THE STORY OF LPG

Poten and Partners

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Photographs

Frontispiece: A modern gas carrier, the *Berge Commander*, enroute to its destination.

Backpiece: How LPG used to be transported. LPG cylinders onboard the *Natalie O. Warren* in the early 1950's.

THE STORY OF LPG
Second Edition

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The Story of LPG

FOREWORD TO THE SECOND EDITION

The story has moved on. Some readers have suggested that this book should have an update. Others have pointed out a few errors and omissions in the original text. For these two reasons, we have decided to release a second slightly more expanded edition.

I hope, for those coming to the book for the first time, that it may prove a pleasant distraction on a journey some time.

For those who have read the first edition, it may be interesting to reread the text to see what new material has been included or to find out what twist may lie in the tail.

Again, my thanks to all in the industry who have offered their invaluable comments or supplied information. As before, I must take responsibility for the views and opinions expressed.

Colin Shelley
London, May 2003

INTRODUCTION

The term LPG - or liquefied petroleum gas to give its longer name – refers to the gaseous liquids that are recovered from the processing of natural gas and the refining of crude oil. This LPG consists of two commercial products – propane and butane - both of which are gaseous at ambient temperature and pressure and yet are liquid when stored and transported under pressure or in a refrigerated state.

These problematic characteristics made LPG a late developer in the hydrocarbon business. The first commercial production had to wait until the 1920's, the first international trade until the 1950's. Seaborne trade in LPG was less than 1 million tons in 1960, reached 17 million tons by 1980, and 48 million tons by 2000.

The story of LPG – which this book relates - is an unusual one. It began with a problem, an unstable transportation fuel, continued with a disaster, the *Hindenberg* crash in 1937, and then developed with the efforts of a few enterprising individuals who had the vision to see its commercial possibilities.

The fruits of enterprise were not always rewarded. The industry has seen its fair share of ups and downs over the past fifty years. Many players exited the stage. Others came in. But a certain continuum has

remained, a certain perceived separateness and specialness about the business, which I hope this book does something to convey.

1. BEGINNINGS

Birth of an Industry

The story of LPG begins in the Appalachian oil fields of western Pennsylvania, some 50 years after oil had first been discovered and produced there. Along with oil came gas. By the turn of the new century, markets for gas had developed. But before the gas could go into pipelines, the contained liquids had to be stripped out.

The raw liquids that were recovered by compressing the wet gas - a mixture of propane, butane, and pentane and heavier material – were dubbed casinghead gasoline. Their light distillate characteristics, made them, as their name implies, an early transportation fuel.

The stream contained, however, a considerable amount of highly volatile light ends, which meant that the product could not be used or shipped at once. Instead, it was left in open tanks for weathering until the "wild" light ends evaporated. The industry at that time had no accurate measuring system for determining vapor pressure. Consequently, there were numerous accidents and explosions which occurred from the storing and transporting of this unstable fuel.[1]

[1] In 1921, it was decided to change the name of the product from casinghead gasoline to natural gasoline because of the bad publicity which had resulted from these incidents.

Photo: Casinghead gasoline plant (circa 1916)

In 1910, Andrew Kerr, working at a casinghead gasoline plant in nearby West Virginia, succeeded in collecting these gases, compressing them, and storing the resulting LPG in small tanks.

Around the same time, Walter Snelling, a chemist with the Bureau of Mines in Pittsburgh, was contacted to investigate the vapors coming from a gasoline vent tank of a Model T Ford. Using coils from an old water heater and other laboratory equipment at hand, he built a still that could separate the gasoline into its liquid and gaseous components.

He subsequently developed a pressurized containment system for these liquid gases and made the first domestic installation at the farmhouse of John Dahring in Waterford, Pennsylvania. The LPG was used for cooking and lighting. A local plumber apparently did the job at a cost of $11.20 for 28 hours of labor.

Commercialization of LPG came slower. Propane was first used as a fuel in a blowtorch for metals-cutting. Nationwide, sales were only 220,000 gallons (400 tons) in 1922. It was not until 1927 that the Tappan Stove Company began to produce cooking ranges based on propane as fuel.

The industry was dogged at this time by patent disputes. The Carbide Company (later Union Carbide) had built a plant to recover stabilized

gasoline and LPG in Clendenin, West Virginia and claimed a monopoly patent for their Pyrofax process.

But rivals appeared in Oklahoma, the new boom state of the oil industry. By 1920, there were over 300 small gas plants recovering liquids within the state. Leading the field was Frank Phillips, who had purchased Walter Snelling's propane patent for the then princely sum of $50,000. His company, Phillips Petroleum, emerged in the 1920's as the largest producer of natural gasoline in the United States. Another entrant was W. K. Warren who, along with his wife, had scraped together $300 to form Warren Petroleum and began buying up the produced liquids to market.

In 1925, the Carbide Company filed suit against Phillips and the other producers, claiming patent infringement. Phillips mounted a vigorous defence, arguing that the Carbide Pyrofax process had copied an earlier design developed in Germany by Hermann Blau. To support their case, Phillips even hired a Blaugas engineer to build a demonstration plant based on the Blaugas technology.

The Phillips' arguments prevailed. The subsequent court decision in their favor in 1927 made the technology available and cleared the way for the development of an LPG industry in the United States.

International Beginnings

The international beginnings of the industry were somewhat exotic. In the late 1920's and early 1930's, the airship had emerged as a serious contender for international air travel. Regular long-haul services were commencing on a number of routes. These airships used butane, carried in cloth bags at low temperature, as an engine fuel. As the butane was consumed, the bags collapsed and their volume was displaced by air. Consequently, the weight remained unchanged and the airship could stay at the same level in flight, even on long voyages.

Butane was chosen because it was a cheaper alternative than the hydrogen that was used for holding up the airship. Butane tanks were therefore erected at various refuelling stations around the world. Butane was shipped to these locations from Houston in small pressure tanks on the decks of cargo liners.

On the afternoon of May 6 1937, the disastrous crash of the *Hindenburg* in New Jersey put an end to airship dreams.[1] They disappeared from the skies and the butane tanks along the routes were being sold for

[1] The cause of the crash was never identified at the time. Both the lift gas, hydrogen, and the fuel, butane, are flammable gases. But archival records suggest that it was the flammable cellulose used on the skin of the airship to protect it against sunlight and moisture that was in fact responsible for the combustion which caused its destruction.

Photo: Ernesto Igel

scrap. The one exception was in Rio de Janeiro. An enterprising Austrian businessman, Ernesto Igel, who imported gas stoves into Brazil, saw its potential as a cooking fuel. He offered to buy the remaining 6,000 butane cylinders that were available in Rio Janeiro.

His salesmen patiently lugged stoves and steel bottles along the streets of Rio de Janeiro to promote this new cooking fuel. By 1939, his company, Ultragaz, was operating three trucks and had 166 customers. As the use of gas stoves spread, his business grew and prospered. By 1950, he had 70,000 customers.

His problem was to source the LPG as the Zeppelin stocks ran out. He began to import cylinders from the US Gulf Coast on the decks of cargo liners. During the war years, when this trade was interrupted, he managed to find some LPG in Argentina.

After the war, a new arrangement was found – with a supplying company in Houston, Socony Vacuum (later Mobil) and a Norwegian shipowner, Oivind Lorentzen, who operated the Nopal liner service to Brazil. Later, these parties were to formalize their relationship in a company that was to be the first international trading company in LPG, Mundogas.

2. AMERICA

Early Times

The Carbide Company had enjoyed an early monopoly on its LPG production patent. But the 1927 court decision against them threw open the door to others.

Phillips was the quickest to react. The company installed new LPG fractionating units at their Burbank gas-processing plant in Oklahoma. This gave them a production lead over their rivals which they were able to maintain throughout the inter-war period.

Frank Phillips entrusted his lieutenant Paul Endacott with the task of developing LPG as a viable business. He and his team began a research and development program on appliances and gas equipment which might use LPG as fuel. Their first bobtail trucks to transport LPG under pressure were built in 1928. And Phillips' subsidiary Philgas invested in LPG storage tanks for household and industrial use at the consumer end.

Other new entrants at this time included Skelgas (Skelly Gas) and oil company subsidiaries such as Shellane (Shell Oil) and, in California, Flamo (Standard Oil of California). Also, as the 1930's went along, a growing number of small independent operators emerged, serving local

Photo: Frank Phillips

markets in New England and the Northeast, the Midwest, and the Pacific West Coast. One of the industry pioneers, Andrew Kerr, set up his own marketing company, Imperial Gas, in Los Angeles.

George Oberfell, who had led the Phillips' defence against Carbide in the famous court case, helped found the National Bottled Gas Association in Atlantic City in 1931. Despite the Depression, sales nationwide increased from 10 million gallons (20,000 tons) in 1930 to 56 million gallons (110,000 tons) in 1934.

The going was initially difficult. The early cylinders produced for consumer use were extremely rudimentary. They were equipped with either frangible disks or fusible plugs to release their contents in the case of a pressure buildup. The frangible disks were particularly hazardous. They would often corrode and prematurely burst. The cylinders themselves, in large 100 pound (45 kg) weights, were expensive, costing $16-18 a time. Few consumers, in the depressed economic climate of the early 1930's, could afford them. They had to wait until 1936 when more economical 20 pound cylinders were first introduced.

The first cylinder buyers were in fact wealthy vacation home- owners who would attach them to their cooking stoves. Some sales were also made to farmers who converted from kerosene or solid fuels.

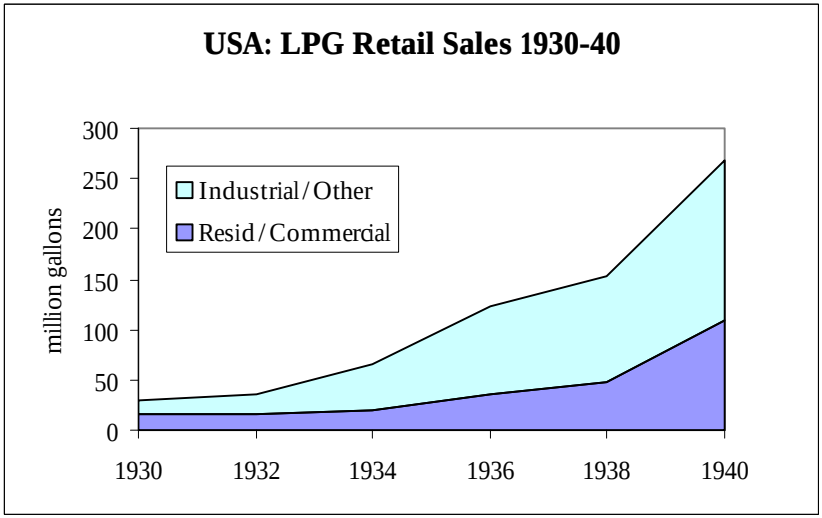
Customer equipment would consist of two cylinders and a regulator. When one of the cylinders became empty, he would have to go out and turn on the other one and then remember to order a replacement. It wasn't until the late 1930's that the changeover regulator was developed which would automatically switch from the main cylinder to the reserve without any shutdown in service.

Stove manufacturers were initially reluctant to make design changes to their burners to accommodate the hotter-burning LPG fuel. But in time new propane stoves came on the market. Pyrofax and Philgas became known as household brands. By the late 1930's, the propane marketers were offering to farmers smaller 20 pound (9 kg) cylinders to purchase at low cost and with the convenience of a bulk delivery on a cash-and-carry basis.

The one-drum system pioneered by Phillips Petroleum equipped the cylinders with two valves instead of one, enabling them to remain in place at the customer's site and be refilled from a tank-truck. The customer did not have to pay for the gas before he used it; he paid instead on a monthly basis after use.

Propane was at this time and has continued to be the LPG fuel for cooking, heating, and other home use. LPG also increasingly found its

way to industrial customers. By 1940, LPG sales nationwide were close to 300 million gallons (600,000 tons).



Retail sales slowed down after America entered the war in 1941. Much of the LPG produced was requisitioned by the Government for the war effort. Isobutane was first produced at that time as a high-octane component for aviation fuel. Still, the market fundamentals were in place for the rapid growth that occurred in the post-war years.

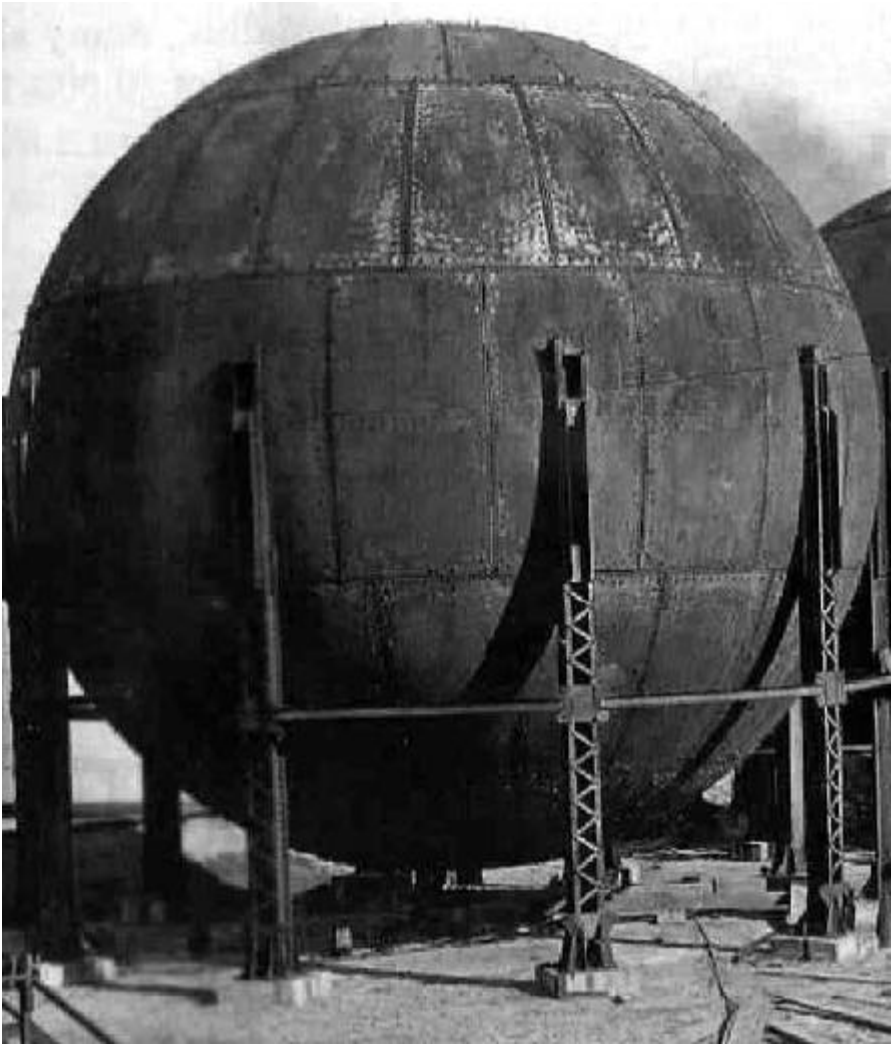


Photo: Early butane storage tank (at the Port Arthur refinery).

