inland countries.

To illustrate the potential net benefit of adding import storage capacity, we can review an example of the economic trade off between the savings obtained from larger parcel sizes (lower shipping costs) and the cost of adding new storage capacity. For this example, we have assumed that the typical import size is currently 2,000 tonnes and existing facilities are nearly fully utilized to accommodate this parcel size. In order to allow the import parcel size to increase from 2,000 to 4,000 tonnes, the total LPG import storage capacity would probably need to be expanded by around 2,800 tonnes to absorb the larger import parcel and preserve a minimum level of operational flexibility.

The capital cost of 2,800 tonnes of pressurized LPG storage is estimated to be around \$US 2.5 million. Total operating costs plus a return on investment of approximately 15% are estimated to be around \$US 575 thousand per year. For a market with LPG imports of around 20,000 tonnes per year, a freight cost savings of around \$29 per tonne would be required in order to meet this economic target. For a market with 40,000 tonnes per year, the required freight savings to meet desired economic returns on the storage investment would be about \$14 per tonne. Thus, the ability to justify additional storage capacity is very sensitive to the size of the import requirements.

For the countries reviewed in this analysis, Senegal has already achieved most of the potential reduction in LPG shipping cost by moving to 4,000 tonne parcel sizes.

Côte d'Ivoire typically imports LPG in 1,500 tonne parcels and import requirements are currently around 20,000 tonnes per year. Ghana currently imports around 35,000 tonnes per year and averages around 20,000 tonne parcel sizes. Both countries might be a candidate for increasing LPG storage capacity to lower freight cost. The economics of these potential projects will be enhanced in either country if import levels continue to rise.

Due to the low LPG import levels in Cameroon, there does not seem to be much economic merit in expanding LPG storage at this location unless the market and import requirements expand significantly.

Pricing/Competitiveness of LPG

The pricing of LPG in the various countries studied in West Africa differs widely, mainly due to the differences in government policies. The price of LPG is at least partially controlled in all the markets, mainly through control of the ex-refinery price and with the help of a subsidy program in certain countries.

The pricing of LPG in the four West African countries analyzed in this study is summarized below:

	Cameroon 12.5 Kg	Côte d'Ivoire 6 Kg 12.5 Kg		Ghana 14.5 Kg	Senegal 6 Kg 12.5 Kg	
Ex-Refinery Price	150.0	235.0	235.0	264.2	306.8	306.8
Shipping	9.2					
Port Charges	6.0	2.0	2.0			
Taxes and Duties	1.7	4.7	4.7	39.6		
Stabilization (Tax)						81.8
Storage and Filling Margin	207.6			103.8	134.7	183.5
Distribution Margin	89.0	268.8	218.6		52.8	30.4
TVA					44.1	49.0
Transport Equalization Subsidy	29.8	6.4 (100.2)	6.4		(202.0)	
Consumer Price	493.3	416.7	466.7	407.5	336.4	651.5

As demonstrated in the table above, the ex-refinery price of LPG varies widely among the countries studied. The ex-refinery prices in Côte d'Ivoire, Ghana, and Senegal are relatively similar, while Cameroon is substantially lower than the others. Côte d'Ivoire, Ghana, and Senegal have been slowly moving towards import parity in their ex-refinery pricing structure over several years. The ex-refinery price in Cameroon differs the greatest from international import parity prices. However, it should be noted that imports of LPG into Cameroon account for approximately 10% of the total supply, the lowest amount of any of the countries studied.

The storage, filling and distribution margins available to marketers and dealers in the countries studied also varied substantially, affected strongly by government policy and market structure. Ghana had the smallest overall margin, at \$US 103 per tonne, probably due to the fact that the marketers just fill the LPG cylinders and there is no distribution involved, as the customer brings his cylinder to the marketer for refilling. The highest distribution and filling margin occurs in Cameroon, at approximately \$US 297 per tonne, which represents over 60% of the end-user price. Margins in the other countries vary from \$US 188 to \$US 268 per tonne.

A transportation equalization system exists in both Cameroon and Côte d'Ivoire. These mechanisms allow the price of LPG to be held constant at either the filling plant or retail locations across the country. In Cameroon, the price of LPG at all filling plants across the country is held constant, while in Côte d'Ivoire, the equalization provides for the transport of product to the inland filling plants.

The subsidies for LPG are explicitly detailed in the price structure in Côte d'Ivoire and Senegal. However, there are often "hidden" subsidies in the other countries through the government control of the ex-refinery price. Since the government often owns an interest in the refinery, and these are often operating at a loss, the government is in effect subsidizing the price of LPG in the country. While Senegal has a large direct subsidy of \$US 202 per tonne for LPG in 6 Kg cylinders, it must be pointed out that Senegal also charges a TVA tax of \$US 44 per tonne on this LPG. In effect, the government is partially offsetting the cost of the subsidy by taxing the LPG sales.

LPG prices in the principal markets of West Africa range from a low of \$US 336 per tonne in small cylinders in Senegal to a high of \$US 652 per tonne, also in Senegal. In markets with no subsidy program, the price of LPG ranges from approximately \$US 408 per tonne to \$US 493 per tonne at the consumer level.

Surprisingly, the retail selling prices of LPG in the various countries are not as dissimilar as might be expected. Additionally, consumer prices in the West African countries studied are not particularly high when compared to other developing markets around the world.

The comparative prices of various fuels on an energy equivalent basis are summarized below:

Fuel	Cameroon	Côte d'Ivoire	Ghana	Senegal
LPG				
6Kg	22.6	19.1		15.4
6 Kg (w/o subsidy)		24.7		29.9
12.5 Kg		21.4	18.7	24.7
Electricity	35.6	49.1		
Charcoal	74.4	21.3	17.1	20.2
Kerosene	21.1	25.4	17.3	22.2

The following calorific values for various fuels and stove efficiencies were used in the calculation of energy equivalent costs presented above:

Fuel	Calorific Value	Stove Thermal Efficiency
LPG	48.4 MJ/Kg	45%
Wood	14.8 MJ/Kg	15%
Charcoal	20.1 MJ/Kg	39%
Kerosene	37.5 MJ/Liter	35%

In the West African countries included in this study, LPG appears to be a reasonably competitive fuel. However, its competitive position varies from country to country and is effected by the presence or lack of subsidies. LPG appears to have the strongest competitive position in Senegal due to the high subsidy applied to 6 Kg bottles. If this subsidy is removed as planned, LPG will no longer be the most attractive household fuel on an energy equivalent cost basis.

In Ghana, LPG appears to be slightly higher than either charcoal or kerosene on an energy equivalent cost basis.

In Côte d'Ivoire, LPG has a competitive advantage versus charcoal and kerosene if the existing subsidy is maintained. However, even without the subsidy, LPG still appears to be a competitive fuel.

In Cameroon, LPG is priced slightly higher than kerosene on an energy equivalent cost basis. Reported data indicated that LPG was priced below charcoal on this basis. However, there is some doubt about this conclusion since the use of charcoal is wide spread in the country and the reported price of charcoal is suspect.

The initial equipment costs for LPG cooking appliances in the West African countries studied in this report are summarized below:

EQUIPMENT COST FOR LPG - WEST AFRICA				
(\$US)				
	Cameroun	Côte d'Ivoire	Ghana	Senegal
	6 Kg	6 Kg	14.5 Kg	6 Kg
Bottle Deposit	13	13	32	10
Burner	10	10	38	5
Cooker/Stand	5	13		5
Total	28	37	70	21

In order to use LPG, the consumer has a higher initial investment cost over using other household fuels. The initial cost includes the deposit on or the purchase of the LPG cylinder and the purchase of a cooking appliance or stove. This becomes an affordability issue to low income potential consumers. The initial investment cost for LPG can be a barrier for users. The minimum equipment cost in the countries reviewed ranged from a low of \$US 21 in Senegal to a high of \$US 70 in Ghana. The cost in Ghana is particularly high because the typical consumer practice is to purchase a cylinder outright (versus payment of a bottle deposit which is the case in other countries) and prevalence of a larger (14.5 Kg) bottle size. The burner cost in Ghana is higher than the other countries because reportedly, consumers in Ghana prefer to purchase a stove instead of an open burner and cooking stand.

V

CAMEROON

Cameroon has a population of around 14.9 million people and a land area of about 465,000 square kilometers. Of the four West African countries covered in detail in this study, Cameroon has the largest land area and the lowest population density. The gross national product of Cameroon was reported to be around \$US 9.1 billion in 1997, which represents an average GNP per capita of \$US 650 per year.

Cameroon has an abundance of natural resources, including petroleum, timber, hydroelectric power, natural gas, bauxite, gold and diamonds. Thus, it comes as no surprise that the economy of Cameroon is oriented toward production of natural resources and agriculture. Petroleum is the largest export product. Other exports include timber, cocoa, coffee and cotton.

Cameroon is a medium-sized producer and exporter of petroleum. Crude oil production rates are currently around 120,000 barrels per day, which is well under the peak production of over 180,000 barrels per day experienced in the early 1980s. Associated gas production in Cameroon is generally flared and is not recovered for processing or domestic applications. The country has considerable potential to increase both crude and natural gas production in the future. This could provide additional domestic LPG supplies for local/regional markets, if, and when, domestic natural gas resources are developed.

LPG consumption in Cameroon is currently 27,000 tonnes per year. The market is supplied LPG from the local refinery and via imports. About 90% of total LPG supplies are from domestic sources.

Like many other countries in West Africa, the LPG industry in Cameroon has both private and public sector participation. The government is involved through its ownership stakes in refining (SONORA) and the storage company (SCDP). LPG marketers include Total, Shell, Mobil, Texaco, Elf, SCTM, and Camgaz.

1

LPG Market Structure/Development

The only source of domestic LPG production in Cameroon is the 45,000 barrels per day refinery operated by Societe Nationale de Raffinage (SONARA) at Limbe. The SONARA refinery includes both public and private ownership. The current ownership is about 52% Cameroon government, 10% Texaco, 10% Total, 10% Shell, 10% Mobil, and 8% Elf. Total serves as technical advisor to the refinery. In addition to its role in providing domestic supplies, the refinery is responsible for all imports of LPG. The location of the refinery and primary storage facilities is shown on Figure V-1.

Cameroon has a joint-venture storage company named Societe Cameroon de Petrolie (SCDP). This company operates refined products terminals at Doula, Yaounde, Belabo, and Ngaoundere. SCDP has storage for petroleum products and LPG. The ownership in SCDP is 52% government and 48% private. The private ownership includes shares by the five major oil marketing companies operating in the country.

There are seven LPG distribution and marketing companies in operation in Cameroon. These companies include all five major oil marketing companies operating in the country. The five companies are Total, Shell, Mobil, Elf and Texaco. In addition to the major oil marketing companies, there are two other private LPG distribution and marketing companies. These companies are SCTM and Camgaz. SCTM was originally only involved in the local LPG business through its manufacture of cylinders. However, SCTM had trouble marketing its cylinders to LPG distributors in the late 1980s/early 1990s and elected to enter the market as a distributor in 1990. Since its entry into the local market, SCTM has built market share to become the largest LPG distributor/marketer in Cameroon. Camgaz was originally a joint-venture company owned by Shell and Total. However, it was sold to a local buyer in 1996 and is now an independent LPG distribution and marketing company.

As in several countries in West Africa, there is a trade organization in Cameroon known as the Groupement Professionnel Petrolier (GPP). All oil marketers are members of this group and it collects data on market size and market share.

Market Size/Development

Total LPG sales in Cameroon were about 27,000 tonnes in 1998. The evolution of the domestic LPG market is summarized below:

	Demand (M Tonnes)
1985	14.3
1990	23.0
1992	19.3
1994	24.4
1996	22.0
1998	27.2

LPG consumption in Cameroon increased by around 60% between 1985 and 1990, but has grown only about 19% since 1990. During this period, the LPG sales of most companies has declined, while the sales of SCTM has steadily increased. Thus, there has been a significant shift in market share during the 1990s, but only a modest increase in overall LPG consumption in the country.

During the 1990s, SCTM has gained significant market share through a very aggressive marketing strategy. Its market share increased from around 4% in 1990 to nearly 49% in 1998. During this same period, the market share of the other LPG distributors and marketers plummeted from 96% to 51%. In absolute terms, the LPG sales by all marketers other than SCTM declined from about 22,100 tonnes in 1990 to about 13,950 tonnes in 1998.

There are probably several factors that led to the decline in LPG sales by the marketers other than SCTM. One reason is the practice that SCTM has reportedly used to capture sales from their competitors. It has been successful in gaining market share by persuading customers to exchange other marketers bottle for SCTM bottles. This, by itself, is not unusual but SCTM has elected not to exchange these bottles with the other marketers. This practice coupled with the difficulty that competitive LPG distribution and marketing companies have had in importing new LPG bottles has made it difficult and unattractive for the other marketing companies to develop new markets.

As is the case throughout West Africa, the majority of LPG consumption in Cameroon is to residential customers in bottles. This end-use accounts for over 90% of total demand and LPG is used almost exclusively for household cooking. Total cylinder sales are currently around 24,800 tonnes per year. Of these sales about 80% are in 12.5 Kg bottles.

Bulk sales of LPG in Cameroon are currently only around 2,500 tonnes per year. Total and Mobil make most of these sales. The bulk sales include various industrial customers, hotels, restaurants, schools and hospitals.

The majority of LPG consumption in Cameroon occurs in the general vicinity of Doula and Yaounde. It is estimated that over 80% of national LPG consumption is concentrated in these two cities. Thus, only 20% or less of total LPG sales currently occur in the rest of the country. This suggests that a particularly large potential market for LPG remains outside of the Doula and Yaounde regions.

LPG Supply/Imports

LPG demand in Cameroon is greater than the supply from the local refinery. As a result, Cameroon is a net importer of LPG to meet domestic consumption needs. Currently, the SONORA refinery has exclusive rights to import petroleum products and LPG into Cameroon.

The refinery is the only source of domestic LPG production. Approximately 90% of the total LPG market requirement in Cameroon is met with LPG production from the refinery. The market price of LPG in Cameroon is below import parity price. Therefore, the government must subsidize any LPG that is imported. The government tries to minimize LPG imports and has not elected to stimulate the LPG market in recent years.

Distributor Market Share

The LPG market is currently divided among seven private distribution and marketing companies. Recent distributor market share is summarized below:

	1998 Sales (M Tonnes)	Market Share (Percent)
SCTM	13.3	48.8%
Total/Camgaz	10.4	38.2%
Texaco	1.9	6.8%
Mobil	1.7	6.3%
Total Cameroon	27.3	100.0%

The top LPG distributor in Cameroon is SCTM with nearly one-half of all LPG sales in the country. The next largest distributor is Total, who handles approximately 40 percent of the total LPG consumed in Cameroon. However, it should be noted that the Total LPG volumes include product that is delivered to Camgaz. Retail sales are split 50/50 between Total and Camgaz. Shell receives LPG from Camgaz. Elf is a relatively new LPG marketer in the country with relatively low sales volumes.

2**Supply/Distribution System**

The supply and distribution system in Cameroon has similarities to many systems seen in West Africa. All imports of LPG are controlled via the government through control of the import facilities. The imports are combined with the supply of LPG from the domestic refinery to supply the needs of the country. For most of the LPG marketers, LPG supply transits through a common supply and distribution chain that is controlled by a joint stock company. This company, SCDP, owns and operates storage depots and bottling plants at Doula, Younde, Ngaundere, and Bafoussan.

SCTM operates in a different mode, picking up LPG supplies directly from the refinery and delivering to their storage depot and bottling facility. As a result of this, SCTM has a different cost structure than the other marketing companies, and there is some question if taxes and duties are uniformly applied.

From the bulk storage point at the Limbe refinery, LPG is delivered via boat to the SCDP depot in Doula. From the Doula depot, LPG is delivered via both train and road transport to the four SCDP bottling plants throughout the country. Small amounts of the LPG is also exported to the Central African Republic and Chad via road transport.

LPG is widely available in the major metropolitan areas of Cameroon. LPG is also available at many of the retail petrol stations throughout the country.

Domestic Supply

Domestic production is sourced entirely of LPG from the SONORA refinery located at Limbe. Additionally, all LPG imports are received at the refinery. Therefore, all LPG supply transits through the refinery storage system. Domestic production in 1998 accounted for about 90% of the total market requirements of 27,200 tonnes.

Imports/Storage Facilities

The SONORA refinery receives LPG imports in parcels of 700 to 800 tonnes each. The channel to the refinery is dredged to a depth of 7.5 meters and the maximum vessel size is reported to be about 10,000 tonnes. The SONORA refinery has three LPG storage spheres, each with a capacity of 500 tonnes, for a total storage capacity of 1,500 tonnes.

Distribution System

From the SONORA refinery at Limbe, LPG is transported to Doula by ship in parcels of 400 tonnes each. Products are also sent via rail to Yaounde, Belabo, and Ngaundere. From Doula, products are trucked to Garoua, and products are also trucked from Limbe to Bafoussan.

The storage capacities of the primary storage depots for SCDP are summarized below:

Depot Location	Capacity (Tonnes)
Doula	1,500
Yaounde	500
Bafoussam	150
Ngaoundere	70
Total SCDP	2,220

In addition to the storage facilities operated by SCDP, the SONORA refinery has approximately 1500 tonnes of LPG storage. Also, SCTM and Camgaz have storage located at their bottling plants.

Utilization of the rail system is an issue at times. The railways are under the control of a state owned company. The capacity to transport larger volumes exists, but the inefficiency of the company has caused problems. The government has used a fleet of trucks as a back up to the railway. However, the truckers have become a powerful union, and the trucks are used on a continual basis. The state has liberalized the railway system and a Franco-South African consortium has recently received the operating concession. This change in operation could result in increased movements of LPG by rail in the future.

Most of the marketers sell bottled LPG at their service stations. The number of service stations operated in Cameroon are approximately 440 as detailed in the following table:

Operator	Number
Total	76
Mobil	85
Elf	94
Shell	70
Texaco	115
Total Cameroon	440

In addition to their service stations, the LPG marketers sell product through dealers. This is particularly true in the larger cities. For example, Total has three dealers in Doula and three in Younde.

Cylinders

Both Total and SCTM have manufactured LPG cylinders in Cameroon. Total elected to discontinue cylinder manufacturing in the early 1990's due to quality concerns. SCTM continues to produce LPG cylinders, but has had trouble selling them to most other marketers. As a result, SCTM entered into LPG marketing in the early 1990's.

SCTM is the only remaining manufacturer of cylinders in Cameroon. The specifications for LPG cylinders in Cameroon are unique to the country and standard cylinder imports from available international suppliers do not generally meet these specifications. There are heavy duties applied to imported bottles. This has effectively stopped the import of LPG cylinders for the last several years.

There are no accurate numbers for the LPG bottles in circulation in Cameroon. It is reported that there are an estimated 300,000 to 400,000 bottles in circulation. The vast majority of these bottles are 12.5 Kg size.

3

Regulatory Structure

As in the other West African countries detailed in this report, the LPG market in Cameroon is not fully privatized. There are a number of governmental entities involved in the refined products and LPG sectors.

The Ministry of Industry is responsible for developing regulations for oil installations, controlling and monitoring these regulations, and issuing licenses for new installations. The Ministry of Energy sets policy in the energy industry, but is not responsible for the regulation of the industry.

The Ministry of Finance is responsible for making LPG and other petroleum related products reasonably priced for households. This agency is directly involved in the control of ex-refinery and end user prices of LPG and petroleum products in Cameroon. Additionally, they handle the stabilization fund for LPG.

There are no regulations to allow additional entrants into the LPG market. Currently, there is a decree on the Prime Minister's desk, awaiting approval that would set out the necessary regulations for additional LPG marketers to enter the market.

4

Pricing/Competitiveness of LPG

Prices of LPG are uniform at the various bottling plants throughout the country. A transportation subsidization program exists to keep the price the same at each of these facilities.

LPG Pricing

The current price structure of LPG in bottles in Cameroon is summarized below:

LPG PRICING - CAMEROON		
(Price per Tonne)		
	CFA	USD
Ex-Refinery Price	90,000	\$ 150.00
Shipping	5,523	\$ 9.21
Port Charges	3,825	\$ 6.04
Taxes and Duties	1,033	\$ 1.72
Storage and Filling Margin	124,543	\$ 207.57
Distribution Margin	53,375	\$ 88.96
Transport Equalization	17,901	\$ 29.84
Consumer Price	296,000	\$ 493.33

The price detailed above is the retail selling price of LPG at Doula. The transport equalization and distributor margin are adjusted at other locations in the country to provide a uniform price structure across Cameroon.