Post-War Boom

By 1947, sales had passed the 2 billion gallon (400,000 ton) per year mark, with LPG being supplied to an estimated 3.5 million customers. Demand was outstripping supply and there was an acute shortage in both storage facilities and rail tank-cars. Dealers were recommending that customers install larger tanks and store more propane as a precaution against times of short supply.

The main storage at the time was the pressurized spherical LPG tank (the Hortonsphere), developed by Chicago Bridge & Iron. Underground storage for LPG in cavern structures began in 1950. Within two years, 77 such storage projects were underway.[1] Even so, with home-heating demand developing and winter/summer demand ratios becoming lopsided, storage remained insufficient at the consuming end and winter shortages recurred.

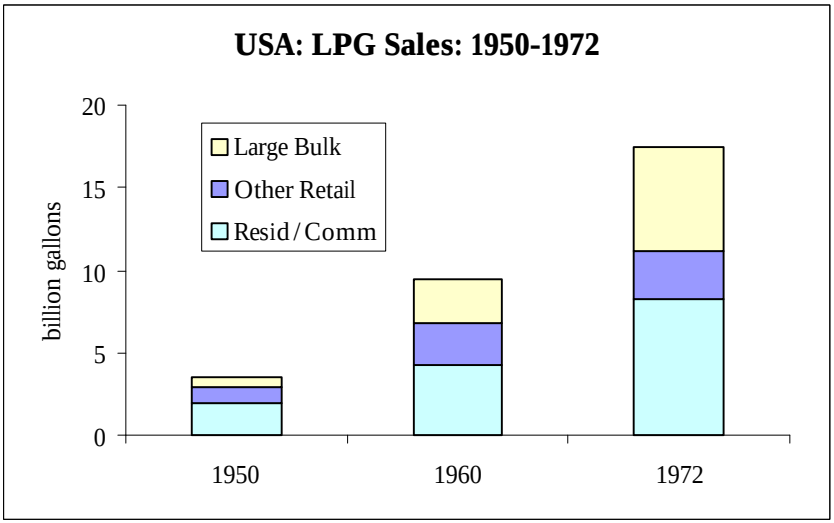
Supplies were not a problem. America's oil and gas production was about to undergo a period of extraordinary expansion; and, following in its wake, came LPG from an equally expanding gas-processing industry.

[1] These even included a plan by Bottled Gas of Virginia to seal up a 3/4 mile railroad tunnel near Charlottesville that had been built in 1859 and was then disused.

Photo: W.K. Warren.

The production base remained Oklahoma. Phillips, based in Bartlesville, and Warren, based in Tulsa, topped the LPG producing league, both still led by their founding fathers.[1] But more LPG was now coming from gas plants further south in Texas and Louisiana.

Liquids recovery increased as well as gas plant technology improved. The new cryogenic technology, and especially the advent of the turbo-expander in 1964, made deep extraction of all of the propane in the gas stream technically feasible. And marketers were able, year by year, to sell more LPG. Nationwide, sales of LPG increased from a total of 3.5 billion gallons in 1950 to a peak of 17.4 billion gallons by 1972.



[1] Frank Phillips retired in 1949. Some Phillips employees still say, when they pick up the tab at a restaurant, "let Uncle Frank pay." W.K Warren sold his company to Gulf Oil Company in 1956, but retained a management position as well as an 11 percent stake in Gulf.

USA: LPG Sales (1)
billion gallons

	Residential / Commercial	**Other Retail** (2)	**Large Bulk** (3)	**Total**	**Total** million tons
1950	2.0	0.9	0.6	3.5	6.9
1960	4.2	2.6	2.7	9.5	18.6
1972	8.3	2.9	6.2	17.4	34.1

(1) The industry data records mainly propane sales.
(2) Farm, internal combustion, industrial, and other uses. Butane sales for gasoline blending are excluded from the totals.
(3) Mainly sales to petrochemical buyers as steamcracker feedstock.

LPG dealers flourished during this period. The low cost of entry encouraged many into the industry, often on a shoestring budget. A large number of them remained "mom and pop" operations, a staple of the business then and still a feature now. But others expanded into regional and later national powerhouses.

Manufacturers produced a wide array of appliances - cookers, water heaters, clothes dryers, and boilers, burners, and other direct heating equipment - to run on propane as fuel.

USA: Propane Appliance Sales

million units	**Cookers**	**Water Heaters**	**Clothes Dryers**	**Space Heaters (heaters, furnaces)**
1955	1.6	2.5	0.3	2.0
1960	1.8	2.7	0.4	2.8
1970	2.4	2.7	0.5	3.1
1972	2.6	3.2	0.7	3.8

Home use grew, mainly in the semi-rural and rural areas that lay beyond the reach of America's gas grid network. The traditional 100 pound (45 kg) propane cylinder began to be phased out. Instead, marketers increasingly installed small-bulk tanks at their customers' premises, thereby lowering the cost and frequency of bulk deliveries.

Propane also became a staple on farms, and not just as a domestic fuel. Uses developed for crop drying, tobacco curing, poultry and pig brooding. It powered trucks, pumps, standby generators, and other farm equipment.

By the late 1960's, with energy prices dropping and propane becoming even more economical to use,[1] it was taking an increasing share of the space-heating load. A typical household might consume 500 to 600 gallons of propane per year. In parts of the Midwest where the winters are severe, three to four fills of a 500 gallon tank (one ton) would be required.

Large-bulk sales of propane also developed as an olefin feedstock to the burgeoning petrochemical industry. Steamcrackers built on the Gulf Coast, often with a pipeline connection to the underground

[1] Bulk propane was selling at less than 5 cents per gallon ($25 per ton) on the Gulf Coast at that time. The price basis then was the Baton Rouge plant in Louisiana. The retail price for small bulk deliveries was in the range of 11-15 cents per gallon ($60-80 per ton).

storage available at Mont Belvieu, were designed around a light liquids feed, either ethane or propane or a combination thereof.

Rail was the primary means of moving propane from the producing plant to the retailer's bulk plant in the 1950's. Producers owned or leased their own railcars. The standard rail-car size was 10,000 gallons (or 20 tons).[1] By 1961, there were 21,000 railcars in service. Larger 30-50,000 gallon (60-100 ton) railcars had come along by that time. But the pipeline developments later in the decade took away much of that traffic.

There were also some barge and coastal shipments. The 6,050 cubic meter vessel *Natalie O. Warren,* a dry-cargo ship refitted with pressure tanks, went into service for Warren Petroleum in the late 1940's. This vessel shipped propane from Houston around the coast to Newark, New Jersey. Purpose-built barges moved LPG up the Mississippi and across the Gulf Coast to Florida.

[1] The rail-car tariff at that time from Conway, Kansas to Three River Falls, Minnesota (a distance of 600 miles) was 5 cents per gallon ($25 per ton), which was more that the FOB cost of the propane at the producer's plant. Transportation could account for as much as 60 percent of the delivered cost of the fuel.

Storage and Distribution Come to the Fore

As sales of LPG expanded in the 1950's and 1960's, storage and distribution became key issues for the industry -

- storage because production was constant over the year but demand rose and fell with the seasons
- and distribution because the producing plants were located in the South (Texas, Louisiana, and Oklahoma), the major markets in the Midwest and Northeast.

During the 1950's, Phillips Petroleum had begun to batch LPG in a products pipeline from its Borger complex in north Texas to St. Louis and Chicago.

But it was further south on the Gulf Coast where the bigger production volumes lay and where salt-dome structures, available at various locations in Texas and Louisiana, offered the best opportunities for large-scale underground storage. In 1955, Warren Petroleum began to leach out wells from the Barber's Hill dome at Mont Belvieu east of Houston. The twelve wells leached out provided Warren with a storage capacity of more than 15 million barrels. Over the next twenty years, the LPG capacity mushroomed to 100 million barrels as Texas Eastern and others added wells.

By this time, Texas Eastern had converted the Little Big Inch pipeline, which ran from Mont Belvieu to Todhunter, Ohio, from natural gas to propane use. Bulk storage was put in place at distribution points along the way and the TET line, as it became known, was subsequently extended to Chicago, Illinois and Selkirk, NY. Another long-distance line, the Dixie, connecting Mont Belvieu with the Southeast, was completed in 1961.

A second major storage hub emerged in the Bushton/Conway/Hutchinson area of Kansas for gas liquids produced in the mid-Continent. Sinclair Oil built the first underground storage there in salt layers in 1960. Initial capacity was 4.2 million barrels. Total storage now is 28 million barrels. Around the same time, a start was made on the construction of the Mid-America Pipeline (MAPCO) from Conway to Minnesota and Illinois in the Upper Midwest on a route which was developed from two railroads' rights of way, the Katy and the New York Central.

Some suppliers expanded into retailing. But others backed away. Shell sold out in the 1950's, Mobil in the 1960's. A number of independent marketing companies - Calgas, Empire Gas, Ferrellgas, Petrolane, National Propane, and Suburban Propane - became prominent at this time. These companies expanded, largely through acquisitions, from regional bases to become large multistate marketers.

Shortages and Regulation

The energy crisis of 1973, which brought with it higher prices for all hydrocarbons (including LPG), and the prospective shortages in the United States for natural gas triggered a major change in direction for the US LPG industry.

On the one side, it opened up potential new uses for LPG -

- in peak-shaving plants (where propane is vaporized, mixed with air, and injected into the gas stream)
- and in SNG (synthetic natural gas) plants.

Gas transmission companies such as Transco, Trunkline Gas, and the Natural Gas Pipeline Co. of America planned large-scale propane purchases to stretch out limited gas supplies. The Federal Government, however, discouraged its use as feed. Purchases increased. But no major new supply contracts were concluded.

Of the five large SNG plants running at this time in the Northeast and Midwest, only one, that operated by Columbia Gas in Green Springs, Ohio, ran much on gas liquids feed, in this case ethane imported from Western Canada via the newly-completed Cochin pipeline.

On the other hand, the situation created a much tighter balance between the supply and demand for LPG and spread fears that there might not be enough LPG to go round.

The Federal Government imposed price controls on the industry in 1971. Two years later, following a heavy crop-drying season and a cold-than-normal winter, which resulted in widespread shortages and high prices on the unregulated spot trading market at Mont Belvieu,[1] the Government intervened again by instituting its own system of supply allocations (towards preferential customers such as home-users and away from less preferential customers such as petrochemical and utility buyers).

This regulatory environment had its effect on LPG demand. So too did the conservation efforts by consumers in response to higher prices. Better insulation, storm windows, and lower thermostat settings led to significant fuel savings. Wood-burning stoves also enjoyed a boom in many rural areas.

Propane sales fell by 15 percent over this period.

[1] In October 1972, the regulated producer posted price at Mont Belvieu averaged 8.8 cents per gallon ($45 per ton), the unregulated price on the futures market 37 cents per gallon ($190 per ton).

USA: LPG Sales (1)
billion gallons

	Residential / Commercial	Other Retail	Large Bulk	Total	Total million tons
1972	8.3	2.9	6.2	17.4	34.1
1975	7.0	3.6	4.6	15.2	29.8
1980	6.5	4.4	4.1	15.0	29.4

(1) The industry data records mainly propane sales.

Supply rationing ended in the late 1970's. But it was not until January 1981, after President Reagan had come to office, that the price controls on the industry were dismantled.

Deregulation and Change

The roots of the American LPG industry lie in its heartland; small towns and communities in the Northeast, Midwest, and Pacific Northwest; oil and gas towns in West Texas, Oklahoma, and Louisiana.

Pyrofax. Far Flame. Flamo. Land O'Lakes. Yankee Bottled Gas. Rock Gas. Hills Gas. Goodhousekeeping Gas. Mayflower Gas. All names that evoke America's past. They are also all LPG retail companies that have been merged, sold out, or simply disappeared in the past fifty years.

Overall, there are some 1,500 marketers in the US, of which 12 are multistate marketers, 80-90 operate on a regional basis, and many are still small, family-owned, and selling locally less than 5 million gallons per year.

During the 1970”s, this industry fell into investor disfavor. It was seen as a low-tech business with low growth, low margins, and, despite the ongoing merger and acquisition activity, one characterized by small-scale inefficient operators. Many producers abandoned that segment of the business at that time to concentrate on upstream and on gas processing.

Deregulation did not improve industry sales much.

USA: LPG Sales (1)
billion gallons

	Residential / Commercial	Other Retail	Large Bulk	Total	Total
				million tons	
1980 (2)	5.4	4.7	4.9	15.0	29.4
1985	4.4	4.6	6.1	15.1	29.6
1990	5.0	3.7	7.2	15.9	31.2

(1) The industry data records mainly propane sales.
(2) The LPG sales allocation adjusted to reflect the data changes introduced in the 1980's.