The price of LPG is set the same at all filling plants across the country. The stabilization fund provides a subsidy mechanism to keep the LPG price constant across the filling plants. The ex-refinery price of LPG in Cameroon has been the same since 1995. As the price of LPG is subsidized, the government incurs additional costs if imports rise. For this reason and perhaps others, the government does not currently have any initiatives to increase the use of LPG.

The market for refined products was liberalized in July 1999. As a result, marketers are in theory free to set prices for their products. However, in practice, the government issues general guidelines that all the oil-marketing companies adhere to.

Competitive Fuels

LPG is used almost exclusively as a cooking fuel in Cameroon. Like other tropical countries, demand for water heating is negligible, except for commercial uses such as restaurants and hotels. Household lighting is usually comprised of electricity in the metropolitan areas and kerosene in the rural areas. LPG use for household lighting is almost nonexistent.

The main competitors of LPG for cooking fuel are charcoal and wood fuel, with kerosene used in some areas. Pipeline natural gas is not available in any areas at the current time. Wood, charcoal and kerosene are all commercial fuels in Cameroon and are used extensively throughout the country. In the larger cities, LPG has a higher penetration of the cooking fuel market.

The approximate raw selling prices of various fuels and their cost on an energy equivalent basis are summarized below:

	Retail Selling Price	Energy Equivalent Basis	
		CFA/MJ	USD/GJ
LPG	296 CFA/Kg	13.6	22.6
Electricity	50 CFA/KWH	21.4	35.6
Charcoal	350 CFA/Kg	44.6	74.4
Kerosene	166 CFA/liter	12.6	21.1

As shown in the above table, LPG appears to be a reasonably competitive fuel in the Cameroon market. On an energy equivalent basis, LPG and kerosene appear to have about the same cost structure. Based on the reported typical price of charcoal of 350 CFA/Kg, LPG appears to be a much lower priced fuel. However, charcoal is commonly used in household applications, so the typical price structure may be well below reported values.

On an energy equivalent basis, electricity is a reasonably competitive fuel. The consumer price of electricity in Cameroon is lower than in neighboring West African countries, mainly due to the large hydroelectric resources of the country. However, even given the cost, electricity is not used extensively as a cooking fuel in Cameroon, and is more commonly used for lighting.

Equipments Costs

The initial equipment costs for LPG cooking applications in Cameroon is summarized below:

Size	6 Kg		12.5 Kg	
	CFA	\$US	CFA	\$US
Deposit	8,070	13.45	11,845	19.74
Burner	6,000	10.00	6,000	10.00
Stand	3,000	5.00	3,000	5.00
Total	17,070	28.45	20,845	34.74

As in most developing countries, the initial LPG equipment cost is a barrier to entry for many consumers, especially in the poorer rural areas. One marketing company has introduced a 6 Kg cooker package in order to promote LPG and increase the affordability to marginal consumers. This package includes a filled cylinder, along with a burner and cooking ring. The target market for this cylinder/cooker combination was students and lower income city dwellers.

It appears that the minimum investment cost for a new LPG consumer is approximately \$US 28. This assumes that entry level consumers opt for a 6 Kg bottle and one burner stove. It was reported that multiple burner stoves can be purchased at a cost ranging from \$US 20 to \$US 35.

5

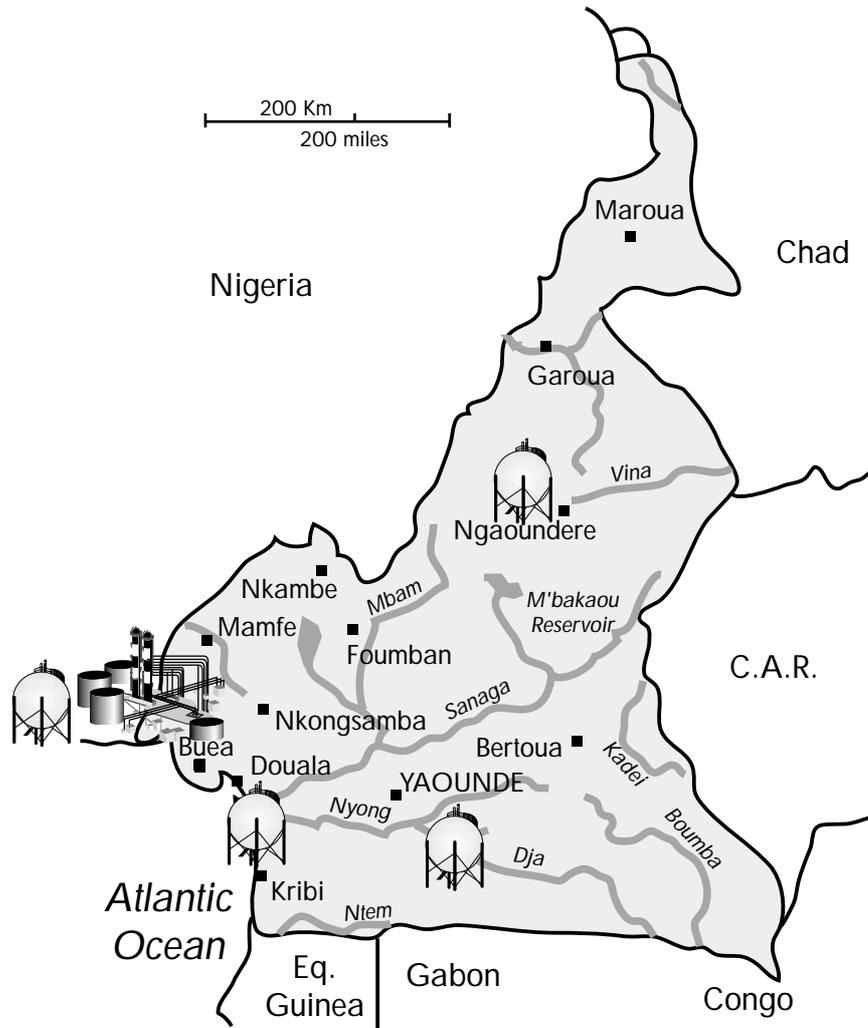
Recommendations

The LPG business and regulatory environment in Cameroon should be liberalized in order to stimulate market development and facilitate the entrance of new LPG marketers. This will require the establishment of transparent and fair regulations that are equally applied to all companies engaged in the distribution and marketing of LPG and the manufacturing of cylinders.

As in many developing countries in West Africa, it appears that government initiatives may be required in order to stimulate LPG consumption in Cameroon, particularly in outlying areas of the country. Consumer education and awareness programs should be developed and utilized to promote the use of LPG in domestic markets to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG over other fuels such as wood or charcoal.

As noted, some government action is needed to accelerate LPG consumption growth in outlying rural areas in Cameroon. These programs could take several forms, but need to address the affordability of LPG for the average consumer in these regions of the country. Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. Subsidies/equipment rebates and/or low interest loans to new customers might be considered in order to overcome the affordability issue.

Figure V-1 Cameroon Orientation Map



	Refinery
	LPG Bottling/ Distribution/Storage

VI

CÔTE D'IVOIRE

Côte d'Ivoire is a moderately sized country in West Africa with a population of around 15.7 million people and a land area of about 318,000 square kilometers. The gross national product of Côte d'Ivoire was reported to be around \$US 10.2 billion in 1997, which represents an average GNP per capita of about \$US 690 per year. Economic growth in Côte d'Ivoire has been relatively strong since 1994, averaging over 6% per year increase in real GNP. Current estimates for GNP in 1999 are in excess of \$US 12 billion.

The economy of Côte d'Ivoire is very heavily orientated toward agriculture. The country is one of the largest producers and exporters of coffee, cocoa beans, and palm oil in the world. Over one-half of the total population is reported to be engaged in some capacity in the agricultural sector of the economy.

Côte d'Ivoire is a modest producer of petroleum and natural gas. Domestic crude oil production rates are currently around 10,000 barrels per day and natural gas production averages over 80 million cubic feet per day. The domestic crude oil production is sold in the regional market and the natural gas provides both gas and LPG supplies for the local market.

LPG consumption in Côte d'Ivoire has grown significantly since the mid-1990s and is now about 50,000 tonnes per year. The market is supplied LPG from both the local refinery and a gas processing plant located in Côte d'Ivoire. Additionally, LPG imports are required to meet total market requirements.

The LPG industry in Côte d'Ivoire has strong participation by both the private and public sector. The government is involved through its ownership stakes in refining (SIR), a storage company (GESTOCI) and a LPG distribution/marketing company (PETROCI). While there are general plans for selling all or part of the government's interest in these facilities, the timing of this divestment program appears somewhat uncertain.

A number of private oil companies have operated in Côte d'Ivoire for many years and constitute the bulk of LPG market sales in the country. The infrastructure for LPG distribution is centered in Abidjan, the largest metropolitan area, and other smaller population centers.

1

LPG Market Structure/Development

The primary source of domestic LPG supplies in Côte d'Ivoire is the 59,000 barrel per day refinery located at Abidjan/Vridi and operated by the Societe Ivoirienne de Raffinage (SIR). The SIR refinery has both public and private ownership. The current ownership is about 47% Côte d'Ivoire government, 5% Burkina-Faso government, 15% Elf, 10% Total, 10% Shell, 10% Mobil, and 3% Texaco. The refinery is responsible for all LPG imports as well as domestic supplies. The location of the refinery is shown on Figure VI-1.

The only other domestic source of LPG in Côte d'Ivoire is a gas processing plant operated by United Meridan Corporation. The gas plant has a nominal LPG extraction capacity of about 25,000 tonnes per year, but actual production rates are well under this rating.

There is a joint-venture storage company named Societe de Gestion des Stocks Petroliers de Côte d'Ivoire (GESTOCI) operating in the country. GESTOCI owns and operates a main storage depot in Vridi, near the refinery, as well as inland depots at Bouake and Yamasaukrou. The company has storage for petroleum products and LPG. The ownership in GESTOCI is 12% public and 88% private. The private ownership includes shares by the major oil marketing companies. GESTOCI was originally set up to provide strategic stocks of petroleum products for the country. The company now has three main functions. It provides strategic stocks of products, storage for the refinery, and storage for private marketing companies.

There are four private marketing companies with significant activity in LPG distribution and marketing in Côte d'Ivoire. These companies include Total, Shell, Mobil and AGIP. Elf and Texaco are two other private oil marketing companies operating in Côte d'Ivoire, but both have a limited presence in the LPG market. In addition to the private marketing companies, there are two public companies involved in the distribution and marketing of LPG in the country. These companies are Societe Nationale d'Operations Petrolieres de la Côte d'Ivoire (PETROCI) and Gaz de Côte d'Ivoire (GDCI). PETROCI has a particularly large presence in the LPG market with about 29% of total national sales.

There is a trade organization in Côte d'Ivoire known as the Groupement Professionnel Petrolier (GPP). All oil company marketers are members of this group and it collects data on market size and market share.

Market Size/Development

Total LPG sales in Côte d'Ivoire are projected to be about 50,000 tonnes in 1999. The evolution of the domestic LPG market is summarized below:

	Demand (M Tonnes)	Percent Increase
1991	23.2	
1992	22.7	(2.2)
1993	21.7	(4.4)
1994	22.4	3.2
1995	29.0	29.5
1996	38.0	31.0
1997	41.4	9.0
1998	45.3	9.4
1999 (E)	50.0	10.4

Overall, LPG consumption in Côte d'Ivoire has increased by over 115% since 1991. Demand growth has been positive since 1994 and was particularly strong during 1995 and 1996. Several factors contributed to the rapid rise in LPG demand during 1995 and 1996. These include the positive impact of the devaluation of the local currency (CFA) that occurred in 1994 on the local economy, favorable refinery-gate LPG pricing relative to import parity and the entrance of PETROCI in the LPG market in 1993. PETROCI adopted an aggressive marketing strategy and quickly built market share, capturing a fairly large portion of the total new market growth.

The breakdown of LPG consumption by type of sale is detailed below:

	Cylinder	Bulk	Total
1995	24.3	4.7	29.0
1996	30.6	7.4	38.0
1997	34.4	7.0	41.4
1998	37.1	8.2	45.3
1999	41.0	9.0	50.0

The majority of LPG consumption in Côte d'Ivoire is to residential customers in bottles. This end-use accounts for over 80% of total demand and LPG is used almost exclusively for cooking in households. Total cylinder sales are currently around 41,000 tonnes per year. Of these sales about 8% are in 6Kg bottles, about 87% are in 12.5 Kg bottles and around 5% are in bottles larger than 12.5 Kg.

Bulk sales of LPG are currently around 9,000 tonnes per year. Of the bulk sales, around 89% are large bulk deliveries, primarily to industrial customers. The small bulk deliveries are to medium-sized consumers such as restaurants, schools and hospitals.

While exact regional LPG sales figures are not available, it is estimated that around 90% of current LPG consumption in Côte d'Ivoire occurs in the general vicinity of Abidjan. Abidjan represents the vast majority of total LPG consumption currently, but only about 20% of the total population in the nation. Only about 10% of current consumption occurs in the rest of the country, and this is mainly concentrated in and around other larger cities. Therefore, it is apparent that there is a large potential market for LPG remaining outside of the Abidjan area.

The residential market share of LPG in the Abidjan area can be estimated with the above estimates for regional demand distribution and several assumptions. The population in the Abidjan area is approximately 3.0 million people and the number of households are estimated to be around 600,000 based on an estimated average family size of five. The total number of households in the Abidjan area using LPG is estimated to be around 185,000. This is based on local consumption of 36,900 tonnes (90% of 41,000) and an estimated average consumption rate of 200 Kg per family per year. This implies a household market share for LPG cooking of about 30%. It was reported that the approximate household cooking market split in Abidjan is roughly 30% LPG, 60% charcoal, and 10% wood and other fuels.

LPG Supply/Imports

Côte d'Ivoire is an exporter of most petroleum products to regional markets due to the size and location of the SIR refinery. However, this is not the case with LPG as local demand exceeds the refinery output. The domestic production of LPG varies from year to year due to changes in refinery operations and LPG recovery rates in the gas plant. During 1998, domestic LPG supplies accounted for about one-half of total market requirements. Imports were around 23,000 tonnes in 1998 and are expected to be around 20,000 tonnes in 1999.

The SIR refinery has had exclusive rights to import petroleum products and LPG into Côte d'Ivoire up to now. However, this might change in the future if the government proceeds with plans to sell a significant part of its share in the refinery in 2000.

Distributor Market Share

The LPG market is currently divided among five private oil-marketing companies and two publicly owned marketing companies. Recent distributor market share information is summarized below:

	1998 Sales (M Tonnes)	Market Share (Percent)
Total	12.0	26.5%
Shell	10.3	22.7%
Agip	4.9	10.7%
Mobil	4.8	10.7%
Elf	0.2	0.4%
Subtotal-Private Marketers	32.2	71.1%
PETROCI	13.0	28.7%
GDCI	0.1	0.2%
Subtotal-Public Companies	13.1	28.9%
TOTAL CÔTE D'IVOIRE	45.3	100.0%

As shown above, approximately 71% of total LPG distributor sales are controlled by the five private oil marketing companies engaged in LPG distribution and marketing. The largest private marketer (Total) has a market share of about 26.5%. However, the largest market share is held by PETROCI which is a publicly held company. This is a relatively new phenomenon since PETROCI just entered the LPG market in 1993.

Elf has only recently entered the LPG market and, as a result, has a relatively low market share. Texaco also just entered the LPG market and did not have any significant LPG sales in 1998. Both Elf and Texaco are already well-established marketers of petroleum products in the country, but did not choose to enter the LPG market until recently.

2

Supply/Distribution System

The supply and distribution system in Côte d'Ivoire is fairly typical of the systems seen in sub-Saharan Africa. All imports of LPG are controlled via the government through control of the import facilities. The imports are combined with some domestic refinery and gas plant supply of LPG to supply the needs of the country. The entire supply volumes transit through a common supply and distribution chain that is controlled to varying degrees by various government entities.

From the bulk storage point, LPG is delivered to one of three primary storage depots in the country. The primary storage depots have storage capacity that is operated by both government and private companies. From the primary storage depots, the LPG is sent to bottle filling plants. At this point in the distribution system, the private oil companies control the majority of the product. The private oil marketing companies distribute the bottles throughout the country, both through their own service stations and also third party retailers. The private oil marketing companies also sell LPG on a bulk basis, delivering the product via their own tanker trucks.

LPG is widely available, both in Abidjan and also outside the metropolitan area. Most petrol service stations in the country stock LPG cylinders, and LPG is also available at a number of retail locations. Outside Abidjan, service stations are the primary retail sales outlet for LPG cylinders. Each oil marketing company has their own policy as to which stations carry LPG. Total carries LPG at all their service stations in the country.

Domestic Supply

Domestic supply is composed of LPG from the SIR refinery, located near Abidjan, and a gas processing plant operated by United Meridian Corporation. LPG from the gas processing plant is sent to SIR for sale and distribution. Thus, all domestic LPG supply transits through the refinery storage. Imports supplement the domestic supply to fulfill the LPG demand in the country.

Import/Storage Facilities

The GESTOCI depot has the capability to receive international tankers up to 30,000 DWT for clean products, in addition to a direct pipeline connection to the SIR refinery. The SIR refinery has approximately 2600 tonnes of primary storage for LPG. The typical parcel size for imports is 1500 tonnes. At the port, the maximum vessel limitation is a draft of 33 feet. In 1998, total LPG imports to SIR were approximately 23,000 tonnes.

The GESTOCI storage depot in Vridi, near the Abidjan refinery, has a capacity of 2000 tonnes. Along with this storage, there are additional depots in Bouke and Yamasoukrou. The additional depots are smaller than the one in Abidjan, as the LPG demand in the country is centered in Abidjan, which comprises approximately 90% of total demand in the country. The additional storage depots serve the inland markets, which are considerably smaller than the Abidjan market.

Additionally, Shell, Petroci, and AGIP all have filling centers in Abidjan. GESTOCI and Shell have additional LPG storage capacity located at their centers.

Outside of Abidjan, Shell/AGIP own and operate an LPG filling center in Bouke. Bouke is located approximately 350 kilometers from Abidjan. Refined products are exported from the Bouke terminal to neighboring countries. The refined products are delivered to Bouke via rail.

Distribution System

The primary storage depot at Abidjan, with an LPG storage capacity of 2,000 tonnes, is the largest of the three and handles product for the southern area of the country. In addition, product that is re-exported to the neighboring countries of Mali and Burkina Faso transits through this terminal.

The terminal at Bouke does not have any storage facilities for LPG. However, Shell/AGIP have LPG storage in the vicinity. The LPG is trucked to Bouke, while other refined products are delivered via rail transport.

The terminal at Yamoussoukro is the primary distribution point for products destined for the western portion of Côte d'Ivoire. All LPG and refined product is trucked from the refinery near Abidjan to the terminal at Yamoussoukro.

In addition to the primary storage facilities operated by GESTOCI, private companies (the oil marketing companies) operate other storage facilities. The total primary and secondary storage located in Côte d'Ivoire is summarized below:

Company	Number of Spheres	Bullets	Capacity (Tonnes)
Total	0	7	325
Shell	3	1	550
AGIP	0	4	134
SIR	3	2	2,595
GESTOCI	2	0	2,000
PETROCI	0	3	300
UMIC	0	2	240
Shell (Bouake)	0	5	74
PETROCI (Bouake)	0	3	100
Total	8	27	6,318

The following table depicts the total number and total capacity of trucks for each oil marketing company:

Company	Number of Trucks	Capacity (Tonnes)
TotalFina	3	33
Mobil	1	20
Elf	1	20
Shell	2	17
AGIP	2	27
PETROCI	8	140
Total	17	257

Some of the private oil marketing companies supplement their service station sales through the use of first level dealers.

In addition to distribution of bottled LPG, the oil marketing companies also sell LPG in bulk quantities, mainly to larger users such as restaurants and other commercial operations. Larger users may purchase LPG in 38 or 50 Kg cylinders. Cylinder sales account for approximately 80% of total LPG sales (1999 estimate).

Cylinders

Currently, no LPG cylinders are manufactured in Côte d'Ivoire. All needed bottles are imported from Europe. There is a 40% import duty and a 20% VAT on bottles. Six Kg cylinders cost approximately 15,000 CFA (excluding VAT) and 12.5 Kg cylinders cost 24,000 CFA. These are the two most common sizes of bottles used in the Côte d'Ivoire market. Petroci had plans to build a bottle manufacturing facility capable of producing approximately 400,000 cylinders per year. They announced the building of a new facility; however, this facility has yet to be constructed.