But it did, after 1986, improve industry profitability. The crash in crude oil prices that year had its knock-on effect on propane prices on the Mont Belvieu trading market. Bulk propane fell from 42 cents per gallon ($220 per ton) at the beginning of the year to 20 cents ($105 per ton) at the end. Consumers saw little benefit. Retail prices hardly budged.

The higher margins attracted much comment, on both the plus and minus sides.

> "These days, dealers are cutting off their noses to spite their faces. They're gouging, that's what they're doing. In the long run, they'll pay for it. At a time when they should be building volume by lowering prices, they're keeping prices high and still trying to hold onto their traditional loads. But, by placing

themselves in an uncompetitive position against other fuels, they're losing load too. In the long-run, they could end losing most of it."

"Look. The little guys have been regulated for so long. Now that they have a chance to make a buck, they're making the most of it. After all, it's only human."

"You have to realize that a number of the majors are now owned by investment groups. They want to see a 20% return on their money. So a lot of the big guys have to keep margins up to keep profits up to keep their investors happy."

The higher margins did stimulate a flurry of merger and acquisition activity and brought in Wall Street and other financial money. The price for propane distributorships soared - from around $0.50 per gallon of annual retail sales in 1983 to $1.60 per gallon in 1989 when Petrolane was sold by Panhandle Eastern for $1.18 billion.

Petrolane, the leading propane distributor in the United States, had perhaps the most checkered history over this period. An independent New York stock-listed company, it had been bought out by Texas Eastern in 1984. Five years later, when Texas Eastern itself was acquired by another transmission company, Panhandle Eastern who in

turn was subject to a takeover bid, Petrolane was deemed surplus to requirements and sold to raise cash.

The buyer then was QFB, a consortium of Quantum Chemical Co. and First Boston (the banking house which supplied the financing). Quantum, previously in the wine and spirits business, had been aggressively pursuing acquisitions in chemicals and propane marketing throughout the 1980's. Suburban Propane had been bought in 1983, Pargas in 1985, and Texgas in 1986.

However, QFB, a product of 1980's-style corporate capitalism, ended the decade deeply in debt. The restructured Petrolane was unable to meet its debt servicing payments and was offered for sale again. The purchasing company this time, UGI/AmeriGas, offered a combination of cash, stock, and debt servicing to secure the controlling interest in the reorganized Petrolane.

Over the past decade, retail sales of propane have shown growth in some areas and the industry has consolidated further. The marketers themselves have little supply control and are generally comfortable buying from producers at Mont Belvieu or at other storage points along the pipeline network. As the prices at both the wholesale and retail end have become more transparent, profitability over time has been determined more by the volume of sales and the efficiency of

operations. Acquisitions and consolidations therefore have continued in this business.

The larger companies, through a process of acquisitions and regroupings, have gotten bigger. Four national marketers - AmeriGas, Ferrellgas, Cenex Propane, and Suburban Propane - account for over a third of all sales, the top ten around half.

USA: Propane Marketers in 2002

	Customers	**Propane Sales**		
	(thousands)	mm galls.		mm tons
		retail	wholesale	total
1. AmeriGas	1,250	930	250	2.3
2. Ferrellgas	1,000	870	90	1.8
3. Cenex Propane	750	570	220	1.5
4. Suburban Propane	750	450	90	1.1
5. Inergy	200	110	430	1.0
6. Cornerstone	450	240	230	0.9
7. Heritage	650	330	50	0.7
8. Next Five	850	440	10	0.9
9. Balance (estimate)				9.8
Total				20.0

The fixed margin nature of the business changed the financial thinking of many of the leading companies. They formed limited partnerships with outside financial investors - offering them a utility-type return for upfront cash investment. AmeriGas Propane, a partnership between UGI and the Prudential Capital Group, has been the largest example of this thinking.

Not all of these limited partnerships have turned out to be well managed. The nation's sixth largest distributorship, Cornerstone, became over-extended in 2002 and filed for bankruptcy. Also into bankruptcy proceedings has gone a second-tier LPG distributor, Level Propane.

The Mexican Connection

The LPG production buildup that occurred in the 1960's on the Gulf Coast became a source of supply for northern Mexico. Trucks rumbled south across the border in increasing numbers. By 1973, these overland movements of LPG were approaching 800,000 tons per year.

Higher prices after 1973 and US Federal supply restrictions put a damper on this trade. It was not until the mid 1980's that the trade recovered to earlier levels. The NAFTA agreement and the building of *maquila* plants across the border provided a stimulus in the 1990's. By 2000, with the completion of an LPG pipeline linking the Hobbs processing plant in west Texas with the Mendez LPG terminal in Juarez, this border trade was approaching two million tons per year.

The main crossing point for the LPG traffic was El Paso/ Juarez, across the Rio Grande. The rough-and-tumble border town of Juarez on the Mexican side offered various opportunities for entrepreneurs. LPG was one of them. The fortunes of the Zaragoza family started here. Their LPG business represents a classic rags-to-riches story.[1]

[1] Miguel Zaragoza senior had started out in Juarez as a kitchen cabinet salesman. Over time, his family built up an LPG business, now the Zeta Group, with total sales (including those in Central America and Peru) close to 2.5 million tons in 2002.

LPG supplies from the United States were complemented in the late 1970's by production from the south of Mexico, as Pemex began to build up gas processing capacity in the Tabasco region. An overland pipeline was constructed to move this LPG north to the consuming markets of Mexico City and Guadalajara.

With these two sources of LPG supply, demand in Mexico grew very rapidly. Government subsidies enabled LPG to reach the urban poor.[1] The pell-mell expansion at the time may have engendered some lax safety standards. Mexico City suffered the worst ever LPG calamity on the morning of November 19, 1984. A series of explosions at the San Juan Ixhuatepec LPG storage and distribution center, located in a heavily populated area on the outskirts of the city, brought about widespread devastation and a death toll which approached 500.[2] Much heart-searching after the event resulted in a tightening of safety standards.

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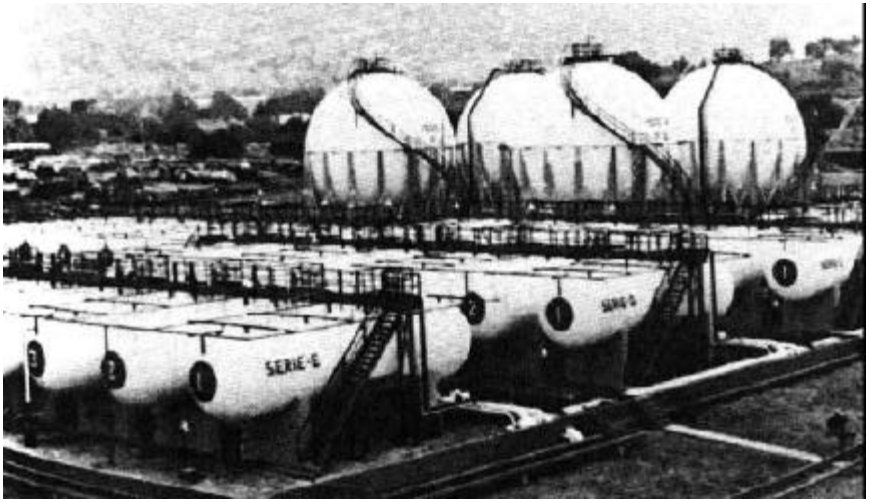
[1] The cylinder price to consumers, for instance, equated to 10 cents per gallon ($0.05 per kg) in 1982. At that time, the average Mont Belvieu bulk trading price was 23 cents per gallon

[2] Flames leapt up 500 meters into the air. For ten hours, the fire, apparently sparked by a gas leak, raged out of control, showering the surrounding area with red-hot pieces of metal. Four of the six propane storage tanks on the site were completely destroyed.



Photos: LPG tanks in Mexico City (before and after explosion).

Today some 80 percent of Mexico's 24 million households depend on LPG as fuel for their cooking and water heating needs. Nationwide, sales were over 10 million tons in 2000, of which the capital, Mexico City, accounted for almost a quarter.

Although there are some 400 retail distributors in Mexico, the industry is reported to be dominated by a few family-controlled businesses who each operate a number of distributorships, under various names, in Mexico City and elsewhere. Within what had developed as a regulated price structure, this concentration of ownership has at times brought forth charges of price collusion and excessive pricing.

Foreign companies have been barred from LPG distribution within Mexico. Yet the private distributors' relationship with Government has never been easy. The price subsidies on LPG were gradually removed during the 1990's. But the Government was slow to allow these companies to develop an auto-fuel market for LPG, something that Mexico City with its heavily polluted air badly needed.

More contentious has been the Government support for gas grid development in the cities. A number of contracts were awarded under tender to foreign companies by the CRE (the Government regulatory agency). The LPG distributors, excluded from these gas franchises, have opposed the developments bitterly, raising the still potent anti-

foreigner argument and organizing local opposition. Their activity has so far had a delaying effect on the pipeline investments.

An International Industry?

The 1970's might have been the time that the US LPG industry adopted a more international profile. The omens then were good. An industry overseas was emerging. Plants were being built in the Middle East and elsewhere to process gas previously flared. The LPG would be produced for export and markets had to be found.

US companies did make some international forays at this time.

Phillips had set up, with Bridgestone Tire, the Bridgestone Liquefied Gas Co. in the early 1960's as a licensed company to import LPG into Japan. They were also an investor in the Multinational trading company, which was formed in London in 1971.

Petrolane formed Petredec with Saudi and Dutch partners as a small-ship LPG trading company in Europe in the late 1970's.

And Northern Natural Gas, perhaps the most adventurous of them all under Sam Segnar, contracted for long-term supplies of LPG with Shell out of the North Sea and placed orders for two 75,000 cubic meter LPG vessels (the *Northern Arrow* and *Northern Eagle*) at the Gdynia shipyard in Poland.

Photo: US and Japanese delegates at the 1976 NLPGA convention (including Sam Segnar, top left, and Michio Doi, bottom right)

The US had previously thought of itself as an LPG exporter. Phillips had built the first LPG terminal on the Gulf Coast (the Adams terminal) as an export facility. Seaborne imports had been precluded until 1970 under the 1957 Mandatory Oil Import Program. But it was increasingly being recognized that the country was no longer self-sufficient in LPG and would require additional imports by sea.

A start had been made on the US East Coast, the consuming area farthest from the pipeline grid network. Propane import terminals at Providence, Rhode Island and Chesapeake, Virginia had been completed in 1973. The SEA-3 terminal at Newington, New Hampshire started up two years later. Seaborne imports supplemented piped propane from the Gulf Coast on the TET line and railed propane from the Dome (now BP Canada) fractionator at Sarnia, Ontario in Canada.

But the tight natural gas market at that time prompted speculation of much larger LPG imports. Forecasters were anticipating that they could reach 6-8 million tons per year by the early 1980's, with most of it moving to the Gulf Coast.

The Warren terminal on the Houston Ship Canal was already pipeline-connected to Mont Belvieu storage. A second large LPG terminal, that of Enterprise Products, started up on Mexican imports in 1983. There

were plans for others. The biggest of them was the scheme by Northern Natural Gas and Texas Eastern, later joined by Mobil and Texaco, to build a new receiving terminal at Sabine Pass, Texas and connect it to Big Hill salt dome storage nearby.

The high-water mark arrived in 1980 when Gastech, the international LPG conference, convened in Houston. Middle East suppliers pursued customers. The largest of them, Petromin from Saudi Arabia, hosted a spectacular reception in a Saudi ceremonial tent recreated within the arena. A bemused US LPG industry attended.

As it was, most of the US import schemes did not materialize. The international market was never as long as some had thought likely. And the US market was never as short. The spectre of shortages disappeared after LPG and then natural gas was decontrolled. A further stumbling block was price. Producers had established their own FOB posted prices. These turned out to be significantly higher than the import prices on the Gulf Coast, based on the Mont Belvieu trading market, once the shipping costs had been taken into account and added to the delivered cost.

Six US companies, Dow Chemical, Northern Natural Gas, Phillips, Sun Oil, Tenneco and Union Carbide, did conclude term supply contracts with Petromin in 1980. Each then phased out. The seller was

unwilling to set a posted price for LPG that related to the Gulf Coast market. The LPG that did move came in on a spot basis, that is when surplus cargoes in the Middle East were available at lower prices than the producer postings.

As a result, throughout the 1980's, the range for LPG imports into the United States stayed at just 1-3 million tons per year. Domestic supplies of LPG, meanwhile, expanded rather than contracted.[1] The gas processing industry did go through a lean time in the mid-to-late 1980's when margins were squeezed and a number of companies left the business. But profitability returned in 1990 as gas liquids prices recovered while gas prices stayed weak. And more liquids production have come in from outlying areas in New Mexico and the Overthrust belt in the Rocky Mountains.

USA Gas Plant LPG Supply

	Propane	Butane	LPG
thousand bbls/day			
1980	466	293	759
1990	473	296	769
2000	525	340	865
million tons			
1980	13.7	9.9	23.6
1990	13.9	10.0	23.9
2000	15.4	11.5	26.9

[1] Ron Cannon, in his book *The Gas Processing Industry*, has described this period as the 'ethane era,' when ethane recovery for petrochemical feed was the principal driver for the US gas processing industry.

Producers made investments in processing plants and pipelines to handle the additional liquids and bring them to the Gulf Coast for fractionation and sale. As a result, LPG exports from the Gulf Coast have exceeded imports in recent years. Only at times of natural gas shortage and skyrocketing prices, such as occurred during the 2000-2001 winter, has there been a flurry of LPG import activity.