The oil marketing companies own the bottles used in the country. The consumer pays a deposit on the cylinder at the time that he receives his first cylinder. After paying the initial deposit, the consumer exchanges the cylinder when empty, receiving a filled cylinder in exchange for the empty.

The approximate numbers of cylinders in circulation are tabulated below:

Company	12 Kg	6 Kg	Total
Mobil	80,000	10,000	90,000
TotalFina	100,000	40,000	140,000
Shell	100,000	60,000	160,000
AGIP	80,000	N/A	80,000
Petroci	100,000	100,000	200,000
Texaco	13,000	17,500	30,500
Elf	25,000	30,000	55,000
Total	498,000	257,500	755,500

The average age of the cylinders are estimated to be between 10 to 15 years.

The oil marketing companies own and operate a number of filling plants. There are four filling plants in Abidjan and two in Bouke. The capacity of the plants is summarized below:

Location	Operator	Capacity (Bottles/Day)		
		6 Kg	12.5 Kg	38 Kg
Abidjan	Total	1,500	5,000	320
Abidjan	Shell	--	9,000	160
Abidjan	AGIP	--	1,750	160
Abidjan	PETROCI	3,000	2,000	400
Bouake	Shell	500	650	160
Bouake	PETROCI	--	4,500	--
Total		5,000	22,900	1,200

3

Regulatory Structure

The market in Côte d'Ivoire is not yet fully privatized, even though plans have been put forward in the past. Currently, a number of government ministries are involved in the regulation of petroleum products and LPG.

The Ministry of Mining and Petroleum Resources, Directorate of Hydrocarbons (MMPR/DH) is responsible for petroleum policy formulation and the direct supervision of all petroleum activities. The Ministry's jurisdiction includes exploration contracts, petroleum legislation and taxation, production conditions and control, crude oil and petroleum product imports, pricing of ex-refinery products and exports, maintenance of security stocks and organization of distribution. PETROCI reports to the government via the Ministry. PETROCI has an LPG sub-directorate, which manages the distribution of LPG to final consumers in Côte d'Ivoire.

The Ministry has a number of functions in the LPG business, these include:

1. collection and collation of industry statistics
2. application of regulations pertaining to import, production and export of LPG
3. definition of LPG quality and specifications
4. coordination of all organizations involved in the LPG industry
5. planning of supply to meet national demand

The Ministry has two sectors: (1) Electricity and (2) Petroleum and Gas. There is no established process for licensing of LPG distributors. The Ministry is working on the establishment of technical standards for the LPG industry.

GETSOI and GCDI, both government-owned companies, report through the Ministry in Charge of Energy and Transportation. The Minister of Economic Infrastructure has delegated financial and administrative responsibilities for these companies to this ministry.

The Ministry of Commerce modifies the controlled price structure for LPG. The Ministry of Commerce, MMPR/DH, and the GPP form a working group that determines/negotiates the controlled price. The Ministry of Commerce is the official custodian and issuer of the controlled price structure.

The government has plans to privatize SIR by selling 37% of the stock. However, they plan to provide some period of product price protection for the buyers of the privatized refinery.

The downstream oil marketing companies currently handle LPG distribution to the consumer level. LPG is sold in a variety of cylinder sizes, most notably 6 Kg, 12.5 Kg and 38 Kg. Households use the 6 Kg and 12.5 Kg sizes. Sales of the 6 Kg cylinder are subsidized in order to make LPG more affordable for the general population.

4

Pricing/Competitiveness of LPG

Prices of LPG vary across the country based on transportation cost from the source (Abidjan). A transportation equalization system exists, where the incremental cost of transportation from Abidjan is refunded to the marketer. Abidjan has a tax surcharge to subsidize the transport of product to other areas of the country. However, approximately 90% of the LPG sold in Côte d'Ivoire is consumed in the vicinity of Abidjan.

For LPG, the ex-refinery selling price is fixed at 140,000 CFA/tonne (approximately US\$258/tonne).

LPG Pricing

The current price structure of LPG bottles in Côte d'Ivoire is shown below:

LPG PRICING - CÔTE D'IVOIRE				
(Price/Tonne)				
	12.5 Kg Cylinder		6 Kg Cylinder	
	CFA	\$US	CFA	\$US
Ex-Refinery or CIF Prices	140,980	234.97	140,980	234.97
Shipping	--	--	--	--
Port Charges	1,220	2.03	1,220	2.03
Taxes and Duties	2,635	4.39	2,635	4.39
Customs Computer System	200	0.33	200	0.33
Storage and Filing Margin	--	--	--	--
Distribution Margin	131,155	218.59	161,253	268.76
Transport Equalization Subsidy	3,810	6.35	3,810	6.35
		--	(60,098)	(100.16)
Consumer Price	280,000	466.67	250,000	416.67

The ex-refinery LPG price is currently set by the government at 140,980 CFA, or about \$US 235 per tonne. Allowances are made for port charges, taxes and duties, and custom computer system costs. Distributor margins are set at different levels for 12.5 Kg and 6 Kg cylinders. A transportation equalization system is used to offset the cost of transporting LPG to market locations outside of Abidjan and Bouke. The 6 Kg cylinder market receives a special subsidy of about \$US 100 per tonne. It should be noted that the above LPG value chain expressed in \$US is based on a currency conversion rate of 600 CFA/\$US.

The government controls the selling price of LPG in Côte d'Ivoire. Current retail selling prices are summarized below:

Cylinder Size	Selling Price/Bottle	\$US/ Tonne
	CFA	
6 Kg	1,500	416.67
12.5 Kg	3,500	466.67

The 6 Kg cylinders were introduced in the market in 1994 and the market has grown substantially since then. The 6 Kg cylinder makes LPG more affordable for a larger portion of the population, as the initial investment cost for the cylinder (deposit and fuel) is lower. Additionally, the 6 Kg cylinder cost is subsidized, so this also increases the affordability of LPG as a cooking fuel. Most of the marketers also sell a burner and pot holder that fit on top of the 6 Kg cylinder. This provides a cooking unit that is stable, inexpensive, and fits well with the cooking style of families in the country. Initial purchasers of 6 Kg cylinders are typically new customers for LPG (versus switching from larger cylinder sizes). It was reported that consumers are not switching from the 12.5 Kg cylinder size to the 6 Kg cylinder size to take advantage of the subsidized costs.

Competitive Fuels

LPG is used almost exclusively as a cooking fuel in Côte d'Ivoire. Like other tropical countries, demand for water heating is negligible. Household lighting is usually comprised of electricity in the metropolitan areas or kerosene in the rural areas. LPG is not typically used for household lighting.

The main competitors of LPG for cooking fuel are charcoal and wood fuel, with kerosene used in some areas. Pipeline natural gas is not available in any areas at the current time. PETROCI is conducting an analysis of a gas distribution system in Abidjan, with the help of international consultants. However, the study is not geared towards the use of natural gas for household consumption. If a natural gas distribution system is established, industrial users will be given a priority on the system, most probably for electrical generation. Côte d'Ivoire will not likely be involved in the proposed West African Gas Line that is planning to bring natural gas supplies from Nigeria to Togo/Benin/Ghana. However, discussions are ongoing about the possibility of bringing some natural gas from Ghana to Côte d'Ivoire (the Abidjan area).

Wood and charcoal are both commercial fuels in Côte d'Ivoire and are used extensively outside the Abidjan metropolitan area. In Abidjan, charcoal and LPG are the primary fuel types. It is estimated that approximately 30% of the households use LPG, 60% use charcoal and 10% use either wood fuel or electricity for cooking purposes. Wood is used predominantly in rural areas.

The approximate retail selling prices of various fuels are shown below with the energy equivalent prices which are adjusted for fuel energy content and estimated stove efficiency for each type of fuel:

Fuel	Retail Selling Price	Energy Equivalent Basis (CFAMU)	Energy Equivalent Basis (\$US/KGJ)
Charcoal	100 CFA/Kg	12.8	21.3
6 Kg LPG	250 CFA/Kg	11.5	19.1
12.5 Kg LPG	280 CFA/Kg	12.8	21.4
Electricity	69 CFA/Kwh	29.5	49.1
Kerosene	200 CFA/Liter	15.2	25.4

On an energy equivalent basis, the cost of charcoal is approximately equal to the cost of LPG in 12.5 Kg bottles. Therefore, LPG appears to be a very competitive cooking fuel in the Côte d'Ivoire market. However the affordability is hampered somewhat by the initial investment required (i.e., bottle deposit and cooker). For kerosene, competitive costs are also in line with LPG costs. Electricity is not used extensively in Côte d'Ivoire as a residential cooking fuel source, mainly due to the cost associated with electricity. Electricity is used more commonly for lighting and domestic water heating. Electricity is not as economical as using LPG for cooking purposes. It appears that LPG is a preferred fuel by many households, especially as income levels grow.

Equipment Costs

The initial equipment costs for various domestic cooking fuels are summarized below:

	6 Kg		12.5 Kg	
	CFA	\$US	CFA	\$US
LPG				
Cylinder deposit	8,000	13.33	15,000	25.00
Burner	6,000	10.00	6,000	10.00
Cooker	8,000	13.33	8,000	13.33
Total	22,000	36.67	29,000	48.33
Charcoal				
Cooker	2,000	3.33	2,000	3.33

In order to use LPG, the consumer has a higher initial investment cost over using charcoal or wood. The initial investment cost includes the deposit on the LPG cylinder and the purchase of a cooking appliance (burner or stove). The private oil marketing companies have tried to address the initial investment issue by providing low cost burners for sale to the public. These burners are designed to fit directly on a 6 Kg cylinder. The consumer must also purchase a stand for the cooking pot to sit on in order to use this system, but the initial costs are much lower than a stove type unit. The lower cost burners have been designed and marketed towards lower income city dwellers and students.

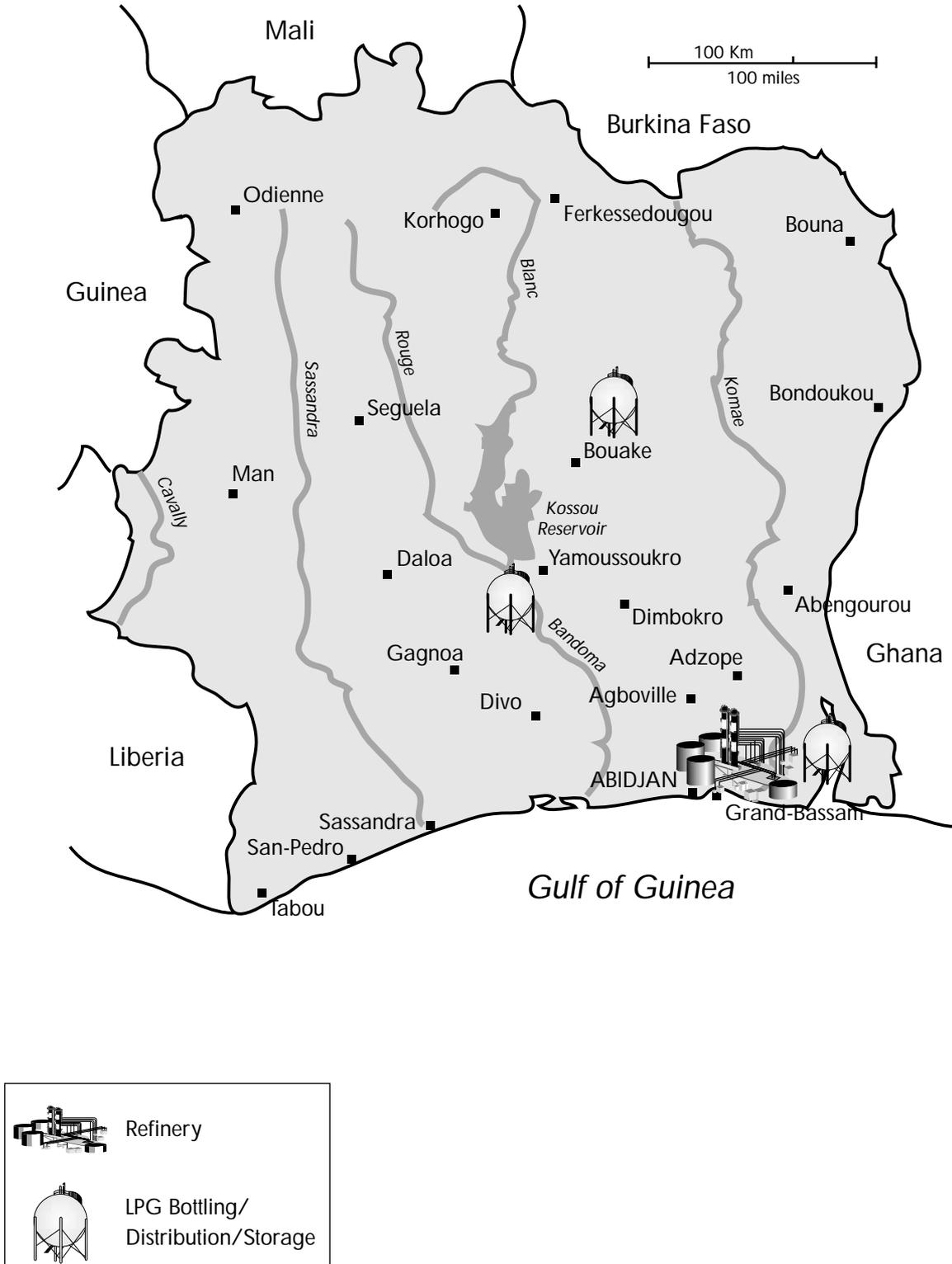
In most developing countries, LPG is primarily a fuel used by the middle and upper classes. This appears to be the case in Côte d'Ivoire also. While LPG is used extensively in Abidjan, penetration in the outlying regions is significantly less and has great potential. Affordability of LPG is a primary issue in the development of the market in Côte d'Ivoire.

5**Recommendations**

Government initiatives to stimulate LPG consumption appear to be needed in the outlying rural areas in Côte d'Ivoire. These programs could take several forms, but need to address the affordability of LPG for the average consumer in Côte d'Ivoire. Selective subsidies might be beneficial if the development of the LPG market is to be accelerated and the deforestation to be retarded. Consumer education and awareness programs might be instrumental in increasing user interest in LPG.

The government needs to take steps to open the market to potential new competitors. This requires clear standards and license regulations.

Figure VI-1 Côte d'Ivoire Orientation Map



VII**GHANA**

Ghana is a moderately sized country in West Africa located adjacent to Côte d'Ivoire. It has a population of around 19.2 million people and a land area of about 228,000 square kilometers. The gross national product of Ghana was reported to be around \$US 6.6 billion in 1997, which represents an average GNP per capita of about \$US 370 per year.

Like many other countries in West Africa, the economy of Ghana is heavily reliant on agriculture. Agriculture accounts for over 40% of the total GNP. Other major sectors of the economy in Ghana include timber and mining (gold). These three sectors of the economy account for a high proportion of total economic activity and exports from the country.

Ghana is not a significant producer of oil and gas. Crude oil is imported for the local refinery. There are some plans to develop natural gas in Ghana to use for power generation. Gas would replace light crude oil that is currently used to generate electricity. However, most of the electricity produced in Ghana is from hydroelectric generators. There are also general plans to begin receiving natural gas from Nigeria through the proposed West African Pipeline, which could be in service as early as 2001 or 2002. This new source of energy would likely be directed toward power generation and large industrial applications.

Consumption of LPG in Ghana has expanded significantly during the 1990s and is now about 40,000 tonnes per year. The market is supplied LPG from both the local refinery and imports. However, domestic LPG production is limited and imports account for the vast majority of the total supply for the market.

The LPG industry in Ghana has both private and public participation. The government is involved through its ownership stakes in refining (TOR) and an LPG distribution/marketing company (GOIL).

1**LPG Market Structure/Development**

The primary source of LPG supplies in Ghana is the 20,000-barrel per day hydroskimming Tema Oil Refinery (TOR) located near Accra. The TOR refinery was originally built in the 1960's by foreign investors. In 1977, the government of Ghana bought out the Italian interests in the refinery and the government wholly owns the refinery. Plans for privatization of the refinery are ongoing.

The TOR refinery is responsible for all domestic supply of LPG in Ghana and also handles all imports of LPG and refined products. Current refinery production of LPG is near 18,000 tonnes per year, and net imports of approximately 22,000 tonnes per year supplement domestic production to meet the total demand of about 40,000 tonnes per year. The location of the refinery is shown on Figure VII-1.

There are a number of private firms engaged in the LPG industry in Ghana. These companies include the major international oil marketing companies (Mobil, Elf, Total, and Shell) and some smaller independent marketers (GOIL and Tropic Gas). In addition, a Nigerian oil marketing company (Unipetrol) has entered the LPG and refined products markets in recent years.

GOIL is a government entity that was formed by the buyout of the former AGIP assets. The government has the intent of privatizing GOIL and both several marketers have expressed interest in buying GOIL's assets. The potential market value of GOIL's assets are reported to be as high as US\$50 million.

Market Size/Development

Total LPG sales in Ghana are expected to be about 40,000 tonnes in 1999. The evolution of the domestic market LPG market is summarized below:

	Demand (M Tonnes)
1994	28.0
1995	32.7
1996	39.6
1997	35.9
1998	37.8
1999(E)	40.0

In the early 1990's, the government actively promoted the use of LPG as a household cooking fuel. It was reported that the government distributed free cylinders in order to accelerate market development.

LPG consumption in Ghana has increased by over 40% since 1994. Demand growth was particularly strong in the period 1994-1996. The autofuel market developed strongly over this two-year period. In 1996, the government removed a price subsidy for LPG. This caused a noticeable decline in demand between 1996 and 1997. It hit the autogas LPG market particularly hard, and LPG use in this application is still declining. Residential LPG demand resumed growth in 1998 and is gradually expanding.

Household use of LPG as a cooking fuel is the largest consumption sector for LPG in Ghana. Historical LPG demand is summarized below by sector:

	1992	1993	1994	1995	1996
Household	76.2	76.4	80.8	82.4	71.5
Public Institution	4.6	4.3	6.6	5.7	4.6
Transport (Auto Gas)	2.2	6.0	2.3	2.1	15.2
Commercial/Industry	17.0	13.3	10.3	9.8	8.7
Total	100.0	100.0	100.0	100.0	100.0

As shown above, the residential sector has generally accounted for 70% to 80% of LPG consumption in Ghana. Auto fuel demand for LPG increased rapidly in 1996, but has been declining since then. In volumetric terms, LPG consumption is increasing in most end use applications, other than auto fuel. However, growth is highest in household applications.

LPG Supply/Imports

The TOR refinery has exclusive rights to import LPG and other refined products. All oil marketing companies involved in the distribution of LPG must purchase LPG at the refinery and transport it to their filling plants. The only significant bulk storage facilities for LPG are located near the refinery. These are owned and operated by Bulk Oil Storage and Transportation (BOST), which is owned by the government.

The TOR refinery is a hydroskimming refinery with an LPG yield of approximately 1% of crude oil throughput. There are currently plans for the addition of a resid FCC unit at the refinery and a crude distillation capacity expansion to 45,000 barrels per day. A financing agreement for the FCC was signed in December 1998. SK/Samsung is currently completing the engineering of the proposed expansion:

	1995	1996	1998
Refinery Production	9.0	10.0	4.8
Imports	27.6	33.3	35.0
Total LPG	36.6	43.3	39.8

Domestic supplies have generally ranged between 5,000 and 10,000 tonnes per year. However, domestic LPG production in 1999 is estimated to be around 18,000 tonnes. Even at these rates, LPG production accounts for less than half of the total market requirement and significant imports are required to balance supply and demand.

Distributor Market Share

The LPG market is currently divided among several private oil-marketing companies, one publicly owned marketing company, and one privately held LPG marketing company. Recent market share information is summarized below:

Marketer	Volume (MTonnes)	Market Share (%)
GOIL	15.2	40.1
Tropic Gas	8.6	22.6
Mobil	5.9	15.6
Elf	3.2	8.5
Unipetrol	2.5	6.7
Shell	1.5	4.0
Total	0.9	2.5
TOTAL GHANA	37.8	100.0

As shown above, GOIL is the largest LPG marketer, with a market share slightly over 40%. Their share of the market has been relatively stable over the past few years.