These import purchases have not really required any term commitment or serious commercial engagement. The Gulf Coast buyers such as Dan Duncan and then Bill Ray at Enterprise could adopt a "take it or leave it" attitude. Offshore suppliers would offer cargoes and the price would be agreed at the prevailing Mont Belvieu trading price at the time, less the costs for handling, storage, margin, and, in the case of mixed butane import cargoes, fractionation. Imports have risen and fallen because of the surplus cargoes available in the international market, not because of import demand in the US.

Mont Belvieu - The Market Hub

The storage hub and price setter for the US LPG industry is the Mont Belvieu storage complex in the Barbers Hill salt dome in Chambers County, Texas on the Gulf Coast 30 miles east of Houston. Some 160 million barrels of total liquids capacity is available in deep structures 2-4,000 feet underground in leached salt-domes structures. Not all of that storage is devoted to LPG. Mont Belvieu also stores other liquids, both lighter and heavier and petrochemicals as well. The storage capacity available for LPG (propane, butane and isobutane) is in the order of 70 million barrels.

A network of pipelines feeds separated liquids from outlying regions to the Gulf Coast where, in addition to Mont Belvieu storage, most of the US ethylene plants and much of its refinery capacity is located. Here, close to their customers, the liquids are turned into marketable ethane, LPG (propane and butane), and natural gasoline.

The domes themselves are hydraulically dynamic with brine (salt water), which provides the balance not filled by the gaseous liquids. When product stocks are high, management of the surplus brine can become a problem for the storage operators.

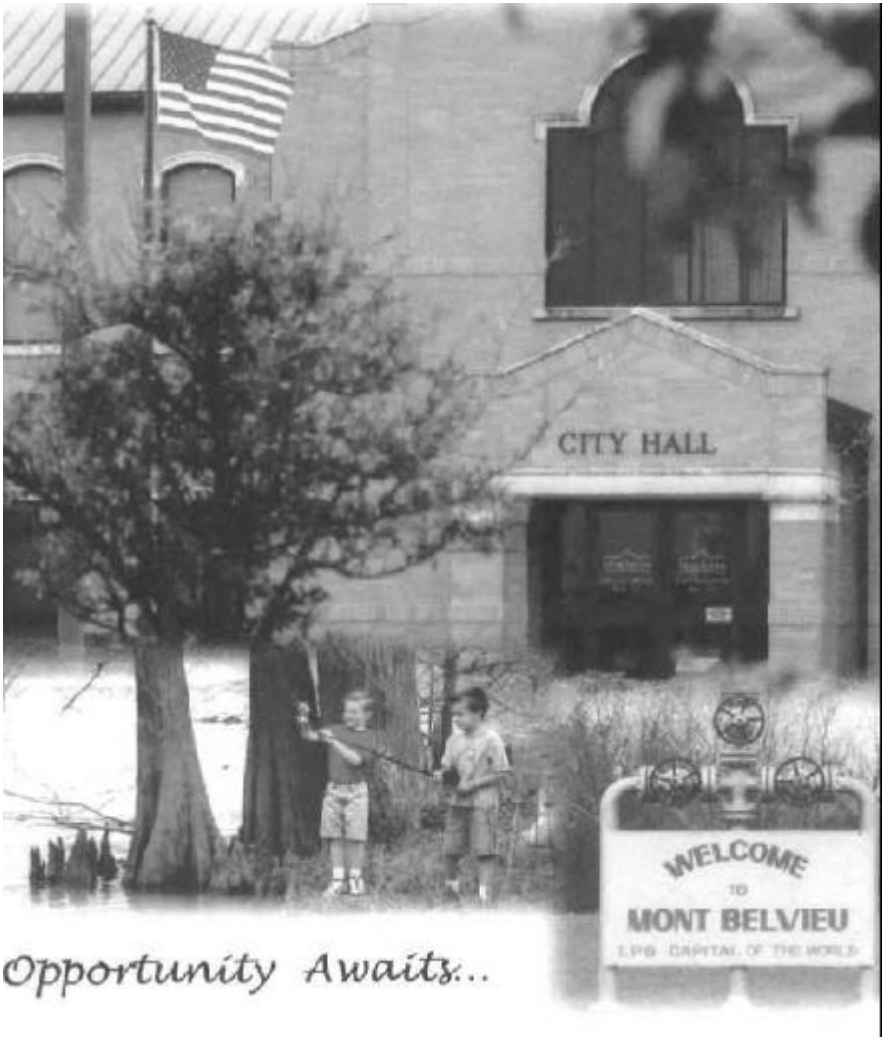


Photo: Mont Belvieu – LPG capital of the world

Mont Belvieu has not only been the storage center for LPG in the United States, but also its main price setter. Producers posted prices for their propane for sales to distributors/marketers at Mont Belvieu and at secondary distribution points along the pipeline network. In the latter case, these prices normally reflected the Mont Belvieu posting plus any pipeline tariff and transportation cost to the point of sale.

A wet barrel cash trading market developed at Mont Belvieu. The growing influence of the petrochemical market was a factor here. Their feedstock demands were flexible and they needed the flexibility to buy in and sell out of the market on a spot basis. Companies such as Dow Chemical and Union Carbide became active players.

The cash trading market also facilitated the marketing of other gas liquids, such as normal butane and isobutane, which lacked term outlets and customers. Normal butane sold mainly to refiners as a gasoline blendstock. Their requirements were again variable, depending on internal balances and the season.[1] Isobutane had more specialized uses in gasoline blending (as a feedstock to make alkylate and MTBE). Arco

[1] Refiners market motor gasoline with a higher vapor pressure in winter than in summer (to improve ignition during cold weather starts). Adding butane to their blendstock slate achieves that purpose. Refiners would often come into the Mont Belvieu market in August and September as they started to make winter grades of gasoline.

Chemical, now Lyondell, was the main buyer on the Gulf Coast for these purposes.

The New York Commodity Exchange started a futures contract for propane in the 1960's. This was assumed by the New York Cotton Exchange in 1972. Neither received much support. The Houston-based LPG industry preferred to trade among themselves rather than trust to the money men of New York. Even when the Cotton Exchange contract was superseded in 1987 by the more influential NYMEX (New York Mercantile Exchange), which traded crude oil and heating oil in a big way, support was not really forthcoming.

The Mont Belvieu market included forward months' trading and, by the early 1990's, had become an increasingly liquid and computer-sophisticated one as well. The Chalkboard electronic trading system, supported at one time by 85 member companies, accounted for a significant share of Mont Belvieu transactions.[1]

By the late 1990's, producers and players in the LPG industry had moved into electronic trading in a big way. For instance, the new 21,000 square foot energy-trading floor of Williams in Tulsa, opened in February 1998, featured a 21 foot full motion video wall and larger

[1] At its peak, Chalkboard was reporting 2,700 transactions each month. The system was acquired by ChemConnect in 2002. Its usage declined after the Enron revelations.

screens for futures exchanges. The traders' desktop information put them in the position to offer options, swaps, and a range of other financial hedging instruments, as well as simply the physical supply of propane.

Trading Woes

The LPG industry underwent its major period of expansion during the 1960's - when the storage and pipeline network expanded to something like its present size. Industry expansionists at that time such as Sam Segnar at Northern Natural Gas and Bill McCollough at Texas Eastern gave shape to what is essentially the physical structure of the industry today.

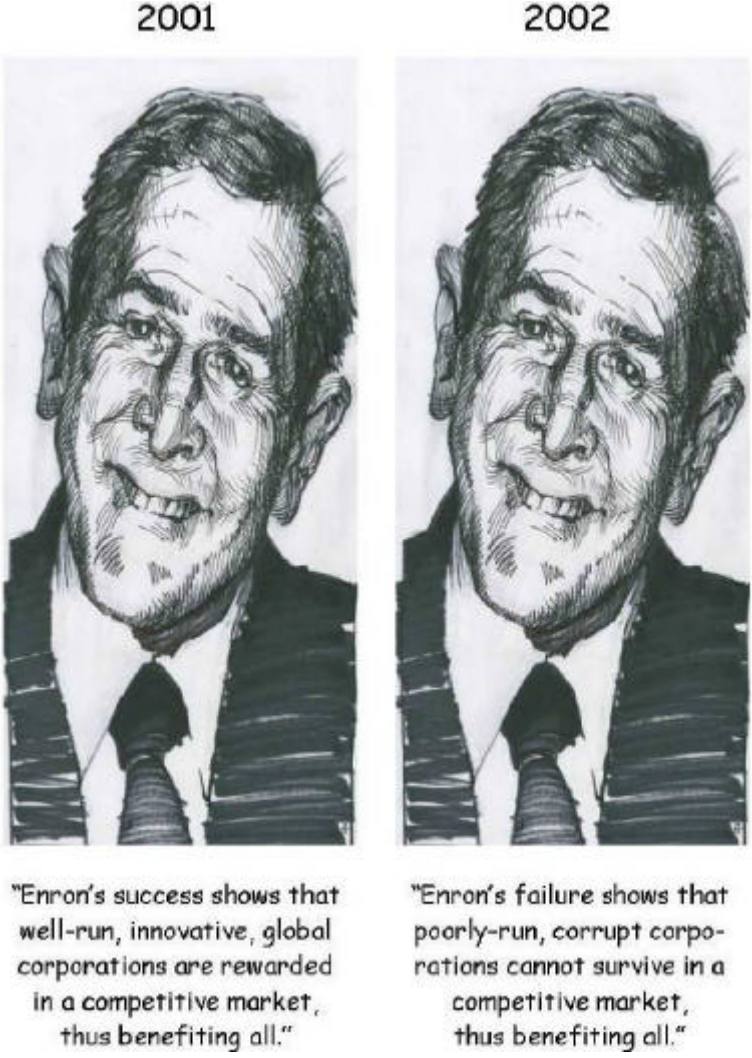
Today's producers and sellers have taken this infrastructure pretty much for granted. Industry knowledge of market trends and outlets has been seen of much lesser importance in a price-transparent market then an efficient trading operation. So companies chose to invest their marketing dollars in state-of-the-art trading rooms and screen-oriented traders with hedge-fund experience.

Many of the companies active in oil and gas production have detached themselves from the complex business of processing and fractionating the liquids and storing them and transporting them to market. Over the years, oil majors such as Exxon and Mobil either reduced or sold out their positions.

Instead, a new breed of midstream companies emerged and, through a process of mergers, acquisitions and asset exchanges, they have each sought to develop their NGL delivery and marketing systems more efficiently. A number of transactions in the late 1990's saw Warren Petroleum acquired by NGC (now Dynegy) and Shell's and Phillips' NGL businesses merged into Enterprise and Duke respectively. Five companies, Duke Energy, Dynegy, Enterprise Products, Koch, and Williams became increasingly dominant in this business.

Enron, a company formed in 1985 from the merger of Northern and Houston Natural Gas, was not one of these companies. Enron's domestic NGL assets had been sold. The retirement of Sam Segnar, soon after the merger had been consummated, and the new management of Ken Lay and Jeff Skilling ensured that this company would move in an entirely different direction.

Enron advocated and pursued an "asset-light" approach – a belief that efficiently applied "intellectual capital" could, by leveraging physical assets into trading and financial vehicles, realize superior results over the traditional "asset-heavy" approach of oil and gas companies. The deregulation in gas and, after 1992, electricity markets provided Enron with the opportunity to exercise this "intellectual capital." Enron offered liquidity in physical and new derivatives trades in these



Caption: Changing views on Enron

emerging markets; whilst their role as market makers was designed to give them a profit-making informational advantage over their rivals.

Enron launched *EnronOnline,* its internet platform, in late 1999. Unlike other energy trading platforms, this one did not require an entrance fee. Enron would instead charge on every transaction. More significantly, to promote liquidity, Enron would take one side on each deal. By early 2001, the system was conducting 4,500 transactions worth more than $2.5 billion daily. While undoubtedly a success, few people then realized the huge trade credits, as much as $20 billion, that Enron would require, trade credits that would depend on confidence in Enron.

That confidence was disappearing over the course of 2001 as revelations of Enron's accounting practices seeped out. Enron's preoccupation with quarterly earnings growth, brought with it ultra-aggressive and, as it turned out, false accounting. This was highlighted by reports of Enron's accountants, Arthur Andersen, shredding documents. The acrimony of the time was compounded by allegations of price-gouging by Enron and other trading companies during California's power crisis of 2000-2001. Enron became discredited and suddenly, by year-end, it was bankrupt.

Enron's stance had been much admired at the time. A number of other US energy companies followed their approach. But those who had ventured too aggressively into gas and power trading saw their credibility eroded and their stock price brought low. This included NGL midstream companies such as Dynegy, El Paso, and Williams. In an attempt to deal with the malaise, they and others cut back or closed out their merchant gas and power trading departments. Williams had to sell its MAPCO and Seminole NGL pipeline systems to Enterprise to raise needed cash.

Liquidity in the Mont Belvieu trading market has been greatly reduced as a result of these developments. Credit-worthiness has become paramount for companies buying and selling there.

Nevertheless, the LPG industry will survive. For the time being, as one observer from the "old school" commented,

> "Suppliers will continue to conduct their business with the larger companies – the chemical companies, the large industrials, and the large multi-state marketers – that buy propane. It is just that the middleman – the broker, the trading company – will have less opportunity to touch that barrel than he had in the recent past."

3. EUROPE

A Cylinder Market

The LPG industry in Europe developed on by-product output from local refineries.[1] The oil major, Shell, had introduced LPG to France in the mid 1930's (with butane shipped from its refinery on the US East Coast in cylinders on the cargo ship *Agnita*). And Liquigas had built a bottling plant in Italy, near Venice, in 1938. But developments then were cut off by the war.

By the early 1950's, Shell France and a company from Denmark controlled by the Tholstrup family, Kosangas,[2] were producing LPG cylinders for household use; and these were being marketed elsewhere under license.

The pattern of LPG development differed from country to country. In France, Primagaz, a company controlled by the Bouton family, had been an earlier marketer. Refiners also moved downstream into bottling and retail distribution after the war. In Italy and later in Germany, it was independent distributors which mainly emerged, buying their supplies from local refiners and developing local markets.