Tropic Gas is a privately held independent marketer with approximately 23% of total LPG sales in Ghana. Tropic Gas has recently entered the market and built a significant presence in the LPG industry over a fairly short time. They operate their own filling plants and also lease small filling plants to independent operators.

Unipetrol is a subsidiary of the Nigerian National Petroleum Company (NNPC) and has entered the LPG and refined products market in Ghana in recent years. The company has a fairly aggressive marketing strategy and has already garnished about 6.7% of total domestic LPG sales.

The major oil companies do not have the market dominance of the LPG market in Ghana as is normally the case in other countries in West Africa. Mobil has the top market presence of any major international oil company with a market share of 15.6%. In total, the four major international oil marketers have only slightly over 30% of the domestic LPG market. This could change if the government proceeds with divestiture of all, or part, of GOIL.

2

Supply/Distribution System

The supply and distribution system in Ghana is different than in most other Sub-Saharan African countries, due to the fact that consumers own their cylinders and do not generally exchange them for filled cylinders at the retail level. The supply/distribution system in Ghana more closely resembles the system that is prevalent in North America vs. the European model of cylinder deposit and exchange. Thus, Ghana is very distinct from the other West African countries reviewed in this study.

All imports of LPG are controlled by the TOR refinery, as they have the only import facilities for LPG and also provide bulk storage at the refinery. LPG imports are combined with domestic refinery production to meet the LPG demand for Ghana.

All marketers pick up LPG product at the refinery. Transport trucks are brought to the refinery to load LPG, which is then trucked to a multitude of small bulk filling plants scattered across the country.

The mini-filling plant concept makes LPG easily accessible in many parts of the country. Approximately 65% of the LPG demand is located in Accra, which is in close proximity to the TOR refinery. As the market has grown, the mini-filling plants have been built further out from Accra, thereby increasing market penetration in outlying areas. The supply and distribution system for LPG revolves around the delivery of LPG to small filling stations scattered across the country, where the consumer brings the empty cylinders to be refilled.

Tropic Gas currently has 30 mini-filling plants with plans for further expansion. Of the 30 plants, 18 belong to Tropic and 12 belong to dealers. Their total storage is near 17,000 liters. They construct the tanks in Accra and provide skid-mounted units to their potential dealers. Tropic Gas has 13 transport trucks, ranging in size from 12,000 to 57,000 liters each. The bulk trucks lift directly from the refinery and deliver LPG to the various stations. Tropic Gas does not have any storage of its own.

It is reported that some oil marketing companies have tried to introduce a bottle exchange program in Ghana in the past. However, this initiative was not successful due to the bottle ownership and customer preference. Many consumers felt they might receive a sub-standard bottle in exchange or be subject to partial fills of bottles.

Domestic Supply

Domestic supply of LPG is comprised of product from the TOR refinery, located near Accra. There are no gas processing facilities in Ghana. Imports supplement the domestic supply to fulfill the LPG demand in the country. Domestic supplies account for less than one-half of the total market requirements.

Imports/Storage Facilities

All LPG imports must transit through the TOR refinery, as the import facilities for Ghana are located at the refinery. The refinery imports crude oil, LPG, gasoline and diesel. There is one berth, with a draft of 9.6 meters. The refinery is connected to the harbor by pipeline and the LPG is transported via this route.

At the refinery, there is one LPG sphere, with a capacity of 3,000 tonnes of LPG. There are several smaller bullets, which raise the total LPG storage capacity of the refinery to approximately 4,000 tonnes. There are current plans to add an additional 3,000 cubic meters (1,600 tonnes) of LPG storage at the refinery. The storage facilities are owned and operated by BOST.

Currently, LPG is typically imported in 2,000 tonnes parcels, mainly from the N’Kossa field in the Congo.

Distribution System

As mentioned previously, the LPG distribution system in Ghana is different than in neighboring countries due to the fact that consumers own their own cylinders. Ghana is different than most other West African countries where a number of large depots are scattered throughout the country. In most countries, these bulk storage depots then become the hub for bulk distribution by road transport and bulk deliveries to centralized cylinder filling plants. However, this is not the system utilized in Ghana.

In Ghana, the distribution facilities are centered around the TOR refinery, as this provides the bulk storage depot for the entire country. LPG is generally transferred directly to mini-filling plants instead of centralized bottle filling plants which are not utilized in Ghana.

Mobil has an additional 50 tonne storage facility near Tema, and GOIL has three additional storage facilities of 80, 75, and 10 tonnes respectively. These three facilities are located at Tema, Kumasi, and Takoradi. As the demand for LPG and the industry grows, mini-filling plants are being located further away from the main metropolis of Accra/Tema.

The approximate number of mini-filling plants in Ghana is 55. Of these, 25 plants are located in the Accra/Tema region. A number of plants are located in regions outside of the capital. The majority of LPG consumption is reported to be around the Accra metropolitan region which suggests that plants in this area have a much higher throughput volume, on average, than the plants in the outlying areas.

Cylinders

There are a large number of used bottles in circulation. They are many varied sizes/types due to private ownership and the lack of a clear standard for bottles. Most of the bottles currently in circulation were imported from Europe. Since 1997, no additional bottles have been imported. Imports are still available, but the import duties placed on cylinders are extremely high. As a result, no marketing companies are importing cylinders at the present time.

Many of the cylinders in circulation are branded, but can be filled at any filling bottle plant that will accept the cylinder. The consumer owns his own cylinder and just pays for the LPG that is used to fill the cylinder.

There are currently two cylinder manufacturing enterprises in Ghana, one financed and owned by the government and the other one privately held.

The government owned cylinder manufacturer, Ghana Cylinder Manufacturing Co. Ltd, was started in June 1998. Approximately 25,000 cylinders have been produced through late September 1999. The plant was built with loans from the Korean government and currently uses Korean manufacturing equipment. The capital cost of the manufacturing facility and equipment was reported to be around \$8 million. The plant has a capacity of 130,000 cylinders per year, but is currently producing approximately 70,000 cylinders per year in a combination of two sizes (15 and 14.5 Kg).

The other cylinder manufacturing facility (Sigma) has a reported capacity to produce 150,000 cylinders per year. The plant was started up in 1997. It is believed to have manufactured 40,000 to 60,000 bottles to date. It was reported that some marketers have experienced quality concerns regarding bottles manufactured by this facility in the past. These issues appear to be being addressed at the present time.

The current cylinder selling prices offered by one of the local manufacturers are shown below:

Size	Selling Price	
5 Kg	35,000 Cedi	\$US 13.16
14.5 Kg	85,000 Cedi	\$US 31.90

Based on average consumption and number of households using LPG, it is estimated that there are approximately 400,000 to 450,000 cylinders in circulation in Ghana. The age and condition of the cylinders is very diverse, as most were imported as used cylinders. Also, the imports were from many different countries.

3

Regulatory Structure

Various government ministries are involved in the regulation of petroleum products and LPG in Ghana. The Ministry of Mines and Energy currently provides the main policy framework for the petroleum industry in the country.

An industry code of practice is currently under development in Parliament. Once in place, the code is intended to establish operating standards and regulations for the safe operation of petroleum distribution and marketing infrastructure.

An Energy Commission was set up in mid-1998 after legislation was passed in 1997. This group will be responsible for licensing all distribution and marketing facilities.

In order to market petroleum products (including LPG), a license must be obtained through the Energy Commission. Before this approval is given, an Environmental Protection Agency permit must also be obtained. While there is a general understanding of the licensing requirements for an LPG facility, they are not explicitly stated in formal regulations. It has been reported that the Energy Commission has inspected Mobil's Atomic Junction filling plant and is considering using it as a basis for license standards.

There does not appear to be adequate regulations in place to assure safe operation of LPG bottles. This results from the fact that the customer owns the cylinders and the marketing companies have limited control over bottle safety and reliability. The bottle filler has the ability to reject bottles that it considers unsafe. However, these bottles are just returned to the owner. There is no provision requiring the recertification of bottles or the ability for the refiller to keep the bottle for eventual refurbishment or destruction. It is reported that when the bottles are rejected at one facility, some customers will just go to another filling stations which is willing to accept the bottle for refilling.

There is no LPG cylinder testing/refurbishment facility in Ghana. The LPG industry has put forward a proposal to fund the services of a Health and Safety Inspector to police safety issues throughout the industry. However, the Ministry has not yet followed through on this proposal. It appears that the Energy Commission may become more involved in safety, fire protection issues, etc in the future.

Pricing/Competitiveness of LPG

The price of LPG is still highly controlled by the government in Ghana. BOST controls the ex-refinery price of petroleum products, including LPG. There are guidelines for the pricing of LPG, but the marketers have some flexibility in establishing final selling prices, especially in outlying areas.

LPG Pricing

The current price structure of LPG bottles in Ghana is shown below:

	CEDIS	\$US
Ex-Refinery or CIF Prices	700,000	\$ 264.15
Taxes and Duties	105,000	\$ 39.62
Distribution Margin	275,000	\$ 103.77
Consumer Price	1,080,000	\$ 407.55

The ex-refinery LPG price is set by the government. Taxes and duties are reported to be roughly 15% of the ex-refinery price. The distribution margin is currently slightly over \$US 100 per tonne. The above prices apply to the Accra region, and prices in outlying areas are generally higher.

The historical end user selling prices of LPG are detailed below:

Date	Ex-Refinery Price		End User Pricing	
	Cedis	\$US	Cedis	\$US
1995	160,280	134.35	344,000	288.35
June, 1996	196,280	120.05	380,000	232.42
Feb. 1997	607,920	297.27	828,400	405.09
June, 1999	565,660	213.46	920,000	347.17
July, 1999	604,340	228.05	970,000	366.04
Sept. 1999	700,000	264.15	1,080,000	407.55

The end user pricing of LPG has increased significantly in the past several years. The changes were most noticeable between 1996 and 1997. The government is currently working to bring domestic prices in closer agreement with international market prices. As a result, LPG prices in Ghana have increased considerably in both local currency and US dollars since 1995.

While the price of LPG is still controlled in order to keep it affordable for the population, end user prices have increased noticeably in recent years and this was responsible, in part, for the slowdown in demand growth observed since 1997.

Competitive Fuels

LPG is used almost exclusively as a cooking fuel in Ghana. Like other tropical countries, demand for water and space heating is negligible. Household lighting is usually comprised of electricity in the metropolitan areas or kerosene in the rural areas. LPG is not typically used for household lighting.

The main competitors for cooking fuel are charcoal and wood, with kerosene used in some rural areas. Wood and charcoal are both commercial fuels in Ghana and are used extensively outside the Accra/Tema metropolitan area.

The approximate retail selling prices of various household fuels used in Ghana are shown in the following table with energy equivalent prices which are adjusted for fuel energy content and estimated stove efficiency for each type of fuel:

Fuel	Retail Selling Price	Energy Equivalent Basis	
		Cedis/MJ	\$/GJ
6 A 1Kg LPG	1080 Cedis/Kg	49.5	18.7
12.5 Kg LPG	1080 Cedis/Kg	49.5	18.7
Charcoal	355 Cedis/Kg	45.3	17.1
Kerosene	750 Cedis/Kg	46.0	17.4

On an energy equivalent basis, the cost of charcoal appears to be slightly lower than LPG. Kerosene is also priced slightly lower than LPG on an energy equivalent basis. However, all three types of fuels appear to be reasonably competitive in this market sector. Electricity is not used extensively as a cooking fuel in Ghana.

There have been some efforts by the Ghana government to promote kerosene as a fuel for poor, rural people in an attempt to fight deforestation in areas of the country. However, there have been several problems with this program. Kerosene supplies are fairly limited in Ghana, and it is reported that kerosene does not always make it to rural locations. Most kerosene is actually sold by distributors and marketers in the Accra region, and sales are not very high in distant markets. This results, in part, from the subsidy applied to kerosene, and a price uplift obtained if kerosene is blended into diesel. In addition to blocking the intended purpose of the kerosene subsidy, the practice of blending kerosene into diesel has often resulted in safety problems.

Equipment Costs

The initial equipment costs for various types of LPG appliances are summarized below:

Equipment	Cost	
	Cedis	\$/US
14.5 Kg cylinder cost	85,000	32
2-burner stove	185,500	70
Single Burner stove	100,700	38
Hose and regulator	45,050	17

In order to use LPG, the consumer has a higher initial investment cost compared to charcoal or wood, due to the purchase price of the cooking equipment, the cylinder, and the associated regulator and hose. As in other countries in West Africa, the oil marketing companies have tried to address the initial equipment cost issue by providing an option for a low cost, single burner that fits directly onto the cylinder and can be used with a pot support to cook on. These items have been marketed in Ghana and have met with some success. This package reportedly sells for approximately \$US 20. Thus, the minimum initial investment required to use LPG appears to be approximately \$US 52.

The Ghanaian government has actively tried to promote the use of LPG. There was a strong emphasis on LPG in the early 1990's, mainly as a means to reduce deforestation. The government gave out free bottles and set the consumer prices of LPG at relatively low levels in order to stimulate demand. As a result of these programs, the affordability of LPG in Ghana increased and utilization of this fuel grew rapidly. However, government policies have changed over time and there appears to be less emphasis on the use of LPG now. LPG is still reasonably competitive with alternative household fuels but affordability appears to be a bigger issue than it was in the early 1990s.

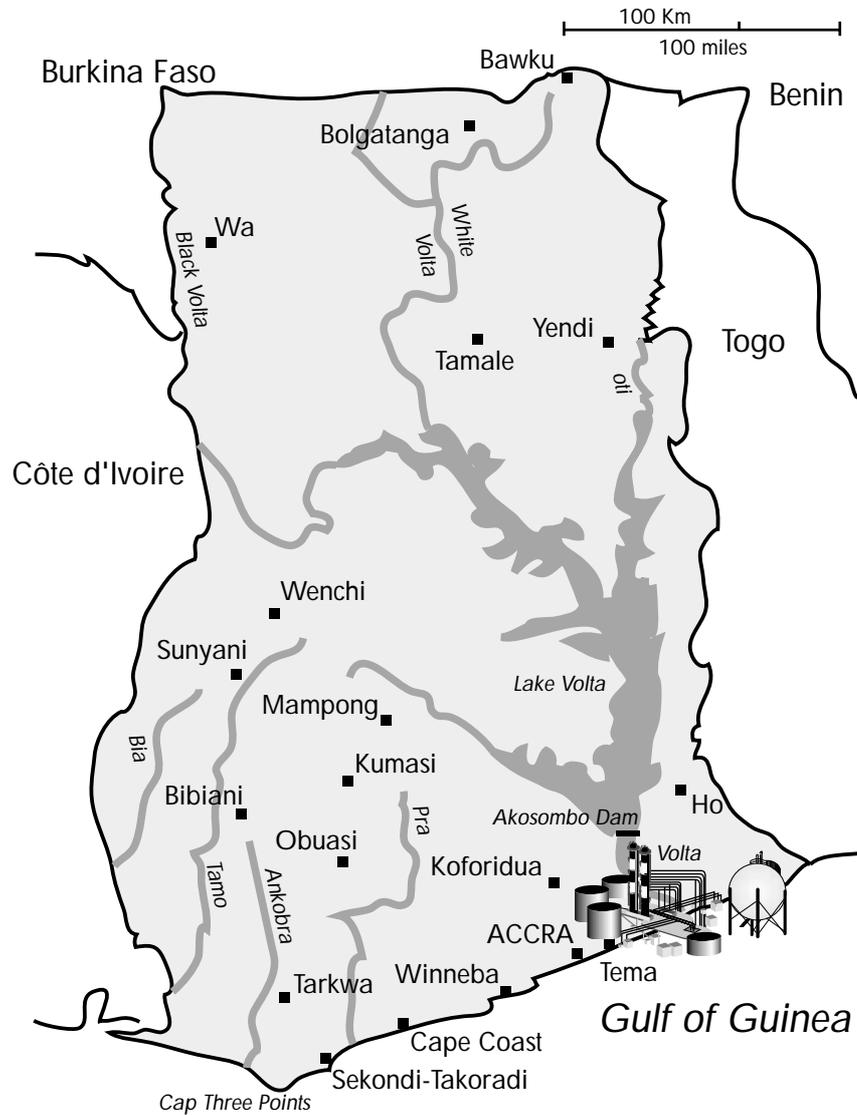
5**Recommendations**

As in many other developing countries in West Africa, it appears that government initiatives may be required in order to stimulate LPG consumption in Ghana, particularly in outlying areas of the country. Consumer education and awareness programs could be developed and utilized to promote the use of LPG in domestic markets to potential customers. These programs should be aimed at increasing the customer's awareness of the cost, convenience, safety and environmental benefits of LPG.

As noted, some government action may be needed to accelerate LPG consumption growth in outlying rural areas in Ghana. These programs could take several forms, but need to specifically address the affordability of LPG for the average consumer in these regions of the country. Selective subsidies may be beneficial if the development of the LPG market is to be accelerated and the rate of deforestation retarded. Subsidies/equipment rebates and/or low interest loans to new customers might be considered in order to overcome the affordability issue.

Several LPG operational and safety issues appear to need attention in Ghana. Standards for LPG marketing and distribution facilities should be developed as soon as possible and uniformly applied across the country. Such standards should be a mandatory part of the licensing procedure for new facilities. Cylinder testing programs need to be established and the marketers given the opportunity and right to remove/replace defective cylinders.

Figure VII-1
Ghana Orientation Map



	Refinery
	LPG Bottling/ Distribution/Storage

VIII SENEGAL

Senegal has a population of around 9.5 million people and a land area of about 193,000 square kilometers. Of the four West African countries covered in detail in this study, Senegal has the lowest population and the smallest land area. The gross national product of Senegal was reported to be around \$US 4.9 billion in 1997, which represents an average GNP per capita of about \$US 550 per year. Economic growth in Senegal has been relatively strong since 1995, averaging over 5% per year increase in real GNP.

Senegal has only limited natural resources. As is the case in many other countries in West Africa, the economy of Senegal is very heavily orientated toward agriculture, particularly peanuts. Other major agricultural products include cotton and sugar.

LPG consumption in Senegal expanded rapidly during the 1990s. Consumption of LPG increased from about 33,500 tonnes in 1990 to an estimated level of about 100,000 tonnes in 1999. With this impressive rise in LPG demand, Senegal has emerged as the top major consumer of LPG in West Africa on an absolute and on a per capita basis.

Senegal is supplied LPG primarily by imports. Supplies are also available from the local refinery, but LPG production from the refinery is small compared to the total market requirements of the country.

The LPG industry in Senegal is primarily in the hands of the private sector. There are four major LPG distribution and marketing companies operating in Senegal. The local refinery, which has responsibility for all LPG supply, is jointly owned by the government and private oil marketing companies.

1

LPG Market Structure/Development

The only domestic source of LPG in Senegal is the 17,000 barrel per day hydroskimming refinery operated by the Societe Africaine de Raffinage (SAR). The SAR refinery, which is located at Dakar, has very limited LPG production. The refinery has both private and public ownership. The current ownership is about 90% split among the four largest marketers and 10% held by the Senegal government. The refinery is presently responsible for all LPG imports as well as domestic supplies. The location of the refinery is shown on Figure VIII-1.

There are four large, private marketing companies with significant activity in LPG distribution and marketing in Senegal. These companies include Shell, Total, Mobil, and Elf. In addition, there is a local private company named ToubaGaz, which is relatively new entry into the Senegal LPG market.

As in many other countries in West Africa, there is a trade organization in Senegal called the Groupement Professionnel Petrolier (GPP). All oil company marketers are members of this group and it collects data on market size and market share.

Market Size/Development

Total LPG sales in Senegal are estimated to be about 100,000 tonnes in 1999. The evolution of the domestic LPG market is summarized below:

	Demand (M Tonnes)	Percent Increase
1990	33.5	14.8
1991	37.7	12.5
1992	42.3	12.3
1993	45.4	7.2
1994	50.4	11.1
1995	52.1	3.4
1996	67.8	30.0
1997	77.1	13.8
1998	86.5	12.1
1999 (E)	100.0	15.7

As shown in the table above, LPG consumption in Senegal has roughly tripled since 1990. Over this nine-year period, LPG has increased by an average annual rate of nearly 13% per year. Demand growth has been particularly strong since 1995 due to the initiatives of two new marketers. Before 1994, only Shell and Total were active in the domestic LPG market. Elf entered the LPG market in 1994 and Mobil entered in 1997. Both companies have been very active in developing new markets for LPG since they entered the marketplace.