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[1] Gas plant LPG did not become available in Europe until the 1970's.

[2] The name Kosangas derived, curiously, from the Spanish words *cocina* and *sano*, meaning "to cook" and "to clean."

Photo: Early LPG transportation in Italy and France

In Spain, the oil industry was nationalized and Franco put Don Cid della Llave in charge of the newly formed Butano in 1957. In the UK, one company, Calor, became so dominant that its name, Calorgas, was synonymous with LPG.

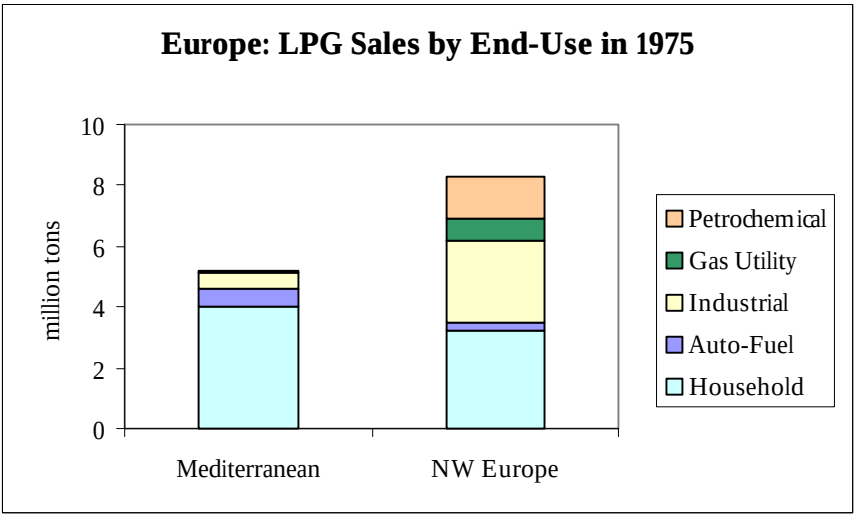
Growth proceeded at the pace of refinery availabilities. These expanded, particularly in the 1960's, as new refineries were built and fuel oil displaced coal as the industrial fuel. Europe-wide LPG sales were 300,000 tons in 1950, 3 million tons in 1960, and 11 million tons in 1970. Propane was the preferred cylinder fuel in most of northern Europe and in Italy, butane or a butane-mix in Spain and elsewhere in the Mediterranean.[1]

Europe: LPG Sales by Use in 1975

million tons	**Med**	**NWE**	**Europe**
Household	4.0	3.2	7.2
Auto-Fuel	.6	.3	.9
Industrial	.5	2.7	3.2
Gas Utility	-	.7	.7
Petrochemical Feed	.1	1.4	1.5
Total	5.2	8.3	13.5

The chart following compares the distribution of these LPG sales.

[1] Butane was preferred in the warmer temperatures of the Mediterranean, as propane would more easily vaporize.



The Mediterranean market was then, and continues to be, mainly a cylinder market for household use. The exception was Italy, where auto-fuel had become a significant outlet. The first LPG pumps appeared at gas stations in 1958 and sales, encouraged by favorable tax treatment, reached 600,000 tons in 1975.

The heating load was heavier in the North, but LPG use was more varied. German refineries sold LPG under long-standing contracts to petrochemical plants and industrial users nearby. Gas utility use (as feedstock for manufactured gas) remained significant in France and Germany. And industrial use was large in the UK. Demand here as elsewhere, however, was to be impacted by the spread of natural gas grids.

The auto-fuel market for LPG in Holland developed, like Italy, with tax incentives in the 1950's and 60's. LPG use received a boost from the 1973 oil embargo. Holland had been particularly targeted. Motorists faced gasoline-less days at the height of the crisis. One company, BK Gas (later acquired by Shell), became a leading distributor of LPG auto-gas in that market.

The Med and the North

In the Mediterranean, LPG became available at coastal locations, at the French refineries near Marseilles and at the Italian island refineries in Sicily and Sardinia. The first seaborne trades took place in the mid 1950's from the south of France to Algeria and Morocco in North Africa. Shell France and SAGA,[1] a French company previously active in the general cargo and wine trade to Africa, became involved in these shipments.

By the early 1960's, the French surplus of LPG was approaching 100,000 tons and the Italian surplus 40,000 tons annually. Many refiners did not want to get involved in the complex business of shipping a highly volatile cargo such as LPG and would make their product available to others out of refinery storage.

The situation provided the opportunity for new entrants who could offer shipping and markets. It was Gazocean, the French company founded by Rene Boudet in 1957, and SAGA which took best advantage. LPG trades were developed at that time to Spain, Portugal,

[1] SAGA (Ste.Anonyme de Gerance et d'Armement), controlled by the Rothschild family, expanded on this position and, by the 1960's, had developed a significant small-ship LPG shipping and trading presence in the Mediterranean and, later on, in South America.

Algeria (for a time), and, as well, the occasional cargo to South America.

Trade in the eastern Mediterranean developed later. Naftomar, a company formed by Talal Zein in Beirut in 1970, was to be the main driving force here. The company had acquired its first pressure tanker, the *Gaz Unity*, in 1977 for trade into Syria and Lebanon and this formed the basis for their future trading expansion in the region.[1]

Some LPG trades were protected. Spanish coastal shipments were mainly reserved for the national company, Butano. And the Italian Government operated a complicated freight subsidy program, the *Cassa Conguaglio Transporti GPL*, for Italian-flag movements in and out of Italy.

Nevertheless seaborne trade in the region was growing, particularly during the early 1970's. Gas plant LPG was by then available out of Libya and Algeria. And Spain was becoming a large importing market.

In the North, the main source of surplus LPG was the ARA refineries[2] which looked inland, to France and Germany, for their market outlets.

[1] Naftomar expanded - following its move to Piraeus, Greece, Jacques Caporal joining from Asmarine, and further vessel acquisitions - into a significant LPG shipping and trading company in the Mediterranean and, later, in trades East.

[2] Refineries within the Antwerp-Rotterdam-Amsterdam range.

Photos: European LPG Pioneers
– Oivind Lorenzen, Knud Tholstrup, Jacques Caporal, Talal Zein

The focus therefore was on rail and barge traffic, less on coastal movements. A regular barge trade developed along the Rhine in winter. German retailers constructed depots at various Rhine locations for LPG storage and onward distribution.

There were some coastal movements. Starting in 1953, the Danish company Kosangas had built up a fleet of 23 small pressurized vessels for coastal shipments. Other Scandinavian owners were to invest in this area later.

Unigas, based in Rotterdam, was formed in 1969 as a pool for European small-ship owners to trade in LPG and chemical gases.

But the small-ship trading opportunities in LPG really came later, in the late 1970's and early 1980's, with UK refinery surpluses and longer-haul trades to Portugal. Two companies came to the fore at this time, Vitol under David Hughes and Petredec under Charles Fearn. Control of pressurized vessels and accurate knowledge of where others were deployed provided the basis for a successful trading operation.

North Sea LPG and Large-Cargo Trade

Europe had some access to gas plant LPG prior to the North Sea. Occidental's Libyan plant at Zueitina and a smaller Algerian unit at Skikda supplied Mediterranean outlets in the early and mid 1970's.

But the big change to European supplies came later in the decade with the advent of North Sea LPG. Between 1977 and 1985, five North Sea gas plants came onstream.

North Sea Gas Plants

Country	Location	Plant Capacity (million tons LPG)	Startup
UK	Flotta	0.3	1977-79
Norway/UK	Teesside	1.4	1979
UK	Sullom Voe	1.8	1982
UK	Braefoot Bay	1.2	1984
Norway	Kaarstoe	1.1	1985

The initial large-volume stream, out of Teesside, was based on Norwegian gas liquids from the Ekofisk fields and was reserved, under an option agreement established by the Norwegian Government, for the Norwegian petrochemical industry. It was mainly committed, under long-term sales and shipping agreements, to the Noretyl steamcracker at Rafnes in Norway.

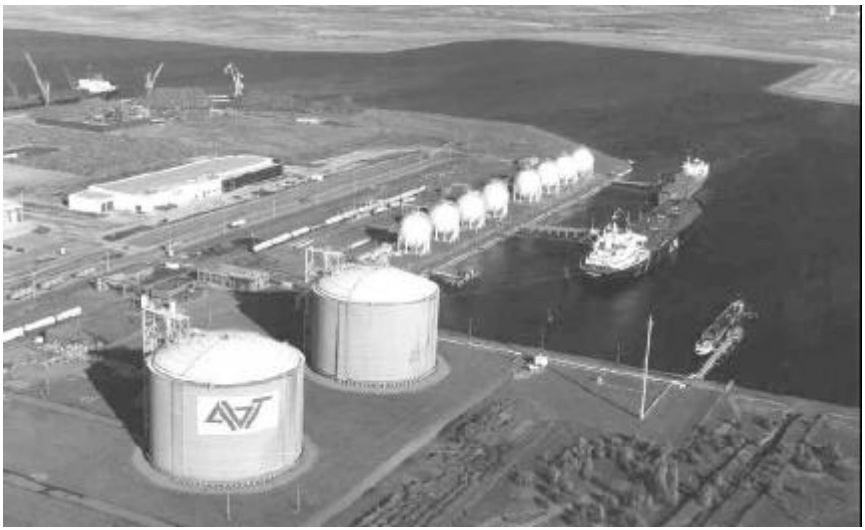
Later production had to be marketed, with state oil companies initially to the fore. BNOC had a 50 percent entitlement to UK production. Statoil had a major share of Kaarstoe output. Among the majors, Shell and Esso had large equity volumes out of Braefoot Bay, BP out of Sullom Voe.

Shell was at first unconvinced of the European market potential and placed a major share of its Braefoot Bay production long-term with an American buyer, Northern Natural Gas.

In time, European outlets developed.

Petrochemicals was one. Most European steamcrackers had been designed around refinery naphtha as feedstock and plant operators were hesitant to try alternative feeds such as gas plant LPG. Dow Chemical's experiment with propane supplied by the trader Trammo Gas out of floating storage at its plant at Terneuzen in 1980 convinced them of its merits. Three years later, the company installed refrigerated tanks at the site for importing LPG directly.

Dow was never a regular North Sea LPG buyer. The company's flexible feedstock strategy and spot purchasing emphasis made them an in-and-out player. Two other companies did become term outlets. ICI (now Huntsman) completed propane cavern storage near its Wilton site



Photos: LPG terminals at Kaarstoe and Antwerp

on Teesside in 1982. Its closer proximity to UK North Sea loadports gave it a freight advantage over ARA buyers. Esso Chemicals (now Borealis) started importing propane at Stenungsund in Sweden via cavern storage in 1983.

North Sea butane went to UK buyers as alkylation feedstock, to Texaco at Pembroke on the West Coast and to Mobil at Coryton on the East Coast. Later, Arco Chemical (now Lyondell) installed refrigerated storage at its Botlek site near Rotterdam where butane was used as a feedstock to make MTBE and propylene oxide.

The impact of these new outlets can be seen in the shift in the pattern of LPG use in Europe.

Europe: LPG Sales by End-Use

million tons	1975	1980	1985
Retail Sales	12.0	14.8	14.8
Petrochemical Feed	1.5	2.3	4.6
Gasoline Feed (alkylation, MTBE plants)	-	0.1	1.6
Total	13.5	17.2	21.0

North Sea producers had hopes on expanding sales for LPG retail distribution. Local refinery supplies were already inadequate for the ARA market. Starting with the 1978/79 winter, the trader Trammo Gas operated floating storage off Vlissingen in Holland. Stocked with

LPG supplies from the Middle East and elsewhere, they did good business selling to local distributors.

BP and Shell consequently concluded throughput agreements with the new Eurogas import terminal at Vlissingen. Statoil entered into a smaller throughput deal with the Antwerp Gas Terminal in Belgium.

But in these hopes, they were disappointed. LPG retail sales stagnated in the first half of the 1980's and the terminals never operated at anywhere near their rated capacities.

BP had a further disappointment in 1987 when underwater corrosion was found in the piping feeding Sullom Voe. One of the two fractionation trains there had to be shut down permanently, thereby reducing the LPG volumes that they would have to market.

North Sea terminals were not the only source of large-cargo LPG for Europe. The Bethioua Jumbo LPG plant in Algeria and the Yanbu fractionator on the Red Sea became important supply sources, particularly for Mediterranean buyers.

Spain was the principal outlet. Butano's import purchases ranged between 0.5 and 1.5 million tons annually. Other important buyers were AGIP (for Italy) and TUPRAS (for Turkey). France also became

an outlet. Geostock began work on a mined cavern for receiving LPG import cargoes at Lavera near Marseille in 1971. French buyers would conclude winter contacts for propane into this storage.

As a result of these developments, the emphasis in European LPG seaborne trade shifted from small pressure to large-cargo refrigerated trade. These large-cargo imports into Europe exceeded 4 million tons in 1980 and were close to 10 million tons by 1990. The table below shows where this LPG came from.

Europe: Large-Cargo LPG Imports

million tons	1980	1985	1990
Source			
North Sea	1.3	3.8	3.9
Africa	0.4	1.7	2.3
Middle East	2.4	1.5	3.2
Elsewhere	-	0.2	0.1
Total	4.1	7.2	9.5

The European buyers usually bought on a CIF basis. In NW Europe, the North Sea producers controlled the lifting program and shipping schedule at their terminals and sold to customers on a delivered basis.

In the 1980's, the Mediterranean buyers had to be the more internationalist in their approach. Butano, for instance, needed to source LPG supply from countries as far away as Saudi Arabia and

Qatar. The London LPG trading community, by contrast, stayed more parochial-minded.

Force of circumstances brought about a change. Greater length in the Mediterranean LPG trading market, caused by the Algerian production buildup, made the importers there more relaxed in their CIF buying. In the north, producers were having to look for a wider distribution of sales, beyond their traditional customers in NW Europe.