Demand growth has strong during the 1990s for several reasons. LPG has been available at competitive prices and in small capacity bottles since the mid-1980s. The competitive pricing of LPG has resulted, in part, from a sizeable subsidy for LPG in small cylinders. This government program has made LPG more affordable to lower-income customers and accelerated the rate of new customer additions. With the strong growth occurring in LPG consumption in Senegal, the private marketing companies elected to make sizeable new investments in LPG storage, bottling, and distribution facilities. These types of investments were essential in order to allow for an orderly expansion of the market, which occurred in Senegal over the past decade. However, the government of Senegal is currently removing the subsidy over a five-year phase-out period (1999-2003). This is expected to have a dampening effect on future LPG consumption rates and may undermine some of the recent investments made by the private marketers.

The vast majority of LPG sales in Senegal are in bottles and cylinders. Bulk sales are reported to be only about 1,500 tonnes per year. The bulk sales are made to a variety of industrial and commercial customers.

As with most other countries in West Africa, the majority of LPG consumption in Senegal is to residential customers in bottles. This end-use accounts for over 95% of total LPG demand. In the residential sector, LPG is used almost exclusively for cooking. The breakdown of LPG sales by bottle size is detailed below:

	2.7 Kg	6 Kg	Subtotal Popular	12.5 Kg or Greater	Total
1996	25.6	57.5	83.1	16.9	100.0
1996	25.9	57.9	83.8	16.2	100.0
1997	26.5	65.7	92.2	7.8	100.0
1998	24.2	68.4	92.6	7.4	100.0

As shown in the table above, most LPG sales are made in 2.7 Kg and 6 Kg sized bottles.

Together, these two bottle sizes (popular gas) account for over 92% of total residential LPG sales in Senegal. The proportion of total sales in 2.7 Kg and 6 Kg bottles has been steadily increasing for many years.

The majority of the LPG consumption in Senegal occurs in the vicinity of Dakar. It is estimated that around 75% of current LPG consumption in Senegal is concentrated around Dakar. The Dakar metropolitan region accounts for around 25% of the total population of Senegal. Thus, the rest of the country outside of Dakar accounts for about 75% of the total population, but only 25% of total LPG consumption. Therefore, it is apparent that LPG has achieved much higher market penetration in Dakar and that a large potential market for LPG remains outside of the Dakar area. This is consistent with the market development patterns observed in other developing markets in West Africa.

LPG Supply/Imports

Senegal is a sizeable importer of LPG as the local refinery (SAR) only accounts for a relatively small part of the total supply requirements. This is illustrated in the following table:

	Local Production	Imports	Total
1990	6.4	27.6	34.0
1992	4.5	38.6	43.1
1994	0.2	49.6	49.8
1996	4.7	63.9	68.7
1998	6.8	83.1	89.9

As shown in the table above, imports currently account for over 90% of total LPG market requirements in Senegal. It is apparent that the dependency of the Senegal LPG market on imported supplies has grown significantly during the 1990s. This has occurred as the size of the market has dramatically expanded while LPG production at the SAR refinery has not increased significantly. It should be noted that the above supply statistics include LPG supplies for re-export from the SAR refinery and do not exactly match domestic consumption figures.

The SAR refinery has exclusive rights to import LPG into Senegal currently. However, this is expected to change in 2003, assuming that the subsidy is fully removed from domestic LPG pricing by this time (as planned).

Distributor Market Share

The LPG market in Senegal is currently divided among four private oil-marketing companies and one private LPG marketing company. However, the private LPG marketer (ToubaGaz) has only recently entered the market and has less than 0.5% market share. Historical distributor market share information is summarized below:

	1995	1996	1997	1998	1999
Shell	48.3	47.5	43.6	43.7	39.7
Total	49.8	44.7	41.7	36.7	36.4
Elf	1.5	7.4	11.3	10.7	12.4
Mobil	0.5	0.4	3.5	8.9	11.0
ToubaGaz	0.0	0.0	0.0	0.0	0.5
TOTAL SENEGAL	100.0	100.0	100.0	100.0	100.0

Prior to 1994, only Shell and Total were active in LPG marketing in Senegal. Together, these two companies controlled 100% of the total LPG market. With the emergence of Elf and Mobil in the LPG market, the market share of Shell and Total has gradually declined. Over this five-year period, the combined market share of these two companies declined to about 76% as Elf and Mobil gained market share. However, LPG sales of both Shell and Total continued to rise during this period. Thus, it appears that Elf and Mobil have been very successful in developing new LPG markets without taking significant sales away from existing markets in the hands of other marketers. ToubaGaz has only recently entered the market and is just starting to build market share.

2

Supply/Distribution System

The supply and distribution system in Senegal is reasonably similar to the systems found in several other countries in sub-Saharan Africa. All imports of LPG are under control of the government through the local refinery. The imports are combined with output from the local refinery to supply the needs of the country.

When import cargos are received, LPG is delivered to bulk storage facilities operated by the SAR refinery and private oil marketing companies. From the bulk storage depots, the LPG is sent to bottle filling plants. The private oil marketing companies distribute the bottles throughout the country, both through their own service stations and also through third party retailers. The private oil marketing companies also sell limited quantities of LPG on a bulk basis, delivering the product via their own tanker trucks.

Domestic Supply

Domestic supply of LPG in Senegal is limited to the output of the SAR refinery, located in the Dakar area. Annual LPG production rates have varied significantly in recent years, but have generally been 7,000 tonnes per year or less. The refinery has the potential to produce up to about 10,000 tonnes per year of LPG. Even at this production level, domestic supplies would only provide about 10% of total current market requirements. Thus, it is apparent that the vast majority of LPG supplies are, and will continue to be, sourced via imports.

Import/Storage Facilities

The SAR refinery can receive crude oil imports in vessels of up to 120,000 tonnes via an offshore buoy. In the case of LPG, a separate single point mooring (SPM) is used to offload LPG imports. LPG is transferred to onshore storage via a 1.8 km pipeline from the SPM. At the LPG buoy, the maximum allowable draft is 9 meters. The refinery indicated that they could receive 8-10,000 tonne LPG vessels if storage capacity were to be expanded.

The LPG storage capacity at the SAR refinery is approximately 2080 tonnes. In addition to the storage capacity at the refinery, storage owned by private marketing companies is utilized to receive LPG imports. This has allowed Senegal to increase LPG import parcel sizes to the range of 4-5,000 tonnes.

The LPG marketers have invested considerable capital to expand total LPG bulk storage capacity in Dakar. As noted above, this has allowed the SAR refinery to increase the import parcel sizes and reduce the cost of imports to the country. However, there is no provision currently in place for the private marketers to receive throughput fees for the use of the bulk storage. As a result, the private LPG marketers do not appear to have any economic incentive to continue to expand storage facilities.

Distribution System

The LPG distribution system in Senegal appears to be fairly well developed overall. Senegal has the largest LPG storage capacity of any country reviewed in West Africa. As noted earlier, the storage capacity is owned and operated both by the local refining company and private LPG marketers.

The bottling plants in Dakar are located very close to the SAR refinery. LPG is transferred by pipeline from the SAR refinery to the storage located at the bottling plants. As noted above, this allows the receipt of larger cargoes and private storage and is an integral part of the LPG import system.

The storage capacities of the primary storage depots in Senegal are summarized below:

Location	Capacity (Tonnes)
SAR	2,080
Total/Mobil	1,650
Elf	450
Shell	2,500
Total Senegal (Dakar)	6,680

Total LPG storage in the Dakar area is approximately 6,680 tonnes. Shell has the largest storage capacity located at its bottling plant at Mbaou. Total and Mobil operate a bottling plant near the same location with existing storage capacity of 1,650 tonnes. Total and Mobil are currently building a new 2,000 tonne LPG sphere near their plant. Of course, the SAR refinery also has significant storage located at Mbaou. Elf operates their own storage of about 450 tonnes.

There is reported to be two LPG storage tanks with a combined capacity of 2,075 tonnes in the Dakar area that are no longer in operation. Total has small storage facilities and bottle filling plants located at St. Louis and Kaolack. A total of 90 tonnes of LPG storage is located at these two facilities.

Unlike other West African countries, Senegal does not have any government owned entities involved in bottling operations, as all bottling plants are owned and operated by private companies. There are currently three bottling facilities in the Dakar area, operated by Shell, Elf, and Total/Mobil, (a joint venture with 20% Mobil and 80% Total ownership). The two smaller facilities located outside of Dakar are operated by Total.

Wholesale dealers generally own their own trucks for transporting LPG cylinders from the bottling plants to the retail facilities. Most trucks have the capacity to transport 500 to 800 6-Kg bottles.

Total operates four bulk LPG trucks in Senegal. These include one six-tonne truck, one nine-tonne truck and two 23-tonne trucks. These trucks support the limited bulk LPG business in the country and provide transportation from Mboa to the other bottling plants outside of Dakar.

Each marketer has a network of distributors that sell LPG to the end-use customers. The marketers sell LPG at petrol service stations as in other countries, but most sales are through distributors. Some marketers only offer LPG at the service stations that are located in the Dakar area.

Cylinders

Both imported and locally produced cylinders are used in the Senegal market. The local manufacturer Distribution de Produits Metallique (DIPROM) started production of cylinders in early 1999. It is reported that they have produced approximately 100,000 bottles to date and have a capacity to produce 300,000 bottles per year. The main customer of this company is Touba Gaz (a subsidiary company). Other LPG marketers import LPG bottles as required.

The estimated cylinder population for 6 Kg and smaller cylinders in Senegal is summarized below:

Company	2.7 Kg	6 Kg	Total
Shell	450,000	371,000	821,000
Total	98,000	470,000	568,000
Mobil	-	170,000	170,000
Elf	100,000	200,000	300,000
Total Senegal	648,000	1,211,000	1,859,000

As noted above, the four primary LPG distributors have approximately 1.9 million small bottles in circulation. This figure does not include the bottles that Touba Gaz (a relatively new market entrant) has distributed to-date. The number of bottles larger than 6 Kg is estimated to be 90,000 based on information provided by a large distributor.

The approximate costs and deposits for cylinders are summarized in the following table:

Size	Deposit		Cost	
	CFA	\$US	CFA	\$US
2.7 Kg	4,500	7.5	9,000	15.0
6 Kg	6,000	10.0	12,000	20.0
12.5 Kg	12,000	20.0	25,000	41.7

The LPG marketers reported that there is an issue with the current deposit system. As illustrated above, the deposits on the bottles is significantly lower than the actual cost of the bottle. A number of the bottles in Senegal are removed from the country and transported to other countries. The marketers have to bear the financial loss associated with the lost bottles. Additionally, the marketers have fewer bottles in circulation, which provides less opportunity for domestic sales.

3

Regulatory Structure

The LPG market in Senegal is not yet fully deregulated, but plans to further open and liberalize the market exist. Of all the West African countries detailed in this report, Senegal has made the most progress towards eventual liberalization of the markets, even though progress has been slower than originally planned.

The government is in the process of reforming the energy sector and liberalizing most aspects of the industry. In 1998, a new law was passed with the intention of liberalizing the hydrocarbon sector of the economy. The law covers the importation of refined products, refining, storage and transportation. Also, it is intended to provide for third party access to existing storage. Currently, only shareholders in the refinery are allowed access to storage facilities located at the SAR refinery.

For the time being, the SAR refinery has been allowed to continue to have a monopoly on the importation of LPG, mainly due to the issue of the existing subsidy and to allow the government to continue the subsidy by direct payment to SAR. However, after the subsidy is phased out over a 5-year period, it is expected that SAR's monopoly on LPG importation would expire and marketers could import LPG directly if desired. Under the current plan, the LPG subsidy is being reduced by 20% per year over a 5-year period, thereby eliminating the subsidy at the conclusion of this period. The first 20% reduction in the subsidy occurred during 1999.

A number of government ministries are involved in the regulation of petroleum products and LPG in Senegal. The Ministry of Energy currently oversees much of the energy industry.

The Environmental Ministry is also involved in the hydrocarbon sector of the economy. The Ministry recently completed a study on the socioeconomic benefits of the LPG subsidy, especially in light of the deforestation issue. The Government would like to diversify the household fuels used in the country and encourage more use of kerosene and alternate fuels to LPG. However, in order to encourage the diversification of fuels, an active forestry management program is needed to provide the additional wood for production of charcoal.

The Energy Ministry participated in the above referenced study conducted by the Environment Ministry. The study also included issues on LPG supply, but no work was done on the study of LPG demand elasticity due to the removal of the LPG subsidy.

The Government would like to encourage private investment in additional LPG storage, which is needed based on the growth in the LPG demand in Senegal. However, this will probably require the establishment of throughput fees for the use of these facilities in order to encourage private companies to make additional investments.

4

Pricing/Competitiveness of LPG

The price of LPG in Senegal has been strongly influenced by government policies to date. The SAR refinery is responsible for all imports and the government controls the ex-refinery price. An LPG subsidy was established in 1987 and has been a significant feature of LPG pricing since. The government is currently in the first year of a five-year subsidy phase-out period.

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LPG Pricing

The current price structure of LPG bottles in Senegal is summarized below:

LPG PRICING – SENEGAL				
(Price per Tonne)				
	6 Kg		12.5 Kg	
	CFA	\$US	CFA	\$US
Ex-Refinery or CIF Prices	184,061	306.8	184,061	306.8
Stabilization		-	49,061	81.8
Storage and Filling Margin	80,825	134.7	110,105	183.5
Distribution Margin	31,666	52.8	18,240	30.4
TVA	26,489	44.1	29,417	49.0
Subsidy	(121,224)	(202.0)	-	-
Consumer Price	201,817	336.4	390,884	651.5

The government controls the ex-refinery price of LPG. It is adjusted based on the acquisition cost of the LPG. At the time of this analysis, the ex-refinery price was over \$US 300 per tonne, which made it the highest ex-refinery price of the countries detailed in this study. For LPG sold in the 6 Kg bottles, the storage and filling margin is approximately \$US 135 per tonne. This is the gross margin available to the marketing companies. An additional distribution margin of approximately \$US 53 is available for wholesale and retail services. The selling price of the 6 Kg cylinders includes a subsidy of slightly over \$US 200 per tonne. The LPG sold in the 12.5 Kg bottles does not receive this subsidy and is available to consumers at a considerably higher price.

Future pricing of LPG in Senegal is a significant issue because the market has developed around a heavily subsidized price and the government is currently in the middle of a program to completely eliminate the subsidy over a 5-year period. In order to appreciate the potential magnitude of this change it is useful to review historical 6 Kg retail LPG prices in the country. The evolution of LPG prices is summarized below:

HISTORICAL LPG PRICES - SENEGAL			
(6Kg Retail Price)			
Date	CFA/ 6Kg	CFA/ Tonne	\$US/ Tonne
1995	945	157,500	315.6
1996	945	157,500	307.6
1997	945	157,500	289.7
1998	945	157,500	266.9
Jan. 1999	945	157,500	262.5
July 1999	1,040	173,333	288.9
Sept. 1999	1,210	201,817	336.4

Pricing in September 1999 already reflects an increase of around 28% from 1998 levels. Consumer prices should steadily increase over the next four years if the government proceeds with the subsidy elimination as planned. Without the subsidy, the current price of a 6 Kg LPG refill would be about 1938 CFA. This represents an increase of 60% over current prices and a near doubling over 1998 prices. As will be shown in the competitive fuel analysis that follows this section, this increase is expected to significantly alter the competitive position of LPG in the household energy market in Senegal. Obviously, this will pose a significant threat to the LPG market in Senegal and may lead lower consumption levels in the future.

Competitive Fuels

As in the other West African countries detailed in this report, LPG is used almost exclusively as a cooking fuel in Senegal. Demand for water heating is negligible in most households, and lighting is usually based on electricity in the metropolitan areas and kerosene in rural areas.

The main competitors of LPG for cooking fuel are charcoal and wood, with kerosene becoming a more important competitor due to government support. Pipeline natural gas is not available in the country.

LPG, wood, charcoal and kerosene are all commercial fuels in Senegal. Retail selling prices of various fuels are shown below with the energy equivalent prices, which are adjusted for fuel energy content and estimated stove efficiency for each type of fuel:

Fuel	Retail Selling Price	Energy Equivalent Basis	
		(CFA/MJ)	(\$US/GJ)
6 Kg LPG	202 CFA/Kg	9.251	15.4
6 Kg LPG (without subsidy)	323 CFA/Kg	14.817	24.7
12.5 Kg LPG	391 CFA/Kg	17.927	29.9
Charcoal	95 CFA/kg	12.119	20.2
Kerosene	175 CFA/liter	13.319	22.2

On an energy equivalent basis, LPG in 6 Kg bottles has a price advantage over both charcoal and kerosene. This is a result of the impact of the subsidy of 121 CFA/Kg (\$US202 per tonne). Since the subsidy is gradually being reduced, it is informative to make this comparison without the subsidy. In this case, LPG in 6 Kg bottles would be higher priced than either charcoal or kerosene on an energy equivalent basis. This suggests that the complete removal of the subsidy could have a detrimental effect on the competitiveness of LPG and potentially result in some erosion of demand.

As shown in the above table, LPG sold in 12.5 Kg bottles is significantly more expensive than the small bottles. This is due, in part, to a stabilization tax of approximately \$US 82 per tonne. Additionally, the LPG sold in larger bottles is not eligible for the subsidy. Therefore, it is not surprising that LPG in 12.5 Kg bottles appears to be disadvantaged relative to charcoal and kerosene on an energy equivalent basis.

While LPG (6 Kg bottles) appears to have a sizeable competitive advantage against charcoal currently, it should be remembered that the potential consumer has a higher initial capital outlay for LPG. Therefore, to promote additional LPG market development, some competitive advantage for LPG may need to be maintained.

Kerosene is also a more expensive fuel than LPG on an energy equivalent basis. Kerosene is also subsidized in Senegal, but to a lesser extent than LPG. The government of Senegal has recently started to promote kerosene as a cooking fuel. Apparently, the government is favoring kerosene due to its portability and interest in diversifying the fuel supplies of the country. Kerosene is easier to transport than LPG and thus has some advantages to serve outlying portions of the country. Additionally, the consumer can purchase kerosene in small quantities, helping to ease the financial burden on lower income individuals. The government is trying to provide higher efficiency kerosene stoves to the general population on a subsidized basis.

Equipment Costs

The initial equipment costs for LPG cooking applications are summarized below:

	6 Kg		12.5 Kg	
	CFA	\$US	CFA	\$US
LPG				
Cylinder Deposit	6,000	10.00	12,000	20.00
Burner	3,250	5.42	3,250	5.42
Cooker/Stand	3,250	5.42	3,250	5.42
Total	12,500	20.83	18,500	30.83

In order to use LPG, the consumer has a higher initial investment cost over using charcoal or wood. The initial cost includes the deposit on the LPG cylinder and the purchase of a cooking appliance (burner or stove). The private oil marketing companies have tried to address the initial investment issue by providing low cost burners for sale to the public. These burners are designed to fit directly on a 6 Kg cylinder. The consumer must also purchase a stand for the cooking pot to sit on in order to use this system, but the initial costs are much lower than a stove type unit.

It appears that the minimum investment cost for a new LPG consumer is approximately \$US 21. This assumes that entry level consumers opt for a 6 Kg bottle and the single burner/pot stand stove.

5

Recommendations

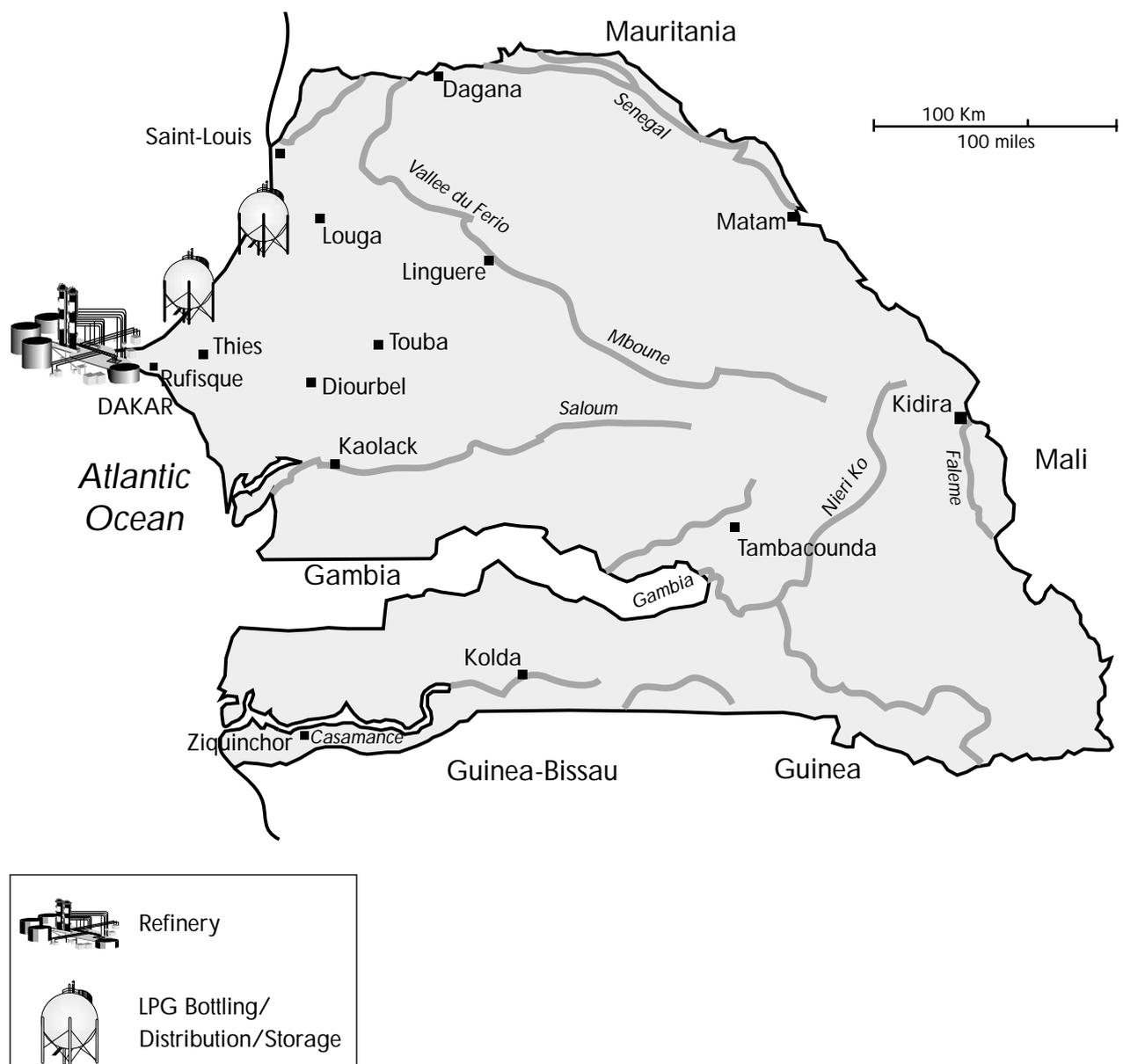
The plan to completely eliminate the subsidy on 6 Kg LPG bottles should be re-evaluated against the price elasticity of existing LPG markets. Additionally, the impact of the loss of the subsidy on the prospects of developing additional LPG consumption in the outlying areas of the country in the future should be reviewed. Possibilities to reduce costs and pass them on to consumers should be evaluated in this process, so that the subsidy, if any, will not compensate overall LPG marketing distribution in efficiencies or result in excessive profits.

Over the long-term, some reduction in the subsidy is probably unavoidable considering the size of the market, the magnitude of the existing subsidy and fiscal constraints on the government of Senegal. However, it is possible that the program to completely eliminate the subsidy may damage a very successful program to utilize LPG and retard deforestation in the country. At a minimum, the planned subsidy elimination is expected to sharply reduce future growth of LPG consumption and threaten the viability of existing and future investments by private industry.

Alternatives to the planned complete elimination of the subsidy should be reviewed and considered. Possible alternatives might include a gradual scale-back of the subsidy to levels that preserve some competitive advantage for LPG, while reducing the fiscal burden to the government. Cross-subsidies with gasoline or other fuels might be considered if the government wishes to continue to promote LPG use, while minimizing the cost of this program to the government.

Bottle deposits in Senegal are quite low compared to the cost of the cylinder. While this has the positive effect of increasing the affordability of LPG for the new consumer, it also results in loss of LPG bottles to neighboring countries. Therefore, the deposit structure should be reviewed and possibly increased to mitigate this problem.

Figure VIII-1
Senegal Orientation Map



IX OTHER COUNTRIES

In addition to the four country analyses covered in the previous sections (Cameroon, Côte d'Ivoire, Ghana, and Senegal), information was collected and analyzed for smaller markets in West Africa. The results of this analysis are summarized in this section of the report. However, it should be noted that the consulting team did not have the opportunity to visit these locations and therefore, both the data available and the analysis are not as extensive as for the four focus countries of the study.

1

Gabon

Gabon has a population of about 1.2 million people and a land area of about 258,000 square kilometers. Gabon is a significant exporter of crude oil, with recent exports reported to be about 360,000 barrels per day. With its comparatively small population and large oil revenue base, it is not surprising that the country has the highest economic activity per capita of any country in West Africa. The gross national product of Gabon, reported to be around \$US 6.4 billion in 1997, represents an average GDP per capita of \$US 4,230 per year. This is around 13 times the average GDP per capita of the whole West African region.

LPG Market Structure/Development

The only source of domestic LPG production in Gabon is the 17,300 barrels per day hydroskimming refinery operated by Societe Gabonaise de Raffinage (SOGARA) which is located at Port Gentil. The SOGARA refinery includes both public and private ownership. The current ownership is about 25% Government of Gabon, 22% Total, 21% Elf, 17% Shell, 11.6% Mobil, and 3.4 % AGIP.

Gabon has a joint venture storage company named Societe Gabonaise d'Entresopage Produits Petroliers (SGEPP). The company operates refined product storage facilities at Port Gentil, Libreville, and Moanda. The ownership in SGEPP is 25% Government of Gabon, 37.5% Shell, 18.7% Total, 9.4% Elf, and 9.4% Mobil.

There are four LPG distribution and marketing companies in operation in Gabon. These companies include Total, Shell, Mobil and Elf. All marketers supply residential and commercial customers. Total is the only marketer with bulk delivery trucks and therefore supplies all bulk customers, both their own customers and bulk customers of other marketers.

Total LPG sales in Gabon were about 16,600 tonnes in 1998. The market appears to have expanded about 20% since 1996, when LPG consumption was reported to be about 13,900 tonnes.

As in other markets in West Africa, the majority of LPG sales in Gabon are cylinder sales to domestic households. LPG is sold via service stations and through distributors and resellers.

The primary LPG markets in Gabon are located in Libreville and Port Gentil, where there are bottle filling centers nearby. It is also reported that new potential markets are emerging in the southern (Franceville, near Moanda) and northern (Oyem, Mitzic, Bitam) parts of the country. In these areas, demand for product exists already, but there are few distributors and resellers.

The SOGARA refinery is responsible for imports as well as domestic production of LPG. In 1998, refinery LPG production supplied about 62% of total market requirements, and imports were reported to be around 6,300 tonnes.

The LPG market is currently divided among four private distribution and marketing companies. Recent distributor market share is summarized below:

Company	Market Share (Percent)
Shell	28
Total	29
Mobil	22
Elf	21
Total Gabon	100

Shell and Total appear to be the top LPG distributors in the country. However, Elf, a relatively new entrant, has rapidly gained market share since it entered the market only five years ago.

Supply/Distribution System

Imports of LPG are combined with local production at the SOGORA refinery located at Port Gentil. LPG is then barged to Libreville and Moanda to storage operated by SGEPP. Total provides technical assistance to the SGEPP depots.

SGEPP operates two filling plants and the port facility which is used to import LPG on behalf of SOGORA. The filling plants operated by SGEPP are located at Owendo and Moanda. In addition, Shell operates a filling plant at Port Gentil. The other marketers have throughput agreements with Shell and are each allowed to fill a set number of bottles per day.

LPG is distributed through service stations operated by the major LPG marketers in Gabon. There are reportedly 114 service stations distributing LPG in the country. Reseller and distributors are mainly exclusive (branded) at the present time. However, it appears that multi-branded depots may develop in the future as resellers and distributors would like to take advantage of the different features offered by the various marketers.

The primary LPG storage capacity is located at Owendo. It is reported to have a total capacity of 2000 tonnes. Additional storage is located at Moanda (165 tonnes) and at the Shell filling plant at Port Gentil (110 tonnes).

There are no cylinders manufactured in Gabon. The total cylinder population is estimated to 250,000 cylinders with around one-half of the cylinders five years old or less.

Cylinder valves are reported to be uniform throughout the country and cylinders are interchangeable. The popular cylinder sizes are 12.5 Kg and 39 Kg. There are no small sizes (3 Kg or 6 Kg) in use in Gabon currently.

Regulatory Structure

The Ministry of Mines oversees the various activities of oil marketing companies in Gabon. The Ministry is responsible for the regulation of the market including enforcement of environment, health, and safety standards. Additionally, the Ministry also issues permits for companies to store and sell LPG.

The Government regulates the LPG market price and there are reportedly no subsidies on LPG in Gabon. The price control is administered by the Ministry of Finance. This agency has apparently recently started to monitor cylinders to evaluate whether or not they were properly filled and if they had leakage problems.

LPG Pricing

As noted above, LPG pricing is controlled by the government in Gabon. There are no direct subsidies included in the price structure. However, the ex-refinery price appears to include an indirect subsidy. Recently the ex-refinery price was reported to be 79 CFA/Kg (\$US 132/tonne). Retail prices appear to vary by location. LPG prices at Port Gentil and Ndjole were reported to be 384 CFA/Kg (\$US 640/tonne). Prices at Moanda were reported to be 592 CFA/Kg (\$US 987/tonne).

2

Nigeria

Nigeria has a population of about 125 million people and a land area of about 922,000 square kilometers. Nigeria has the largest population and the highest population density of any country in West Africa. Nigeria is a significant exporter of crude oil, with recent exports reported to be about 2.1 million barrels per day. The gross national product of Nigeria, reported to be around \$US 30.7 billion in 1997, represents an average GDP per capita of \$US 260 per year. This is below the average GDP per capita of the entire West African region.

LPG Market Structure/Development

LPG is produced both from domestic refineries and gas processing. However, LPG recovery from natural gas processing is a very recent phenomenon, and this product is aimed exclusively at export markets. Thus, the Nigerian LPG market is supplied product exclusively from refinery production and imports when required.

Nigeria has four refineries with a total capacity of about 439,000 barrels per day. Three of the refineries are large (100,000 barrels per day or more) high conversion refineries and the fourth refinery is an older 60,000 barrels per day hydroskimming refinery. Refineries are located at Kaduna, Port Harcourt (2), and Warri. The country has experienced many refinery operating problems over the years, causing operating rates to be very low. As a result, Nigeria has generally been a net importer of refined products since the early 1990s. All the refineries are owned and operated by Nigerian National Petroleum Company (NNPC).

The LPG market is fully deregulated and marketers are licensed to import LPG.

The LPG marketers include Total, African Petroleum, Texaco, AGIP, Unipetrol, Elf, and multitude of independent marketers. There are reported to be around 500 LPG marketing companies operating in Nigeria.

Total LPG sales in Nigeria were reported to be about 56,000 tonnes in 1998. From the supply/demand data reviewed, LPG consumption does not appear to have expanded much since the mid 1990s. However, there are conflicting reports about the current market size and recent growth trends.

It is reported that about 40% of total LPG consumption is in the residential/commercial markets with the balance of 60% in various industrial applications. Thus, residential consumption appears to be only around 23,000 tonnes per year. This implies a very low per capita LPG consumption rate and extremely small average sales volume per marketer. Recent distributor market share is summarized below:

Company	Market Share (Percent)
Unipetrol	6.4
Total	2.8
African Petroleum	2.8
Agip	2.5
Texaco	1.2
Elf	0.7
Independents	83.6
Total Nigeria	100.0

As shown above, the largest LPG marketer in Nigeria only controls a little over 6% of total national sales. Therefore, the market is extremely fragmented and there is not a dominant marketer.

Supply/Distribution System

There are reported to be five LPG import facilities (jetties) in Nigeria. Three of these are located at Apapa. The other two import facilities are located at Nidogas and Calabar. Total storage capacity at these five facilities is reported to be 7,275 tonnes. Of this capacity, 5,675 tonnes are located at Apapa. The port facilities are reported to have a draft of 7.5 meters and can receive vessels up to 15,000 tonnes capacity.

In Nigeria, customers own the cylinders. However, customers normally exchange empty cylinders for filled ones. The retail outlets are expected to carry out visual inspection checks on the incoming cylinders before exchanging these for filled cylinders. Cylinders are reported to be subject to technical inspection checks regularly and to pressure testing every five years. Most cylinders are reported to have a uniform standard valve for easy interchangeability. The dominant cylinder size is 12.5 Kg although, there are also reported to be cylinder sizes of 3 Kg, 6 Kg, and 50 Kg. The total cylinder population is reported to be over 700,000.

The LPG marketed in Nigeria is reported to be a butane product with a minimum specification of 80% butane and a maximum of 20% propane.

LPG Pricing

There is reported to be no direct subsidy on LPG in Nigeria. Recent end-user LPG prices were reported to be about 600 to 700 Naira per 12.5 Kg cylinder. This translates to an end-user price of around \$US 580 per tonne.

3

Democratic Republic of Congo

The Democratic Republic of Congo (Congo), also referred to as Congo-Kinshasa, has a population of about 49.6 million people and a land area of about 2,267,000 square kilometers. Congo is an exporter of crude oil, with recent exports reported to be about 28,000 barrels per day. The gross national product of Congo, reported to be around \$US 5.1 billion in 1997, which represents an average GDP per capita of \$US 110 per year.

The only source of domestic LPG production in Congo is the 17,000 barrels per day hydroskimming refinery operated by SOZIR which is located at Moanda. The refinery is owned 50% by the Government and 50% by AGIP.

Congo has a storage company named Services des Entreprises Pétrolières (SEP). It receives, stores and distributes products.

Total (Fina) is reported to have 100% market share for LPG in Congo. The market size is reported to be between 100 to 150 tonnes per year. Commercial and industrial demand is reported to be 95% of total sales. The typical bottle size is reported to be 20 Kg.

X

BOTTLE/VALVE DISTRIBUTION SYSTEM REVIEW

The system for distributing, recycling, inspecting and filling LPG cylinders is a key element of the safety system utilized by the LPG industry throughout the world. In this analysis, the bottle/valve distribution system was reviewed for the four countries visited-Cameroon, Côte d'Ivoire, Ghana, and Senegal.

1

General Guidelines/Practices

General guidelines and practices for LPG distribution systems are discussed below before the results of the review of the specific bottle/valve distribution systems are presented for the four countries covered in this analysis.

Regulations and Standards

There are no globally recognized international standards in existence today, but many countries have developed their own standards for LPG activities, based on the physical characteristics of LPG. These include standards for tanks, cylinders, burners, other appliances and transportation.

Many countries cooperate on the issue of LPG regulations and standards. In addition, there are several organizations which have been established to coordinate the rules and standards for handling of LPG. Examples include the World LP Gas Association (WLPGA) and European LPG Association (AEGPL).

Many private marketing companies have established their own standards for the handling of LPG. Often, these are even stricter than the government regulations in many countries.

LPG marketing companies can find guidelines in the publication entitled "LP Gas Safety - Guidelines for Good Safety Practice in the LP Gas Industry" jointly published by the United Nations Environment Program (UNEP), and the WLPGA.

Supervision and Control

LPG is, by its nature, a hazardous product with potential to cause major accidents with serious economic damage and loss of life if it is not handled properly.

LPG distribution and filling plants have been observed to have different levels of safety standards worldwide, ranging from very good to very dangerous and risky conditions. This has led the authorities in many countries to tighten the regulations and rules for installation and use of LPG. The rationale for this tightening is supported by the recorded experience of accidents and "near misses".

Even though regulations for handling LPG exist, personnel are often negligent, lazy or not trained properly. In many cases even experienced staff forget or violate the rules, often resulting in accidents. This leads to the conclusion that almost all accidents involving LPG are due to human error.

To eliminate these errors, enforcement of safety regulations and proper training of staff is needed, but a combination of this and installation of equipment which can operate automatically, has shown the best results. Since safety equipment costs money and it is often difficult to prove the necessity of the investment and show an explicit payback of such investment, many companies are reluctant to introduce more advanced equipment.

Safety

The most important consideration when handling LPG is to ensure that the responsible personnel are familiar with its physical properties, so they can work and act in accordance with safe practices. If LPG is handled with due respect for its nature and characteristics, it is a clean, convenient product and attractive to end-users.

Because LPG is under pressure when handled at ambient temperature, a leak will result in an uncontrolled escape of liquid and/or vapor. Since LPG is heavier than air and not visible at ambient conditions, it can move undetected and settle in low places. It has been observed that LPG can move as far as 500 meters from the point of leakage, and there is a risk that it will encounter some source of ignition.

To control leaks in an installation, operating companies often install a gas detection system, which will sound an alarm if LPG is measured in the air. These systems can automatically alert the fire brigade, and deploy emergency equipment such as closing all emergency stop valves and starting sprinkler systems. In some countries, the authorities make it mandatory to have such a gas detection system.

It is important that in addition to the safety equipment, there must be an emergency plan, which shall be elaborated in conjunction with the local fire brigade. It is important that such a plan be tested in joint exercises between the operating company and the fire brigade. It is critical that the fire brigade be very familiar with the design, layout and configuration of the installation and the attendant emergency equipment. There have been cases where emergency plans were not tested and failed when accidents occurred.

It is important that the filling plant be established in an area with sufficient land that the minimum safety clearances can be met. The area should be fenced in and admittance to the filling plant has to take place through a guarded gate, so only people with permission can enter the filling plant. For safety reasons, it is important to minimize the number of people at the plant. The plant should be equipped with warning and guidance signs. The plant area should be kept clean. Fire fighting equipment, emergency stop buttons and emergency shut off valves should be marked clearly. All escape routes should be marked clearly and be kept free of any obstructions. An emergency plan should be worked out; it is recommended this be done jointly with the local fire brigade. It is very important that the emergency plan be tested frequently, preferably in joint operations with the local fire brigade.

Centralized Filling Plants

Large centralized cylinder filling plants have been utilized around the world, with high filling capacities, and with facilities for comprehensive checking and testing of cylinders.

Today there are several types of filling plants, which operate more or less fully automatically, with automatic sorting of cylinders for re-qualification or painting, electronic filling carousels, electronic check scales, electronic leak testers, and capping machines or sealing machines.

The automated operation of these plants minimizes the possible impact of human error on plant safety. Cylinders which not are filled correctly or which are leaking are sorted out automatically.

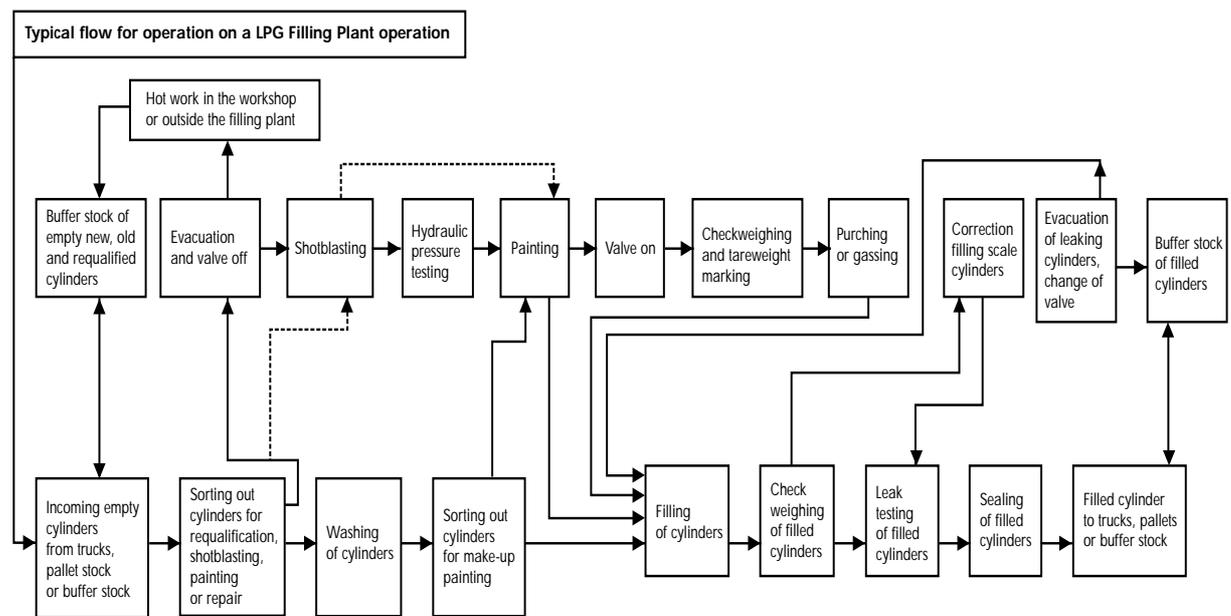
In addition to the attractive safety and efficiency features of the automatic filling plant system, a lot of important data can be collected from the system, which can be helpful in connection with stock control of cylinders and LPG, filling productivity, information about percentage of leaking valves, etc.