North Sea LPG Seaborne Outlets

million tons	1990	1995	2000
NW Europe	3.9	5.4	4.8
Mediterranean	-	1.2	1.3
Elsewhere	-	0.5	0.6
Total	3.9	7.1	6.7

The progression went first to Spain, then to south France (Lavera), and, for Statoil, further onto Turkey. Statoil had exported one VLGC cargo East in 1999 from the expanded storage at Kaarstoe. That arbitrage trade became 400,000 tons in 2002 as both Statoil and BP were moving North Sea LPG cargoes that way.

The Russian Connection

Russian LPG first became available to Western Europe in the mid 1960's. For a while, two Russian pressure tankers, the *Kegums* and *Kraslava*, shipped ammonia and some LPG across the Atlantic to Cuba.[1] In 1965, Rene Boudet first went to Moscow to meet with Soyuz Gas Export and, in follow-up, his trading company Gazocean was able to secure an FOB contract for 120,000 tons per year of propane out of the Baltic port of Riga. It was shipped to Petit Couronne in France under a Government-to-Government deal.

Russia's huge gas reserves have given it a very large LPG potential, particularly in Western Siberia. The main problem has been logistical, how to move that product to market. The construction of a dedicated 1,150 kilometer gas liquids pipeline across the Urals - from South Balyk in Tyumen Oblast to Minnibaevski in European Russia – appeared to have solved, or at least partially solved, that problem. But the line suffered a devastating explosion in June 1989 near Ufa, caused by the spark from a passing Trans-Siberian train, and has never operated

[1] These vessels were built in Japan and delivered in 1965. Their vessel design was unusual in that the fuel tanks were as big or bigger than their cargo tanks, it is said, so that they could refuel Soviet submarines at sea.

beyond Tobolsk. Since that time, LPG evacuation from anywhere in Russia has continued to depend on railcar movements.[1]

Gas plant production of LPG contracted rather than expanded after the collapse of the old Soviet Union. There was no central planning agency to provide funding. And the new oil producing companies which emerged had little incentive to recover as much gas liquids as they could. The Government continued to set artificially low transfer prices for the gas processed at the field. Consequently, much associated gas at the wellhead was still wasted or flared.

Some volumes of LPG did make it West during the 1970's and 1980's, shipped out of the Baltic from Riga in Latvia or Hamina in Finland. The trade direction shifted in the 1990's after the Berlin wall came down. Former Warsaw pact countries such as Poland and Hungary opened up their retail markets to Western LPG companies. These companies invested in storage at trans-loading stations, such as Brest-Malesewitch on the Belarus-Polish border, to receive Russian LPG. By 2000, this overland trade in LPG was close to a million tons per year.

The LPG, originating from European Russia or from Western Siberia, would move long distances by railcar to reach its destination. Block

[1] The state plant Azovmash in Ukraine built the first generation of Russian LPG railcars. In 2001, the rolling stock of railcars in Russia and other countries of the former Soviet Union totalled some 25,000.

trains were programmed a month at a time. Unit freights were in the $60-80 per ton range at prevailing exchange rates in 2001, the number depending on distance, negotiation, and the number of border crossings. There have been few term contracts in this business. Lots are usually sold spot at the border at fixed prices. Sales are done either FCA, free carrier, or DAF, delivered at frontier.

At one time, the buyers of Russian LPG were never quite sure of some of the parties with whom they were dealing. There were many uncontrolled cowboys around. More recently, LPG export marketing has required Government approval. Of those authorized, Sibur emerged as the main supplier and exporter. But Sibur ran into financial and domestic political problems in 2001, resulting in the removal of its management structure (its President ended up in jail) and its takeover by Gazprom. Buyers now have to deal with a new cadre of management.

Starting in 2001, competition has come from a Western consortium, Tengizchevroil, producing LPG by the Caspian in Kazakhstan. This LPG makes the long rail journey through Russian territory into Poland and other Central European countries. The movements were close to 500,000 tons in 2002. Tengiz term sales into Poland have undercut to some degree the Russian LPG trade there.

Photo: Russian LPG railcars at the Hungarian border

Pricing

The earliest LPG market price indicators in Europe were spot ex-refinery prices in the ARA region and at coastal plants in Italy and France. These prices, for rail, barge, and coaster movements have been the mainstay for price reporting services such as *Platt's LPG GasWire*, and, more recently, *Petroleum Argus*.

The startup of North Sea LPG in the early 1980's introduced a new price reference point, the BNOC term price. Set during the days while there were still crude postings, the BNOC price was fixed over a quarter and was intended to provide a stable price environment for term customers.

BNOC went out of business in 1985. But the two UK oil majors took over the term price obligation, BP with their BPAP (BP Agreed Price) and Shell with their SSP (Shell Scheduled Price). A quarterly price soon proved to be unworkable in the unstable oil markets of the mid 1980's and prices were set on a monthly basis instead.

This monthly pricing system held for a long time, even though crude and product prices were moving in a different direction.

Spot LPG prices could be extremely volatile in an uncontrolled situation. Europe has lacked the buffer stocks that large underground storage such as Mont Belvieu could provide the American market. Consequently, when there was an unexpected burst of cold weather or when there were loading delays at North Sea terminals or other logistical problems, storage would empty fast and spot prices could skyrocket. It has not been unknown for spot prices to jump 100 percent or more in the space of a week. A monthly reference price offered some sort of stability in these turbulent times.

By the early 1990's, the storage problem had been recognized and companies had begun to make throughput deals in what storage existed, with Borealis at Stenungsund, with Dow at Terneuzen, and, more recently, with BASF at Antwerp. Even so, the storing company has to make careful assessments as to when to build up stocks and when to liquidate them in the context of an uncertain LPG trading market.

But the momentum for change probably came from a different direction. The term reference price was no longer being seen as a contractual price between buyer and seller, but simply as a traded price. Sellers were no longer fully committing their supplies to certain customers. Instead, they were trading LPG more and increasingly

outside the reference points of NW European buyers. Probably for this reason, Shell abandoned the SSP in 1995.

Sellers and buyers now use a range of price reference points in their contracts, such as BPAP, Sonatrach, *Argus* NWE, and others, either separately or in a price basket.

Another pricing development has been the emergence of a paper trading market to complement the physical trading. Companies saw this market as important from a risk management perspective, to hedge positions taken in the physical market. Some also saw it as a tool for speculating. ICI introduced the Flexideal concept, which mixed paper and physical trading, in 1988. The mixture never quite worked and trading in it lapsed after a few years.

However, a swaps market, purely a paper market for 2-5,000 ton lots, emerged in the mid 1990's and was more successful. By the late 1990's, the number of paper deals transacted were approaching 40-50 a week for forward months over the winter heating season. These volumes exceeded to a considerable extent what was being done in the physical market. For a time, it looked as if electronic trading of LPG might take off. But the collapse of Enron and the demise of *Enron OnLine* put a brake on these developments.

Spreading Their Wings

European LPG retail companies have gone along a separate path than their LPG trading counterparts.

The business traditionally divided along country lines - with different types of companies involved in the marketing in different countries. National companies have dominated in some countries (Repsol Butano in Spain for example), refiners/marketers in others (such as France and Portugal), and independents in others again (such as Germany). Small-scale retailers, often family-owned, have operated in local markets.

France, with its 10 million consumers, has been Europe's biggest retail market. LPG sales there totalled 3.1 million tons in 2001. The country is served by seven main distribution companies, around 140 wholesalers, and over 100,000 retail outlets.

Spain runs France close. The number of consumers is larger,[1] although average per capita consumption is lower. Repsol Butano remains the dominant supplier here.

[1] In the early 1980's, before the introduction of piped gas, butane was being supplied to over 90 percent of all households in Spain.

The third largest market has been Germany. LPG retail sales by DVFG[2] members were 1.5 million tons in 2001.

With the retail expansion opportunities limited in their home market, Europe's LPG companies began to look outside.

An opportunity came East in 1990 when the Berlin Wall came down. The LPG retail expansion into the former East Germany proved overly optimistic. But elsewhere, Primagaz, followed by Shell and Totalgaz, bought into the state-owned distribution companies, acquiring with them large and sometimes dominating market share positions. These companies subsequently invested heavily in storage, distribution, and downstream marketing, and, most noticeably in Poland, were able to increase LPG sales and market penetration sharply.

Turkey - also at the perimeter of Europe - has been another growth market and area of investment. Primagaz, Totalgaz, and BP all acquired local LPG distributorships to compete with Aygaz, the leading LPG marketer there.

Latin America, meanwhile, has been the focus of Repsol's attention, acquiring YPF in Argentina and buying into LPG retail companies in

[2] The German LPG trade association.

Photo: LPG celebrations in Turkey

Chile, Ecuador, and Peru in the late 1990's. SHV and AGIP, by this time, had already established themselves in Brazil.

These policies enabled European LPG companies to expand their sales base, despite the relatively flat demand outlook in Western Europe. By 2000, three European-based LPG marketers - SHV, Shell, and Repsol YPF - had global LPG sales in excess of three million tons per year, and one – SHV[1] – close to six million tons per year.

This expansion has not come without problems.

In Central Europe, a looser regulatory environment, from siting and safety standards to poor tax collection, enabled small entrepreneurs to get into this business with a minimum of capital investment and fuss. These small operators - benefitting as they might be doing from illegal fillings, use of the black market, and tax evasion – were often undercutting the marketing efforts of the more established distributors.

In Asia, meanwhile, it has been difficult for these European companies to break into the two largest LPG retail markets of them all, India and China. Ongoing price subsidies in India, despite the abolition of the administered price mechanism, have made it uneconomic for them to

[1] SHV, an unpretentious Dutch holding company based in the provincial city of Utrecht, emerged as the leading LPG marketer in the world after its purchase of UK-based Calor and French-based Primagaz.

compete with imported supplies. In China, the market has been freer. But competition has been fierce, particularly in the Pearl Delta area, and not necessarily to the advantage of outsiders. Consequently, Shell decided to exit China in 1998. Other companies retain a foothold, but not a significant one.

4. JAPAN

Early Developments

Post-war, the use of LPG in Japan was pioneered by Iwatani & Co. Their *Marui propane* cylinders first became available to consumers in November 1953. It took some time for sales to develop. The early cylinders were expensive; and supplies were limited to what was available from local refineries.

Even so, by 1960, more than 4 of the 20 million homes in Japan had access to propane as a household fuel. And it was clear by then that demand could go much higher. Customers appreciated the cylinders supplied for their cleanliness and portability in what were often cramped living quarters. Manufacturers by then were supplying them with propane rice-cookers and bath-burners as well as water-heaters.

And so, as household incomes rose, consumption went up.[1] Interest in LPG was also spreading to outlying areas, particularly those areas where manufactured gas from town gas plants was not available. By 1965, LPG had penetrated over half of Japanese homes.

[1] Average propane consumption per household in the early 1960's was a frugal 90 kilograms per year, just a quarter of levels today.

Japan: LPG Market Characteristics 1960-65

	1960	1965
Households using propane (millions)	4	20
% in Japan	20	55
Kg use per household (annual average)	90	140
LPG Consumption		
million tons		
Household Use	0.3	1.6
Other Uses	0.1	0.9
Total	0.4	2.5

Butane found an outlet in 1962 as fuel for taxi-cabs. The Government encouraged its use by exempting it from tax. The early generation of vehicles was bi-fuelled, using gasoline and LPG interchangeably. Although the resulting engine performance was relatively poor[1], some 60,000 cabs were running on butane by 1965.

The problem was - where to source the increasing quantities of LPG that were being demanded?

Japan had no indigenous supplies of oil and gas. Although crude was being imported from the Middle East and elsewhere, most gas was still being flared. And even if gas plants were built in these producing

[1] The adaptor for mixing LPG vapor with air, was sandwiched between the carburettor and the intake manifold of the engine. This layout had the effect of reducing the amount of intake air and making it difficult to achieve efficient combustion.

regions, the technology had not yet developed to transport a highly volatile substance such as LPG economically long distances to Japan.

LPG deliveries from Ras Tanura in Saudi Arabia to Japan had begun in 1961. The trade employed three combined crude oil/LPG carriers – the *Gohshu Maru, Nisseki Maru,* and *Toyosu Maru* – each having 5-7,000 tons of LPG storage in addition to their larger crude carrying capacity. This type of combined carriage continued for a number of years, but did not prove a very satisfactory delivery system.

It was Bridgestone Liquefied Gas, a joint venture formed between Bridgestone Tire of Japan and the American oil company Phillips Petroleum, which pioneered the fully refrigerated LPG carrier for the trade.

The initial fully-refrigerated LPG vessel, the 28,875 cubic meter *Bridgestone Maru*, was ordered at the Mitsubishi Heavy Industries yard in Yokohama and delivered in 1962. Its first LPG shipment was made from BP's Mina Al-Ahmadi plant in Kuwait to Bridgestone's Kawasaki terminal in March 1962.

Two larger vessel orders then followed at the Yokohama yard, the 36,000 cubic meter *Bridgestone Maru II* and the 46,720 cubic meter

Bridgestone Maru III, and they were delivered to Bridgestone in 1964 and 1966.

The schemes to import LPG got the support of the Japanese Government. The tax on imported LPG was lowered in 1963. Officials were concerned, however, about a dependency on supplies from distant sources. They consequently set up the system of import licensing and monitoring for LPG, which has continued to this day.

Under the licensing system, a prospective importer would have to provide assurances that he could secure term supplies of LPG on the international market, make term shipping arrangements to transport the LPG to Japan, and invest in receiving facilities in Japan. For many years, each international supply contract entered into had to be reviewed and authorized by MITI's Agency of Natural Resources board.