In connection with the centralized filling plant there can be established re-qualification facilities, so that the cylinder transportation cost for maintenance can be reduced.

The number of cylinders in the centralized filling plant operation is larger for a given number of consumers than for the mini-plant system described in the next section because a significant buffer stock of filled cylinders must be maintained in order that the system can operate smoothly without encountering shortages or “run-outs”. The working stock of filled cylinders is held in several places - at the filling plant, in transit, at the premises of distributors and smaller dealers and at the consumers’ residences. It may require between 1.8 and 2.5 cylinders, on average, to support one residential consumer, depending on the length of the supply lines.

The decision to choose a centralized filling plant, or a mini-filling plant distribution system should normally be based on the economics of the two logistics systems. Safety considerations also often come into the picture here, however, as the centralized system of closely controlled filling, leak testing and re-qualification of cylinders is often perceived to be much safer than a mini-plant system.

Typical centralized filling plant operations are illustrated in the following flow chart:



Mini-Filling Plants

The term “mini-filling plant” is usually used when talking about filling plants with up to six filling machines. Some marketing companies who operate filling plants with several carousels will often use the term for filling plants with up to 12 or 18 filling machines.

Marketing companies, depot owners, or dealers can own and operate mini-filling plants. Dealers and individual customers generally come to the plant with empty cylinders, get them filled and leave the plant with the same cylinders. In most cases the customer insists on getting his own cylinder back. In some cases marketing company may have a network of small LPG filling plants to which it delivers LPG regularly by bulk road tanker, similar to a network of automotive fuel service stations. Instead of filling an automobile gasoline tank, the mini-filling plant fills the consumer’s empty cylinder, which has been brought to the plant by the consumer.

The investment in the mini-filling plant is much lower than for the centralized plant, but as mentioned above there are certain safety concerns about the mini-plant operation. Usually, if the plant is owned by one of the major marketing companies, it will do its best to operate the plant in a safe way and it will ensure that the plant is operated by trained operators. However, in the case of plants owned and operated by individual small operators, there is generally a higher risk involved, because profit generation may have a higher priority than operating the plant safely.

Such a plant, operated by a small “independent” operator often does not have facilities to empty leaking cylinders. Additionally, it may not have tools for removing and replacing defective valves, or have spare cylinder valves. As a result, LPG may be released to the atmosphere resulting in pollution and fire risks. There may be no control to prevent unauthorized personnel from passing through the immediate filling area, no control of open flames, smoking, etc.

The most recent mini plant installations are skid-mounted package units with the standard measures of a 20’ container, so they are economical to ship and install, relatively easy to handle, and may be closed and locked during night. These represent inherently safer mini-plant designs compared with the typical installations of today.

The container unit will have all necessary equipment built-in for a good safe filling operation such as filling machines, check scale, leak tester, evacuation unit, cylinder clamp and tool for change of bad/damaged valves, LPG pump, electrical switchboard, emergency stop, etc.

The only additional items required for a containerized unit are: 1) a piece of land sized according to minimum safety clearance distances, often 50 x 50 meters, with fencing, 2) a small storage tank, 1 to 5 tonnes depending on consumption in the area and supply frequency, 3) electric power, 4) compressed air, and 5) foundation blocks to place the container on.

An additional advantage of the containerized mini-plant is its flexibility and portability. If the area the mini-plant serves has a strong growth in consumption of LPG, eventually exceeding the plant’s capacity, the smaller plant may be replaced by a larger one, and the smaller plant used to start new business elsewhere.

2

Situation by Country

The consulting team visited the following countries during their trip to West Africa: Cameroon, Côte d'Ivoire, Senegal, and Ghana. The time spent in each country was limited, so complete information on the entire LPG infrastructure and operations in every country was not obtained. Only one of the LPG marketing companies in each of Cameroon, Côte d'Ivoire and Senegal were visited. In the case of Ghana, two marketing companies were visited. To conduct a more comprehensive review of the bottle/valve distribution system, it would be necessary to spend more time in each country, so that all LPG marketing companies, and several depot/dealers could be visited.

Cameroon

Cameroon has a centralized cylinder filling plant system. As in other countries, this type of system involves a deposit placed by the consumer on company-owned bottles which are then exchanged for filled cylinders when empty.

Operators

There are five oil marketing companies (OMC) involved in LPG distribution. These are listed below:

ELF	No primary filling - buys cylinders from others.
TOTAL	Primary cylinder filler/distributor - sells to CAMGAZ as secondary.
MOBIL	Primary cylinder filler/distributor.
TEXACO	Primary cylinder filler/distributor.
SHELL	Secondary only - buys cylinders from CAMGAZ.

Each of these companies own shares in SONARA, the refining company, located at Limbe, as well as in the national joint oil product storage/depot company Société Camerounaise des Depots Petrolières (SCDP). SCDP has jointly-owned LPG storage and bottle filling plants in four population centers: Douala, Yaoundé, Bafoussam and Ngaoundere. TOTAL is the technical adviser to both the SONARA and SCDP operations. The largest and most important LPG storage/filling installation is that at Doula, which was visited by the consulting team.

The major non-OMC participant in the market is SOCIETE CAMEROUNAISE DE TRANSFORMATION METALLIQUE (SCTM). SCTM started to fill and distribute cylinders, because it had manufactured a rather large number of cylinders, which, due to quality concerns, were not purchased by the OMC's. The company has since managed to capture around 50% of the total LPG market.

Cylinder Manufacturing

There is one company manufacturing cylinders in Cameroon - SCTM. It was not possible to visit the fabrication plant during our visit to Cameroon. It was reported that due to quality issues with SCTM cylinders, the OMC's do not purchase cylinders from SCTM.

SCTM was given an advantage due to the establishment of a special national LPG cylinder specification, which could not be met by imported cylinders. The OMC's were, therefore, in a situation where they did not wish to buy cylinders from SCTM since they considered them unsafe, while being unable to import cylinders due to the unusual specification. The OMC's shortage of cylinders gave the advantage to SCTM resulting in it rapidly attaining its present 50% market share.

The Government indicated that it has new draft regulations ready which, when promulgated and enforced, should tighten up on this substandard domestic cylinder fabrication as well as permitting the OMC's to import internationally-standardized cylinders.

Cylinder and Cylinder Valves

While in Cameroon, the consulting team visited the Doula filling plant which is operated by SCDP. This facility is the largest and most important LPG storage/filling installation in Cameroon. Based on the observations made and the information obtained during the visit to this plant, we have the following comments and recommendations.

All cylinders should carry necessary information about volume, manufacturing year, tare weight, test pressure, and allowable maximum filling weight of different products. To make an easier and safer operation, the tare weight and re-qualification year should be marked on the shoulder of the cylinders, with paint or ink in easily readable figures.

Not all the cylinders we have seen appear to be in an adequate condition to ensure their safety in circulation. During our visit, there were a large number of dented and corroded cylinders observed. Cylinders with sharp dents and/or bad corrosion should be removed and sorted for maintenance, repair or scrapping.

Filling Plant Operation

In the filling operation that we observed at the Doula plant, it appeared that not all of the filled cylinders were check weighed. Only a few cylinders are check weighed at the start of the morning operations to verify the filling scales. We strongly recommend that there must be 100% check weighing carried out at all times.

Overfilled cylinders can be dangerous if they are heated. In particular, cylinders without safety relief valves are dangerous, as they can rupture, causing serious damage to people and property. Furthermore, a loss of product revenue can result if cylinders are overfilled. On the other hand, if the cylinders are under-filled, the customers are short changed, and this could possibly damage the marketer's reputation.

Leak testing of filled cylinders is carried out manually. In operations where the cylinders are filled on carousels and transported on a chain conveyor system, it is possible to do the leak testing automatically, so that human error can be eliminated. We recommend that the companies look into this possibility. This would have safety advantages and can improve the companies reputation.

We recommend that data on over/under-filled cylinders and leaking cylinders be collected and filed for reference. This can help the management of the companies exercise better control of the operation, ensuring that the filling machines and the cylinder valves are in good condition. It will also be good to have this information to back-up any claim against the equipment supplier if there are any problems with the equipment.

Filling Plant Safety

The visited plant fulfilled all general recognized recommendations for safety in a filling plant, and, in particular, it had a rather large quantity of water for fire fighting, 2,900 m³. The size of the water reservoir is usually a requirement of the local authorities, and is based on the length of time the fire brigade needs in order to establish an additional supply of water.

Recommendations-Cameroon

The substandard domestic cylinder fabrication in Cameroon should be ceased as soon as possible and the use of such cylinders prohibited. Also, the Government should tighten the control and inspection of cylinders to prevent the circulation of severely dented and corroded cylinders.

In the filling operations of SCDP Douala filling plant, not all the filled cylinders are check weighed. Check weighing of all cylinders is imperative to assure a safe operation. Furthermore, it is recommended that automatic leak testing of the filled cylinders be introduced in order to improve safety. The overall safety system at the Douala filling plant appeared to be good.

There is currently no palletization in the truck transport of filled and empty cylinders by any of the operators in Cameroon. The introduction of palletization would improve cylinder handling, reducing damage and increasing cylinder life.

Côte d'Ivoire

Côte d'Ivoire has a system of centralized cylinder filling plants with exchange of company-owned bottles.

Operators

There are eight oil marketing companies (OMC) involved in LPG distribution. These are Elf, Total, Mobil, Texaco, Shell, AGIP, Petroivoire, and PETROCI. The SIR Refinery has a monopoly on imports, and all LPG produced at the refinery or imported is supplied/sold by the refinery to depots in Vridi/Abidjan. There are filling plants in Vridi/Abidjan owned by PETROCI, Shell, AGIP, and TOMO (Total/Mobil).

Cylinder Manufacturing

There are no local cylinder manufacturing facilities in Côte d'Ivoire. And, as a result, all cylinders are imported.

Cylinders and Cylinder Valves

While in Côte d'Ivoire, the consulting team visited the Tomo filling plant which is jointly owned by Total and Mobil. Based on the observations made and the information obtained during the plant visit, we have the following comments and recommendations.

Much of the cylinder stock appeared to be in poor condition during the visit. Many of the cylinders observed were dented with damaged collars. The cylinders looked old. In general, the average age was estimated to be about 15 years. However, some cylinders appeared to be as old as 40 years. It was reported that about 5,000 cylinders have been scrapped during the last 5 years, mainly due to the presence of a stock of old EXXON cylinders.

Filling Plant Operation

In the filling operation that was observed, not all of the filled cylinders appeared to be check weighed. Only a few cylinders were check weighed at the start of the morning operations to verify the filling scales. We strongly recommend that there must be a 100% check weighing carried out at all times.

Overfilled cylinders can be dangerous if they are heated. In particular, cylinders without safety relief valves are dangerous, as they can rupture and cause serious damage to people and property. Furthermore, a loss of product revenue can result if cylinders are over filled. On the other hand, if cylinders are under filled, the customers are short changed and this could possibly damage the marketers reputation.

Leak testing of filled cylinders is carried out semi-automatically in a water bath where the cylinders are submerged. With this kind of operation, it is still the operator who decides whether a cylinder is leaking or not. There is the potential for human error that might lead to dangerous situations.

We recommend that data for over/under-filled cylinders and leaking cylinders be collected and filed for reference. This can help the management of the companies better control the operation, ensuring that the filling machines and the cylinder valves are in good condition. It will also be good to have this information to back up any claim against the equipment supplier if there were any problems with the equipment.

The plant had an evacuation unit and valve on/off screwer device so that it could empty cylinders and change bad/leaking valves without polluting the atmosphere with LPG. Furthermore, the plant had pressure testing equipment, so that re-testing of the cylinders could be done.

Filling Plant Safety

Although the safety norms and practices in the filling plant are not completely up to modern standards, there is an upgrading program underway. This investment program involves the expenditure of about 90 million FCFA for safety upgrading. If the plant is upgraded to fulfill the French standard, it will be acceptable.

Recommendations-Côte d'Ivoire

Much of the cylinder stock at TOMO Filling Plant appeared to be in poor condition. It is recommended, therefore, that the government tightens-up on the control and inspection of cylinders to prevent the circulation of unsafe cylinders. Furthermore, the filling plant should carry out a 100% check weighing to improve safety. It is also recommended that the plant introduce automatic leak testing of all the filled cylinders.

There is no palletization in the truck transport of filled and empty cylinders by any of the operators in the industry. The introduction of palletization would improve cylinder handling, reduce damage and increase cylinder life.

Ghana

Ghana has a LPG distribution system employing many bulk-supplied mini-filling plants throughout the country, with the consumer owning and retaining his own cylinder. As a result, there is no significant exchange of cylinders in Ghana.

Operators

There are seven oil marketing companies involved in LPG distribution in Ghana. These include Elf, Total, Shell, Mobil, GOIL, Unipetrol, and Tropic Gas. GOIL is a large state-owned company. Unipetrol is a subsidiary company of NNPC (Nigerian National Petroleum Company). Tropic Gas is a local independent LPG marketing company that has been very active in developing new markets.

TEMA OIL Refinery (TOR) has a monopoly on LPG product supply. All LPG that comes from the Refinery or is imported is supplied/sold from the refinery facilities to the oil marketing companies for delivery to depots throughout the country.

In Ghana, the customer owns the cylinder, and generally wants to keep his cylinder. As a result, there is no significant cylinder exchange system in operation and the filling takes place in many small filling plants. It is estimated that there are more than 60 small filling plants all over the country, of which approximately 25 are in Accra.

Cylinder Manufacturing

There are two companies involved in manufacturing cylinders in Ghana. Both companies are located in Accra. Ghana Cylinder Manufacturing Company Ltd. (GCMC) is government owned while Sigma is a privately held company.

The consulting team visited the GCMC plant in Accra. This factory has been established with South Korean financing and all equipment is new, imported from South Korea. They produce 5.0 Kg and 14.5 Kg cylinders. The plant capacity is reported to be 130,000 cylinders per year. Cylinders are manufactured in accordance with British Standard BS 15.5(2). The cylinder wall thickness was reported to be about 2.8 mm. The working pressure of the cylinders was reported to be 18 bar and the test pressure is 35 bar.

Cylinder testing and re-qualification is performed at the plant. The Standards Board of Ghana and Lloyds performs independent inspection on the facility. The steel used for the cylinders is imported from South Korea and South Africa. The company is looking to obtain certification according to ISO 9000, 9001 and 9002. There are no exports for the time being, but exports are anticipated in the future.

The consulting team did not visit the Sigma plant, but discussed their situation with a large LPG marketing company. The Sigma plant capacity is reported to be approximately 150,000 cylinders per year. They reportedly export cylinders to Côte d'Ivoire, Burkino Faso, and elsewhere in the region.

In 1997, a major oil company bought 5,000 cylinders from Sigma. Independent quality inspection was performed by Bureau Veritas. After 2000 cylinders were delivered, the company asked for a second independent quality assessment which was performed by a company called "APAVE". The APAVE inspection reportedly indicated several problems at the Sigma facility. These included a lack of manufacturing records and procedures, inadequate training and certification of welders, and unsatisfactory stress relieving procedures. Following this audit, the company recalled the 2,000 cylinders from the market, although there were no accidents attributed to these cylinders in Ghana. There are indications that LPG marketing companies in Ghana are reluctant to use cylinders manufactured by Sigma at the present time.

We strongly recommend that the government resolves this problem and tightens up on cylinder manufacturing operations. To the degree that any manufacturer has questions about their quality control, it negatively impacts the reputation of the whole LPG industry.

Cylinders and Cylinder Valves

During the visit to Ghana, the consulting team visited a filling plant operated by a major oil company. A subsequent visit was made to a filling plant operated by a large independent LPG marketing company in Ghana. Based on the observations made and the information obtained during these visits, we have the following comments and recommendations.

The customers own the cylinders in Ghana. Some 15 different sizes, from 1.8 Kg to 72.0 Kg, were observed at the plant operated by the major oil company. Marking of tare weight and re-qualification year was not clear. Additionally, the overall condition of cylinders seemed to be poor. At the plant operated by the independent marketer, 14 different sizes of cylinders, from 2.7 Kg to 15 Kg were observed.

To make an easier and safer operation, the tare weight and re-qualification year should be marked on the shoulder of the cylinders, with paint or ink, in easily readable figures. Cylinders with sharp dents and/or severe corrosion must be sorted out for maintenance, repair or scrapping.

Filling Plant Operation

In both filling operations that were observed, the cylinders were not checked before filling. Only extremely bad/dented cylinders were rejected, and cylinders which have passed the re-qualification date were not sorted out, but were still being filled. Leak testing of filled cylinders is carried out manually.

We recommend that data for over/under-filled cylinders and leaking cylinders be collected and filed for reference. This can help the management of the companies control the condition of the filling machines and the cylinder valves. It will also be a good reference source to substantiate any claim against the equipment supplier if there are any problems with the equipment.

There is no evacuation unit at the plant, so it's not apparent what would be done if there were an over-filled or leaking cylinder. Neither facility could provide a satisfactory answer to this question. We strongly recommend that the filling plants install evacuation units, so that LPG from overfilled and leaking cylinders can be recovered and sent back to the storage tanks. The issue is about safety, pollution of the atmosphere and a loss of revenue if the LPG is simply vented to the atmosphere.

With this mode of distribution, there is usually a problem with the re-qualification of the cylinders because the customers own and control them. If the cylinder has passed the re-qualification date, it should not be filled, but many filling plants fail to comply with this rule.

Filling Plant Safety

The safety in the major oil company filling plant does not appear to meet all standard industry safety practices, even though it is a generally well controlled plant which is fenced in and restricted from the general public. There is no water spray over the filling area, no breakaway device for the tank truck, no fire hoses and the emergency plan is minimal. The Company indicated that they intended to invest more in different safety equipment. We recommend that they obtain qualified assistance from an expert and cooperate with the fire brigade to see what is needed, so they do not invest in unnecessary or useless equipment.

The overall safety condition in the independent marketer's filling plant seemed to be very poor. The facility is located in a very busy location, with no fence around the plant. It is possible for unauthorized people to walk around and through the premises. Safe distances have not been established in the facility. There is no emergency pump stop, no water spray over the filling area, no breakaway device for the tank truck, no fire hoses and no emergency plan.

We strongly recommend that this plant (operated by an independent marketer) be brought up to a much stricter safety standard as soon as possible to minimize the risk for accidents at the plant.

Recommendations-Ghana

In the case of at least one plant visited, the filling operation is below safety standards in all aspects of operations. Cylinders, which have passed the re-qualification date, are not removed, but are filled. Cylinders are not checked, weighed and leak tested, and there is no effective evacuation system for cylinders that are found to be leaking. There are not adequate safety measures to control unauthorized personnel from site access, minimum spacing/clearance standards were not observed, and there was no equipment such as water sprays, fire hoses and emergency stops in the truck discharge set-up.

In the case of the plant operated by the major oil company, the facility appeared to have good site control, layout and spacing. However, the plant will always suffer from inherent difficulties with this mode of mini-plant operation. There appears to be a lack of an effective system of rejecting cylinders, manual leak testing, and evacuation of leaking cylinders. The plant appeared to have a definite investment program underway to remedy safety deficiencies in terms of water sprays, fire hoses, etc.

Cylinders are owned by the customers in Ghana. In general the observed cylinders seem to be in poor condition, but only extremely bad/dented cylinders are rejected. The safety at the filling plants does not meet international standards, and should be brought up to these standards. We strongly recommend that the government establish regulations and procedures to resolve these safety issues.

Senegal

Senegal has a system of centralized cylinder filling plants with exchange of company-owned bottles.

Operators

There are five oil marketing companies (OMC) involved in the LPG distribution. These are Elf, Total, Mobil, Shell and Touba Gaz (a local independent).