Japan: First LPG Receiving Terminals

Location	Operator	Startup
Kawasaki	General Gas	1961
	Bridgestone	1962
Toyosu	Tokyo Gas	1962
Osaka	Bridgestone	1964
Mitzushima	Nikko Gas	1965
Chiba	Idemitsu	1965
Negishi	Tokyo Gas	1965
Sakai	Bridgestone	1966
	Maruzen	1967
Kawasaki	Kyodo	1967
Kobe	Mitsubishi	1967

The list above shows that Bridgestone, General Gas, Tokyo Gas, and Nikko Gas were among the early licensed importers. They were joined later in the decade by refining companies such as Idemitsu, Maruzen, and Kyodo, and the first of the *sogo shoshas* to enter the LPG importation business, Mitsubishi Corporation.

Mina-al-Ahmadi in Kuwait and Ras Tanura in Saudi Arabia were early sources of LPG supply in the Middle East. Canada became another in 1966. And LPG from Bandar Mahshahr in Iran and Westernport in Australia became available by 1970. Imports by that time had reached 2.9 million tons and were supplying 40 percent of the Japanese market.

Japan: Sources of LPG

million tons	1960	1965	1970
Domestic Refineries	0.4	2.1	3.5
Imports	-	0.9	2.9
Total	0.4	3.0	6.4

It would usually be a Japanese shipowner - such as NYK Line, Sanko, Yuyo Steamship or Yamashita-Shinnihon - who would, with the backing of a long-term charter arrangement with a licensed importer, enter into a contract with the shipyard for the newbuilding vessel. Most of the LPG ships that delivered in the 1960's were built with a specific trade in mind and were designed for that purpose. The *Yamahide Maru*, for instance, was designed for propane-only carriage out of Canada.

Japan: Large LPG Fleet 1960-1970

Vessel	**Charterer / Owner**	**Year Built**	**Size** (000 cbm)
Bridgestone Maru	Bridgestone	1962	28
Toyosu Maru	Tokyo Gas	1963	12
Bridgestone Maru II	Bridgestone	1964	36
Joyama Maru	Idemitsu	1965	46
Yamahide Maru	Nikko	1966	38
Bridgestone Maru III	Bridgestone	1966	47
Yuyo Maru No. 10	Yuyo Steamship	1966	47
Tatsuno Maru	NYK Line	1967	51
Kazutama Maru	Yamashita-Shinn.	1967	52
Bridgestone Maru V	Bridgestone	1969	72
Izumisan Maru	Exxon	1970	61
Kanayama Maru	Idemitsu	1970	70

One vessel design turned out to be unfortunate. The *Yuyo Maru No. 10*, which delivered in 1966, was designed and operated as a combined LPG/naphtha carrier, with tanks segregated for refrigerated LPG and for clean products.

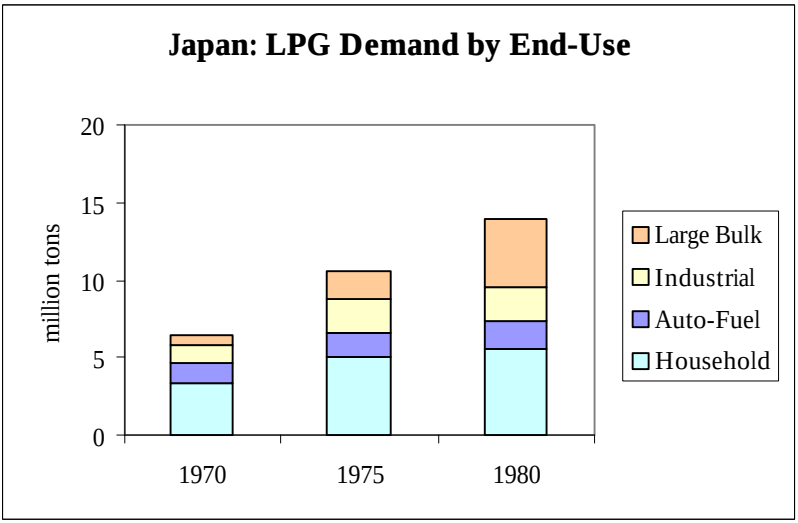
On its arrival in Tokyo Bay on November 9, 1974, the vessel collided with a bulk carrier. Three hours later, a huge explosion ripped through the hull of the ship. The naphtha tanks caught on fire and burned for a week. There was tremendous concern that the LPG tanks might rupture, emitting the combustible LPG in gaseous form into the atmosphere over Tokyo with potentially catastrophic consequences. Eventually, the Japanese Navy sent out a gunboat to blow up the ship. Inspection of the wreckage afterwards revealed that the LPG tanks had held intact despite the intense heat and pressure.

This vessel design was never repeated. And since that time there has not been a serious incident of similar magnitude involving an LPG carrier. These vessels have had in fact a lower accident record and better safety record than crude oil or products carriers.

Photo: A VLGC of the 1970's – the *Ogden Bridgestone*

Decades of Growth

The decade of the 1970's was a time of spectacular growth for the Japanese LPG industry. Demand doubled over the period and imports tripled.



More import terminals were built. And the Japanese large LPG fleet dedicated to this trade increased from 11 to 28 vessels.

Japan LPG Trade

million tons	1970	1975	1980
Demand			
Household	3.3	5.0	5.6
Auto Fuel	1.3	1.6	1.7
Industrial	1.2	2.2	2.2
Large Bulk Sales	0.6	1.8	4.4
Total	6.4	10.4	13.9
Supply			
Domestic Supplies	3.5	4.3	3.9
Imports	2.9	6.1	10.0

Importers generally bought propane and butane as a package in their supply contracts with producers.

The propane went mainly into the retail distribution chain. Importers moved it out - by road and coastal tanker - from primary receiving terminals to secondary distribution points around the country, for onward sale to domestic wholesalers.

Few LPG importers got involved in the downstream distribution business. This had evolved, in a rather unplanned way, as an outgrowth of general products distribution in Japan. Propane moved from 26 main wholesale buyers, via some 2,800 cylinder filling stations and a myriad of sub-wholesalers and distributors, to an estimated 30,000 retail outlets around the country. Although the total number of outlets for propane within Japan was large, the competition between retailers was not always that great and local suppliers could often

achieve a high degree of market control of the sales within their own particular territory.

Propane was (and still is) used in the home for cooking and water heating, but not for space heating.

Japan: Propane Share of Household Fuels in 1995

percent	Cooking	Water Heating	Space Heating
Fuel			
Propane	65	19	1
City Gas	28	24	4
Kerosene	4	37	75
Electricity	2	10	18
Others	1	10	2

Regulations have required that residential users store their propane cylinders outside the home. Consequently, the average size of cylinder (20-50 kg) has been larger than elsewhere in Asia.

Local retailers provided personal service, which the customer appreciated. But the service was expensive. The 10 cubic meter propane cylinder on sale in the Tokyo area cost 3,450 yen in 1978, equivalent to $0.70 per kilo at prevailing exchange rates then. The CIF import cost for LPG at the same time was $0.15 per kilo.[1]

[1] By 2001, as a result of rising labor costs and the yen appreciation against the dollar, the price spread on cylinders had widened much further. The cylinder price equated to $2.40 per kg. versus a CFR import cost of $0.32 per kg. Some consumers were moving towards less expensive mini-bulk and small-bulk deliveries by this time.

Photo: LPG cylinder plant in Japan

Importers negotiated quarterly with domestic wholesalers on price. The two sides were more evenly matched than might have been expected. Importers competed aggressively among themselves to increase their market share and the buyers were sometimes able to take advantage of this situation. Ex-tank sales prices were usually settled quarterly on a retroactive basis after the import cost, including producer FOB prices, freight costs and exchange rate, was known by both sides.

While the propane went mainly for retail distribution, new outlets were needed for the imported butane. Suppliers were able to find large bulk customers. The lack of natural gas available in Japan at that time enabled butane to be considered as a feedstock for methanol, ammonia, propylene, and ethylene manufacture and as a clean-burning fuel for the booming steel industry. Two steel companies, Kobe Steel and Sumitomo Metal, built large new refrigerated storages to import butane directly at their coastal plants. Butane might have been too expensive in these uses in the USA or Europe where natural gas was available. But in high fuel-cost Japan, when combined with their propane distributor sales, importers could make it competitive.

LPG growth continued in the 1980's despite the inroads made by piped gas. Gas companies such as Tokyo Gas and Osaka Gas had by then built large new terminals to receive imported LNG by sea.

Industrial sales of LPG remained buoyant, however.[1] And imports continued to climb.

Japan: LPG Supply/Demand

million tons	1980	1985	1990
Demand			
Household	5.6	5.8	6.2
Auto Fuel	1.7	1.8	1.8
Industrial	2.2	3.5	4.5
Large Bulk Sales	4.4	4.7	6.5
Total	13.9	15.8	19.0
Supply			
Domestic Supplies	3.9	4.3	4.5
Imports	10.0	11.5	14.5

The two largest LPG importer/suppliers at that time were Nippon Petroleum Gas and Idemitsu Kosan.

The market growth attracted new entrants.

Among them were many of the trading houses; Mitsui & Co. had by then acquired Bridgestone Liquefied Gas; C. Itoh (now Itochu) contracted for new LPG supplies out of Dubai; and Marubeni went further to Venezuela and ordered the Panamax-designed VLGC, the *Benny Princess*, for the trade to Japan.

[1] The demand increased despite unfavorable price signals at times. One supplier described the situation as follows. "Those end-users who had made the investments in LPG burning boilers or new LPG facilities continued to buy LPG, because they wanted to prove to themselves that their decision was right."

Japanese domestic companies venturing into the international LPG market were the LPG manufacturer and distributor, Iwatani, and the agricultural co-operative, Zennoh, each of whom contracted for FOB supplies out of Saudi Arabia.

This expansionary posture was made possible by the shift in LPG supply control from the majors to the national oil companies; and by the build-up of new production capacity, particularly in the Middle East.

Not all of these ventures proved to be successes. Mitsui & Co, for instance, had invested heavily in a new gas liquids plant and petrochemical complex in Iran. The Iran-Iraq war put the project in jeopardy, Iraqi air strikes causing extensive damage to the two fractionator trains at Bandar Khomeini. Eventually, after the Iranian revolution and no financial resolution in sight for the funds already expended, Mitsui had to walk away.

Supply Scares

Japan's dependence on distant sources of LPG had its risks. An early scare came in 1972. In September, just prior to the winter demand season, the Japanese All Seaman's Union went on a lengthy strike which dragged through the balance of the year. The Japanese LPG fleet was immobilized. During that time, importers had to charter-in Western vessels and venture into the spot market for supplemental cargoes to cover domestic shortfalls.[1] Western traders sold them CIF cargoes from as far away as Venezuela and Libya.

The Japanese LPG industry survived the oil shocks of 1973 and 1979-80 with relative equanimity. The next crisis in 1983, however, came as a surprise.

Crude markets were then long and Saudi Aramco had adjusted downwards its own crude oil production in an attempt to balance supply and demand. By February, output had slipped below four million barrels per day.

[1] Thus begun the shipping and trading activities between Japanese importers and Western traders and shipowners. Shin Aoki, a former submarine officer, left Nippon Petroleum Gas to set up his own brokerage company, Ocean Chartering, and became an important conduit for this trade as the 1970's progressed.

The relationship between crude and LPG was slow to be realized, but soon hit home. In March 1983, Petromin notified its LPG customers of possible deferrals of up to a third of their first quarter contractual volumes. Many lifters had their March nominations rejected completely or curtailed sharply. The cutbacks continued in April and May.

During March and April, the months of critical shortage, a large number of cargoes were diverted - at high cost - to Japan from other import outlets. MITI intervened to try to protect residential customers. Petrochemical and power plant users were asked to cut back on LPG.

Nevertheless supply allocation notices went through to domestic buyers and this sent shock waves through the industry. Companies had always felt a social obligation to maintain deliveries. Failure to do so meant a loss of face and public apology. Memories of this embarrassment lasted a long time.

A legacy of the various supply crises was MITI's conviction in a mandatory stockpile program for LPG under Japan's Petroleum Stockpile Law. Under this program, importers were required to set-aside LPG volumes as a reserve stockpile in their receiving terminals.[1]

[1] This amount was increased by 5 days of annual imports each year until, by 1989, it had reached 50 days' of imports, a level to which it has remained subsequently.

To sweeten the pill, the Government provided importers with subsidies and low interest-rate loans to set up the reserve.

Japan needed to build new LPG receiving terminals to accommodate the mandatory as well as the running stockpile requirements.

Few were in fact constructed. One problem was the scarcity of suitable land sites near large urban areas. A second was the slow process of local approval. And a third was the very effective campaign waged by local fishermen's associations for advance compensation against any possible loss of income from the increasing traffic.

Among the terminal plans shelved at this time were the MITI-sponsored joint-venture project at Nagasaki, the Showa Oil project at Yokoshima, the Nissho-Iwai project at Ariake, and the Mitsui/Mobil project at Tsurumi.

Japan continued to be able to import its LPG. But with few new terminals being built, importers' throughput capacity was effectively halved and their operational flexibility severely reduced. From that time on, it has been very difficult for them to play the spot market and to take advantage of cheap product when it has become available. Instead, companies have had to depend on the certainty of term supply contract deliveries for, usually, 90 percent of their import requirements.

Demand Expansion and Slowdown

The LPG supply situation improved in the second half of the 1980's and demand and sales in Japan recovered. Samarec, the marketing arm of Petromin, sought to find new outlets for its LPG with Japanese power and petrochemical companies. Five petrochemical buyers - Mitsubishi Kasei, Mitsubishi Petrochemical, Mitsui Petrochemical, Mitsui Toatsu, and Showa Denko - concluded LPG term purchase contracts on a naphtha-related formula in 1989.

However, a new international crisis came along which had some long-lasting repercussions. The Iraqi invasion of Kuwait and the resulting Gulf War in 1991 caused supply shortages, both short and longer term. Japanese shipowners, under union pressure, refused for a time to let their vessels enter the Straits of Hormuz. Afterwards, with Kuwaiti and prospective Iraqi supplies no longer available, the international LPG market tightened up.