The local refinery, Société Africaine de Raffinage (SAR), has a monopoly at present on LPG product supply. This will be eliminated in about 4 years, in line with the planned phase-out of the LPG consumer subsidy. The refinery supplies all the LPG-either from refinery processing or from direct imports. The refinery LPG is supplied/sold from the refinery facilities, to three depot/filling plants in Dakar and two plants located outside of Dakar.

Cylinder Manufacturing

There is one private company manufacturing cylinders in Senegal - DISTRIBUTION DES PRODUITS METALLIQUES (DIPROM). This company is the holding company for the operating company - SOCIETE INDUSTRIAL DE TRANSFORMATION D'ACIER (SITRA), that actually operates the cylinder fabrication.

The consulting team visited the fabrication plant. The plant started to operate in early 1998 and has a reported capacity of 300,000 cylinders per year in two shifts. It fabricates the cylinders in accordance with ISO 4406, with a shell thickness of 2.5 mm and a test pressure of 30 bar.

Its largest customer of DIPROM is its own affiliated company - TOUBA GAZ, an LPG distributor in the same private Senegalese capital group.

Some marketing companies indicated the quality of the DIPROM cylinders has been poor in the past. One company, which bought 5,000 cylinders, had two fatalities within the first 10 days of use. Particular deficiencies in the case of these cylinders were leakage at the collar weld and valve leakage due to the LPG product deteriorating the seal.

Independent inspectors have been selected in accordance with particular client's wishes - e.g. Bureau Veritas, SGS, etc. The company which had problems in the past and recalled all its 5,000 cylinders, is putting in a new order for 2,000 cylinders - but with new specifications and a stricter inspection by SGS.

The cylinders are manufactured by DIPROM with a test pressure of 30 bar, so they should be suitable for operation with propane. No test certifications were observed.

We strongly recommend that the government examine cylinder fabrication standards and tighten up regulations if deemed necessary. It damages the reputation of the whole LPG industry every time there is an accident. We will also recommend the marketing companies put adequate pressure on the cylinder manufacturer to ensure that the cylinders are of a good quality and in full accordance with specifications.

Cylinders and Cylinder Valves

The consulting team visited the Total/Mobil joint venture filling plant located at Mbao, which is near Dakar. Based on the observations and the information obtained during the visit to this plant, we have the following comments and recommendations.

The cylinders observed at the filling plant appeared to be in fair to good condition and safe to have in circulation. Most of the cylinders used by TOTAL are imported. It was reported that currently, about 1500 cylinders are refurbished per year. It was also reported that Total has about 460,000 6-Kg cylinders in circulation. This means that eventually about 92,000 cylinders must be re-qualified each year, assuming that a five-year re-qualification period is maintained.

Filling Plant Operation

The overall operation of the Total/Mobil filling plant appeared good. During the visit, it was observed that the filled cylinders are check weighed at the outlet of the carousel.

Filling Plant Safety

The overall safety in the filling plant appears to be good. There is support and collaboration from the SIR refinery fire department, with the conducting of joint exercises.

Recommendations-Senegal

The Total/Mobil MBAO plant appears to be operated in a safe and efficient manner. We do recommend that management verify that 100% check weighing and leak testing are always carried out at this facility.

Regarding the cylinder fabrication in Senegal, we strongly recommend that the government tightens-up control and inspection of the cylinders produced.

Shell was the only operator with palletization in the truck transport of filled and empty cylinders. The introduction of palletization by all operators would improve cylinder handling, reducing damage and increasing cylinder life.

3

Overall Conclusions and Recommendations

The overall conclusions drawn from observations at selected LPG distribution facilities in the countries visited during this study is that safety improvements are needed in several segments of the LPG industry in West Africa.

Local cylinder fabrication takes place in three of the four countries visited, but only one of the manufacturing companies appears to produce cylinders of international standard. The other companies produce either cylinders of substandard quality or have had quality problems in their production in the past. It is a severe problem for the entire LPG industry if cylinders of substandard quality are circulated. Therefore, we strongly recommend that the governments strengthen and enforce cylinder manufacturing standards in each country with manufacturing plants in operation.

There was a general observation that the majority of the filling plants did not perform check weighing and leak testing of all the filled cylinders. We strongly recommend that there must be 100% check weighing carried out, since over-filled cylinders can be very dangerous if they are exposed to heat. Additionally, a thorough leak testing program should be a standard procedure. Where possible, introduction of 100% automatic leak testing is highly recommended in order to reduce the possibility of human error and, therefore, improve safety.

The overall safety condition of the filling plants observed varied from very good conditions to very poor. Those plants that had very poor safety conditions typically lacked the following features: emergency plans, remotely-located plant shutdown systems, water spray over the filling area, gas detection systems, breakaway devices at the tank truck discharge or loading facility, fire hoses, and emergency plans integrated with local fire brigade.

In three of the four countries visited, the system used is centralized filling plants where exchange of company owned bottles takes place. In Ghana, the customer owns his cylinder and wants to keep his cylinder. Therefore, in Ghana there is no bottle exchange system in operation. In the latter distribution mode (in Ghana) many cylinders in use were observed to be in poor condition-either dented or corroded. In the countries with company owned bottles, the bottles appear to be in much better condition than is the case in Ghana.

Generally, the distribution mode of customer-owned cylinders with no exchange system tends to compromise safety. With this system, it is also more difficult to improve safety standards than in filling plants with exchange of cylinders. In principle, the customer-owned system might be improved through the promulgation and enforcement of stricter regulations on the criteria for rejection of cylinders for re-qualification. The incorporation of cylinder replacement cost in the LPG price might aid such a program. Such measures would provide formal support to the plant operator in rejecting the filling of a customer's cylinder. It could also give the operator the financial means of replacing the customer's cylinder with a new or rehabilitated one at no immediate cost to the customer. In spite of these possible improvements to the customer-owned system, the practicalities of depending upon a low-qualified filling operator in this developing country context for these decisions on cylinder rejection and replacement, cylinder leak control and plant safety in general, render this system inherently unsafe compared with the centralized filling, bottle exchange system. It is recommended, therefore, to only operate with an exchange system, to ensure that only safe cylinders are circulated.

None of the visited plants collected and filed data for over/under-filled cylinders and leaking cylinders. It is recommended that this be implemented to help the management of the filling plant to better control the operation, ensuring that the filling machines and the cylinder valves are in good condition. Such records will also be a good tool to have for back up of any claim to the supplier of equipment, if any problems are observed.

XI

TECHNICAL SPECIFICATIONS / EQUIPMENT RATING

Technical specifications and equipment rating are important factors that influence the operability and safety of LPG distribution systems at any location. In this analysis, LPG specifications and equipment ratings were reviewed for the four countries visited-Cameroon, Côte d'Ivoire, Ghana and Senegal.

1

General Issues/Considerations

General technical issues for LPG distribution systems are discussed below prior to the review of specific specifications and equipment ratings for the four countries covered in this analysis.

LPG Product Characteristics

Liquefied petroleum gas (LPG) is a by-product produced from refining crude oil and processing natural gas. LPG includes both propane and butane.

The international LPG industry operates with three grades of products-commercial, chemical and high-purity product. The two grades "chemical" and "high purity" are odorless and used by the chemical industry or as a propellant in aerosol sprays. This report only concerns commercial LPG, which is the grade normally used for households and industry.

Commercial LPG is either propane or butane, or a mixture of the two products in different ratios.

Physical data for LPG is presented below:

	Propane	Butane	50% Propane 50% Butane	30% Propane 70% Butane
Specific gravity, d15	0.508	0.584	0.546	0.561
Vapor pressure at 15°C, bar	7.4	1.8	4.6	3.5
Boiling point, °C	-42.1	-0.5		
Chemical Formula	C ₃ H ₈	C ₄ H ₁₀		

Usually pure propane or mixtures of propane and butane are used in cold countries and pure butane is used in warm countries because the product needs heat to vaporize. Consequently, the ambient temperature of the consuming location plays an important role in selection of the LPG product. In some cases electrically heated, steam heated or gas fired vaporizers are used to increase the vaporization rate from cylinders or storage tanks. But, if the ambient conditions permit it, then the choice between use of a pure product or a product mix will depend on several other factors:

- availability of the product
- price of the LPG
- technical aspects
- heating value

In addition to these factors, the technical specifications and the condition of equipment (such as storage tanks, cylinders, regulators etc.), plays an important role in the determination of which LPG composition should be used.

Commercial propane and butane are produced to meet the specifications prescribed by internationally recognized standards. These standards set limits for the content of other hydrocarbons such as the lighter, higher vapor pressure components, methane and ethane, the presence of which would tend to increase the vapor pressure above maximum limits, and for "heavy ends" products like pentanes and heavier that will lower the vapor pressure of the LPG resulting in the user not being able to empty the cylinder. Furthermore, the international standards specify that commercial LPG must not contain high concentrations of sulfur, since sulfur can cause damages to most materials in the end-user appliances and accessories which the LPG may get into contact with, such as rubber gaskets, rubber hoses, etc. However, commercial butane is often sold with quite high propane content, up to 15% to 20% propane.

In many countries the equipment used, such as storage tanks, cylinders, hoses, piping systems etc. is rated for use with propane. However, in some countries, especially in the areas with a tropical climate, LPG companies have selected equipment designed and fabricated for commercial butane service. This is done because the vapor pressure for butane is lower, and therefore allows for a reduction of technical requirements which results in a lower investment than for a propane-rated system.

There are many international and local standards that describe the kind of material to be used for LPG cylinders, storage tanks, etc., as well as, formulas for calculating thickness of materials, etc. However, if cylinders are designed and fabricated to operate with butane only, it means that the permitted working pressure is lower than for cylinders designed for use with propane. Butane rated cylinders must, therefore, not be filled with propane. This is not only because of the pressure rating, but also the allowable filling volume of the cylinder is different for a butane and a propane-rated cylinder. A 3 Kg cylinder constructed for butane needs to have a water volume of minimum of 5.9 liter, but a 3 Kg cylinder constructed for 3 Kg propane needs to have a water volume of minimum 7.1 liter. Therefore, if a 3 Kg butane cylinder is filled by mistake with 3 Kg of propane, then the cylinder will be filled nearly 100%. Due to LPG's rather high thermal expansion rate, this will be very dangerous, because if the cylinder is heated up only a few degrees, the liquid will expand and there will be no vapor space left in the cylinder. At this point, when the cylinder is completely full and the cylinder is heated more, then the internal pressure will increase by 6 to 7 bars for each degree the temperature increases and the safety valve will release or the cylinder will rupture.

This has created a problem today, because many caravan and wagon users are moving around from warm areas to cold areas, with the result that they cannot get any gas out of their cylinder, because it is filled with butane. They need propane in the cold climate to get a decent delivery rate but if they contact a filling plant in the cold country, they are not allowed to have their butane cylinder filled with propane.

Cylinders

Approximately 90% of all LPG cylinders produced in the world have a test pressure of 30 bar, or in some cases 40 bar. A cylinder with a test pressure of 30 bar is normally accepted for a service or design pressure of 17 to 20 bar. This allows the cylinder to be used for either propane or a mixed product.

In some instances, special butane rated cylinders have been produced. These typically have a test pressure of between 15 to 18 bar and are thus acceptable for a working pressure of 7 to 8 bar.

Cylinders, when ordered from the manufacturer, have a specific volume specification, even though LPG is typically sold on a weight basis (i.e. Kg) in most areas. For example, a cylinder with a volume specification of 26.2 liters would be filled with 11.0 Kg of propane or 13.0 Kg of butane in most countries. At 15°C, 11 Kg propane has a liquid volume of 21.8 liters. The liquid in the cylinder would expand to 23.3 liters at 40°C. At 60°C, there would be little expansion room left in the 26.2 liter cylinder. The vapor pressure in the cylinder would rise from 7.4 bar at 15 degrees C to around 20 bar at 60 degrees C in this same cylinder.

The two most common LPG cylinders sizes used in the West African countries visited have the following characteristics:

Nominal Size (Kg)	Tare weight (Kg)	Capacity (Kg)		
		Propane	Butane	Water
6.0	8.5	5.0	6.1	12.0
12.5	14.0	11.0	13.0	26.2

In most countries, a LPG cylinder is typically marked with the following data: name of producer, production number, production date, approving authority, tare weight, water volume, test pressure, and maximum filling for propane and butane (weight).

In order to determine the suitability of a cylinder for propane service, the test and working pressure, along with the water volume must be checked. This will help determine the quantity of propane that can be safely filled in the cylinder.

LPG Composition Issues

For safety purposes, staff employed to handle LPG must be trained on the characteristics and nature of the products, especially the vapor pressure and expansion characteristics of the liquids.

Commercial propane operators have the possibility of changing to a higher butane product mix, but the many companies world-wide, that have decided to operate with equipment, storage tanks, cylinders and regulators which are designed for commercial butane only, do not have the flexibility to increase the propane content. If they want to operate with another type of LPG containing higher propane, they must carefully analyze the consequence of adding propane to the butane in terms of the allowable vapor pressure and the maximum permitted filling ratio for cylinders and storage tanks.

If a filling plant operates using a mixture of butane and propane then a number of safety issues must be addressed to ensure the safe handling of the LPG.

In most cases the plant receives the LPG as a mixture of propane and butane. However, in order to take advantage of low LPG prices for individual components, or if propane and butane are normally available as separate components, the plant operator may be in a position to mix the propane and butane at the filling plant. In this instance, the operating company must take special precautions to insure the safe handling and mixing of the product. Specifically, the LPG tank must be filled with butane first, and then the appropriate quantity of propane added into the tank. This will ensure that the propane properly mixes with the butane, due to the vaporization of the propane as it enters the tank.

Furthermore, experience shows that it can be necessary to pump the LPG from the tank, which received the LPG to another tank to make sure that the butane and propane are mixed properly. But in all cases a check of the specific gravity and vapor pressure must be carried out to secure that the two products are mixed properly.

Another operational point to be taken into account in the mixing of propane and butane is the use of any gas compressors. At the suction side of a gas compressor, a higher percentage of propane will be vaporized, due to the relative volatility of the two components. As a result, the propane/butane mixture may be higher in propane content than anticipated or desired.

If LPG cylinders are inadvertently filled with a higher percentage of propane than intended, there is a higher probability that the cylinder may rupture when heated or that the cylinder may have an uncontrolled gas escape as the safety relief valve discharges.

Finally, it should be noted that if cylinders of different working pressures are used by different LPG companies in a country, and the companies operate with different product mixes, there could be a risk of accidents, if one LPG marketing company fills the cylinders of another company without checking the pressure rating and allowable fill volume of the cylinders.

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Situation by Country

For LPG facilities designed and constructed for a commercial propane operation, a changeover to a propane/butane mixture is relatively easy based on the specifications of the products and the design ratings of equipment. However, if facilities are designed for butane use and the operator wishes to convert them to propane only or mixed product use, a thorough assessment must be carried out before the changeover can be made. This assessment should, at a minimum, include the following: cylinder and valve specifications and design pressure ratings of all equipment and accessories used in the handling and distribution of product, including filling plants, storage tanks, road tankers, etc.

It has to some extent been possible to collect explicit, reliable information on the above mentioned subjects for the five filling plants visited, and the industry professionals interviewed provided their view of the industry position as a whole in each country. It should be pointed out, however, that no comprehensive, rigorous information was obtained on the infrastructure pressure rating for the other operating companies not interviewed in the four countries visited and for the countries not visited.

Of the four countries visited, three (Cameroon, Côte d'Ivoire, and Senegal) use a commercial butane specification for LPG. It was reported that Ghana had a specification allowing use of a mixed product, which ranged from 10% to 30% propane.

Nameplates on storage tanks would normally provide the following information: name of manufacturer, year of manufacture, date of hydraulic pressure test, volumetric capacity, name of product, identification number, design pressure, hydraulic test pressure, construction code, and approval stamp. Some of the tanks that were observed by the consulting team carried incomplete data.

The subsections to follow state the observations made as well as an evaluation of the situation in relation to the possible increase of the propane content of the LPG product.

Cameroon

LPG sold in Cameroon is commercial butane.

Cylinders

All the 6 Kg cylinders in the Cameroon industry seem to be propane rated with a working pressure of 17 Kg and a test pressure of 30 bar. About 90% of the cylinder stock in the remaining sizes are propane-rated. A possible move to a higher propane mix would require a thorough check of the cylinder stock and a phase-out of lower pressure-rated cylinders.

The cylinders observed appeared to be in poor condition.

Storage Tanks

All observed storage tanks were rated for commercial butane with a working pressure of 8 bar and a test pressure of 15 bar.

Recommendations-Cameroon

We recommend that higher propane mixes should not be introduced before all specifications of the tanks and cylinders are thoroughly checked and any lower-rated equipment is taken out of service.

The installation of new storage tanks rated for propane would be a major required investment in the Cameroon infrastructure, if higher propane mixes were to be considered.

Côte d'Ivoire

LPG sold in Côte d'Ivoire currently adheres to the commercial butane specification.

Cylinders

The cylinders for the entire industry all seem to be rated for propane with a working pressure of 17 bar and a test pressure of 30 bar. It is recommended that this be checked for all companies in the market before any possible move to a higher propane content.

The cylinders appeared to be rather old and in bad condition.

Storage Tanks

All observed storage tanks were rated for butane with actual working pressure at 5 bar and maximum working pressure 8 bar and test pressure 15 bar.

Recommendations-Côte d'Ivoire

We recommend that higher propane mixes should not be introduced before all specifications of the tanks and cylinders are checked 100 %.

The installation of new storage tanks rated for propane would be a major required investment in the Côte d'Ivoire infrastructure, if higher propane mixes were to be considered.

Ghana

Of the countries visited by the consulting team, Ghana was the only one where the generally available LPG was a mixture of propane and butane.

Cylinders

The cylinders which the consulting team observed at the two mini-filling plants were all propane rated with working pressure of 17 bar and test pressure of 30 bar. However, since there are such a huge variety of cylinders from many sources outside the control of the LPG marketers, it is recommended that a close check on cylinder ratings be made, if a move was made to a higher propane-containing product. It would be the ultimate responsibility of the filling attendant to reject a substandard cylinder whether it is due to cylinder condition, valve condition or too low a pressure rating for the given LPG product.

This large variety of cylinders being filled, at times, by poorly qualified mini-filling plant attendants makes it imperative to have clear, straightforward correlation tables showing allowable filling amounts for every possible water volume size and propane-butane composition.

The consumer-owned cylinders appeared to be in poor to fair condition on average.

Storage Tanks

Both of the mini-plants visited had propane rated storage tanks. The Tropic Gas network of some 30 plants all had a standard design for tanks, each with a propane rating.

Recommendations-Ghana

A more detailed survey shall be carried out before it can be decided whether higher propane content can be allowed. From the information we have got, it seems possible to increase the propane content without any problem.

Senegal

LPG sold in Senegal meets a commercial butane specification.

Cylinders

The cylinders observed were rated for propane with a working pressure of 17 bar and a test pressure of 30 bar. We recommend that this be verified for all companies in the market before any possible move to a higher propane content in LPG is made. The cylinders observed appeared to be in fair to good condition.

Storage Tanks

At the bottling plant visited in Senegal, there are 3 storage tanks, one - 75 tonne horizontal, and two - 800 tonne spheres. One 2000 tonne sphere is under construction. All observed storage tanks were rated for butane with a working pressure rating of 8 bar and a test pressure of 15 bar. No certificates were available.

Recommendations-Senegal

We recommend that higher propane mixes should not be introduced before all specifications of the tanks and cylinders are checked 100 %.

The installation of new storage tanks rated for propane would be a major required investment in the Senegal infrastructure, if higher propane mixes were to be considered.

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Overall Conclusions and Recommendations

During the visits it was found that more detailed information must be obtained from all the marketing companies before it can be decided which components of the infrastructure and equipment can be used to handle a higher propane content product and which must be replaced.

Most of the cylinders seem to be designed for propane use, but a more comprehensive check is needed.

The storage tanks appear to be mostly butane rated, so they would have to be replaced by tanks designed for propane use, or, alternatively, new propane-rated tanks have to be added.

Since only a few installations have been visited, we do not know explicitly whether the condition of the other marketing companies' installations and cylinders differ from the visited companies. The individual industry professionals interviewed, however, assured us that the total industry picture was very similar to their specific infrastructure and operations.

Most likely a pre-condition for handling a higher propane content product is that investments are made in new propane rated storage tanks, a rather expensive component, but other components might be required to be replaced as well.



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