Prior to 1991, LPG had generally been available at a discount to Arab Light crude oil prices on a calorific energy-content basis. Subsequent to 1991, it has sold at a significant premium.

The higher cost of imported LPG has rendered difficult importers' efforts to sell into the industrial sector. Petrochemical interest dropped away.[1] And buyers elsewhere found LPG increasingly uncompetitive against the other fuels and feedstocks available.

The 1990's saw the end of the Japanese bubble economy and a general slowdown from which LPG demand was not exempt. The decade was marked by the Kobe earthquake and the Aum Shinrikyu poison gas attacks on the Tokyo metro in 1995.

The LPG retail market should have been more profitable, but hasn't been. Consumers in Japan pay more for LPG in cylinder form than almost anywhere else in the world. Yet importers, wholesalers, and many of the retailers report low margins on their businesses. The multi-layered distribution structure, unreformed since its early days, has proven difficult to streamline.

[1] Its use as steamcracker feedstock dropped from 600,000 tons in 1991 to a level below 200,000 tons by 1997.

The Future?

The LPG market in Japan would appear to offer little if any growth opportunities today. Indeed, the problem of dealing with an unpredictable and volatile price for the LPG imported (the Saudi CP) has tended to mean headaches instead.[1] Some consolidation of the twenty or so companies that import LPG looks likely in the years ahead.

Ships and shipbuilding continue to be Japan's strength and LPG shipping remains an area of interest. Mitsubishi has invested heavily in VLGC newbuildings, as have, to a lesser extent, Idemitsu and Itochu.

China has also attracted attention. Marubeni and Mitsubishi invested in large new LPG terminal projects there and other Japanese companies have smaller LPG terminals or marketing activities underway.

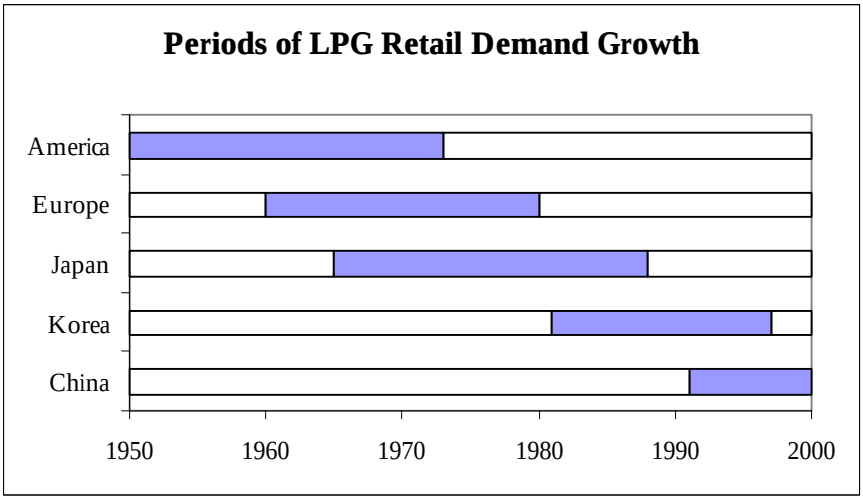
[1] Imported LPG still accounts for 75 percent of market demand in Japan.

Photo: Launching of the *Linden Pride*

5. AND ELSEWHERE

Patterns of Usage

America, Europe, and Japan each have had their periods of retail demand growth - until a point was reached when LPG consumption approached saturation point and piped gas had begun to make inroads into household and other traditional demand sectors.



For LPG, the growth momentum in the last decades of the twentieth century shifted, as the chart above suggests, to Asia, and to Korea and China in particular.

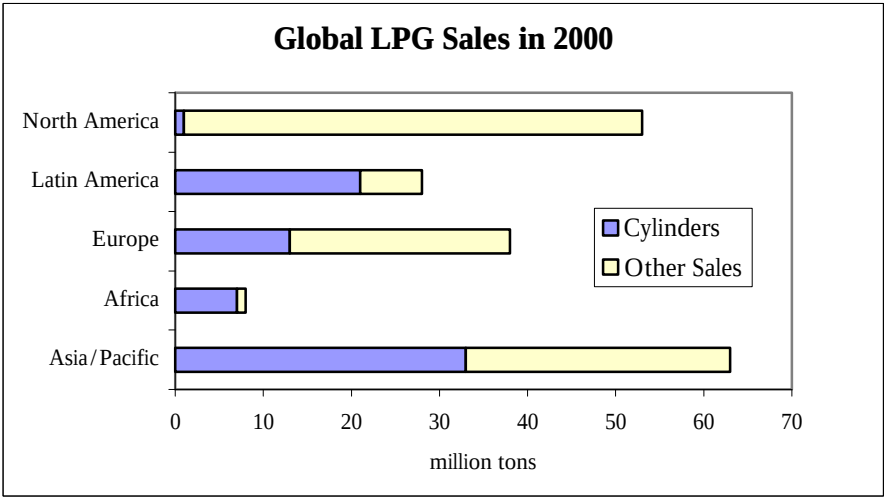
The attractiveness of LPG as a household cooking and heating fuel has, however, proven to be universal. The LPG cylinder, usually marketed

in 10-15 kilogram sizes, provides clean portable energy with a minimum of investment.

The technology of carousel-style filling plants is not that sophisticated and has been readily transferable to developing countries and local companies there. Distribution systems have turned out to be adaptable. In poorer areas, boys can be seen carrying cylinders on their bicycles to connect them into cooking ranges at home. Sometimes cylinders are simply sold by distributors driving through neighborhoods soliciting business from open-bed trucks.

As a consequence, cylinder usage is to be found everywhere, even in the remotest locations.[1] Outside of North America, cylinders accounted for more than half of the global LPG sales of 190 million tons in 2000.

[1] In parts of the Pacific, LPG cylinders are transported on trading boats (*goelettes*), which supply outlying islands. The cylinders are often thrown into the sea, attached one after the other by a rope, and hauled ashore by native swimmers.



Only Africa – south of its Mediterranean coastline – has had a relatively limited LPG penetration, with average usage being less than 3 kg. per capita. Even South Africa, with a population of 45 million, has an LPG cylinder consumption of only 120,000 tons per year. Traditional charcoal burning in kilns has continued to provide the main source of household fuel for African families.

International institutions such as the World Bank have been promoting LPG schemes for environmental reasons, but with little success. Limited urbanization, lack of disposable income, and some lack in entrepreneurship, all of these factors have tended to keep LPG use low, even in countries such as Nigeria which have the resources.

Photo: Indian shop with LPG cylinder

The increasing pace of urbanization elsewhere has helped LPG sales. In growing markets, as the Indian survey data following suggests, LPG is very much an urban fuel.

Cooking Fuels in India

Percent of Households Using -	Urban	Rural
LPG	36	1
Kerosene	26	1
Other Commercial Fuels	15	6
Firewood	26	72
Biofuels	-	20
Total	100	100

China presents a similar picture. An estimated 44 percent of the urban population has access to LPG. But not that much LPG has penetrated into rural areas where straw and coal remain the primary fuels.

The cycle of demand expansion and then maturation may well be repeated in these new LPG markets, as and when gas grids get developed.

Photo: Cooking with LPG at a stall in China

The Ability to Pay

A constraining factor on LPG use has been the ability to pay, particularly in countries where disposable incomes are low. Firewood or charcoal may be dirty. But at least these fuels do not strain the family finances as much.

Governments have often finessed the problem by controlling or subsidizing the LPG cylinder price to the consumer. This approach has worked best where the country is self-sufficient in LPG and state-owned oil companies control the means of production. Price subsidies for LPG used to be prevalent throughout Latin America and remain a feature in many countries of the Middle East and elsewhere. Resource-rich countries can supply their populations with very cheap LPG by international standards.[1]

Perhaps the most elaborate LPG price control system was instituted in India. In 1975, the Indian Government began the Administered Price Mechanism (APM) for LPG and for other retail fuels. This prescribed maximum selling prices. LPG as a consequence became affordable. But it also had to be rationed. There was simply not enough LPG to

[1] As an extreme example, LPG has been available without charge at gasoline filling stations in Iran. Motorists instead have paid a monthly charge, equivalent to $0.63, for unlimited usage.

go round to meet demand. As of 1998, the number of households in India wanting LPG supply and waiting for a connection with a public sector distributor reached twelve million.

Subsequent modifications – the introduction of parallel marketing in 1993 and the abolition of the APM in 2002 (although subsidies were to remain) – were intended to address the problem. But they left open a different issue. As a country becomes more open, how does a Government relate domestic prices for LPG to those prevailing in the international market?

In some countries, such a balance has not been possible and the price gap has had to be covered by Government funds. Egypt, for example, relies on imported LPG for 30 percent of its demand. In 2001, the cost of these imports averaged $280 per ton; the selling price to the consumer, after bottling costs, equated to $100 per ton; and the resulting price subsidy was in the order of $200 million, a considerable sum for a financially stretched country.

A few countries have used an Oil Fund to provide a buffer between international and domestic LPG prices. The Oil Fund would build up when international LPG prices are weak and deplete when these prices are strong. Usually, however, this Oil Fund has been in deficit and it has ended up as the variable subsidy for domestic LPG prices.

The problem is expected to continue, particularly as LPG prices in the international trading market have been getting more volatile.

6. SHIPS AND TRADING

Ships and Trading

America was largely self-sufficient in LPG. But Japan, Europe, and South America had developed markets which became reliant on imported supplies. Ships had to be designed and built to move this volatile cargo safely and economically from loadport to disport.

The pioneers in this business turned out in large part to be enterprising individuals, rather than major oil and gas companies; and it was these individuals, and the companies that they formed, which shaped the early seaborne trade in LPG and established a role for the independent trader that has more or less continued to this day.

The first LPG to be shipped internationally was, as we have seen, transported in the deck tanks of cargo liners. The Norwegian shipowner, Oivind Lorentzen, had deck-mounted 10-ton skid tanks installed on his liner ships operating between the US Gulf and Brazil. This method became too costly, however, as LPG trade volumes increased.

The technology for storing and transporting LPG under pressure on land had already developed and the same approach was followed in the early ship designs.

The first specialized LPG vessels to trade were in fact dry cargo ships converted and refitted with cylindrical pressure tanks by the Bethlehem Steelyard in Beaumont, Texas. The first of these, completed in 1947 for Warren Petroleum, was the 6,050 cubic meter *Natalie O. Warren* (with 68 vertically installed tanks in five holds) and the next, delivered two years later for Lorentzen, was the 3,000 cubic meter *Ultragaz* (with 29 vertical and two horizontal tanks). The steel tanks had to be designed of such thickness so as to withstand working pressures up to 17 kg. per square centimetre.[1]

At the same time, Esso began converting T2 ships for combined LPG and petroleum products carriage. Their initial venture in this field, the *Esso Sao Paulo*, included 8 vertical pressure tanks installed in the vessel's centre tanks. The *Esso El Salvador* and *Esso Brazil* followed with similar configurations. The combined transport of LPG and petroleum products proved to be somewhat cumbersome for Esso to manage in their trade to Brazil and they sold out their business in 1954.

The first purpose-built LPG pressure tanker was the *Rasmus Tholstrup*, ordered by Knud Tholstrup of the Danish company, Kosangas, in Sweden in 1953. This vessel had twelve vertical pressure tanks and a carrying capacity of 600 cubic meters. Later on in the 1950's, pressure

[1] Equivalent to 240 pounds per square inch. One kg. per square centimetre approximates 14 pounds per square inch.

tankers with cargo capacities ranging from 200 to 1,000 cubic meters became commonplace in Europe.

They were built bigger for Caribbean and South American trades where shipping distances were longer. In 1956, Tropigas[1] ordered the 2,000 cubic meter tanker *Marian P. Billups* and, two years later, the larger 2,850 cubic meter *Fred H. Billups.* The design of these vessels reduced the number of tanks and consequent complex piping systems that had been a feature of the earlier vessel conversions.

Some even larger pressure tankers continued to be built for specific purposes. The *Esso Puerto Rico*, originally designed as a 35,000 dwt conventional tanker, was later modified at the building yard for LPG carriage (with pressure tanks installed in each of the center tanks). The vessel, when delivered, combined 7,000 tons LPG storage with larger crude oil carrying capacity. Shell's 18,000 dwt *Iridina* was converted just to trade in the heavier butane and butadiene liquefied gas cargoes (at their more moderate -5°C carriage temperatures).

But an efficient design - given the thickness of the tanks –usually limited the carrying capacity to around 2,500 cubic meters.

[1] Tropigas, based in Miami, had until 1954 been the LPG marketing arm of Esso in the Caribbean.

Photos: The *Natalie O. Warren* and the first purpose-built pressure LPG tanker, the *Rasmus Tholstrup.*

The solution for larger payloads was refrigeration. By cooling the cargo, the pressure can be reduced and there is a consequent reduction in the thickness and weight of the cargo tanks.

What was needed for the vessel design was:

(a) onboard refrigeration equipment to maintain the cargo within specified temperature and pressure limits;

(b) steel in the tanks which would remain ductile at the low temperatures of LPG; and

(c) tank insulation that would protect the hull structure.

In 1959, Gazocean, with its team of young engineers (later reorganized as a separate company, Technigaz), had the first of these vessels of semi-refrigerated design, the 920 cubic meter *Descartes*, constructed at the La Ciotat yard in France. This vessel was able to operate at a reduced working pressure of 9 kg. per square centimetre.

The semi-refrigerated vessel designs of the 1960's achieved further reductions in working pressure requirements (to 5-7 kg. per square centimetre) and enabled the cargo tank capacity to increase, first to 2,000 cubic meters and later to 4-6,500 cubic meters.[1]

[1] In many pressure tankers, the tanks weighed as much as the cargo. With refrigeration equipment onboard, the reduced pressure of the cooler cargo created savings in the weight of the steel needed in the cargo tanks, thereby increasing cargo payload.

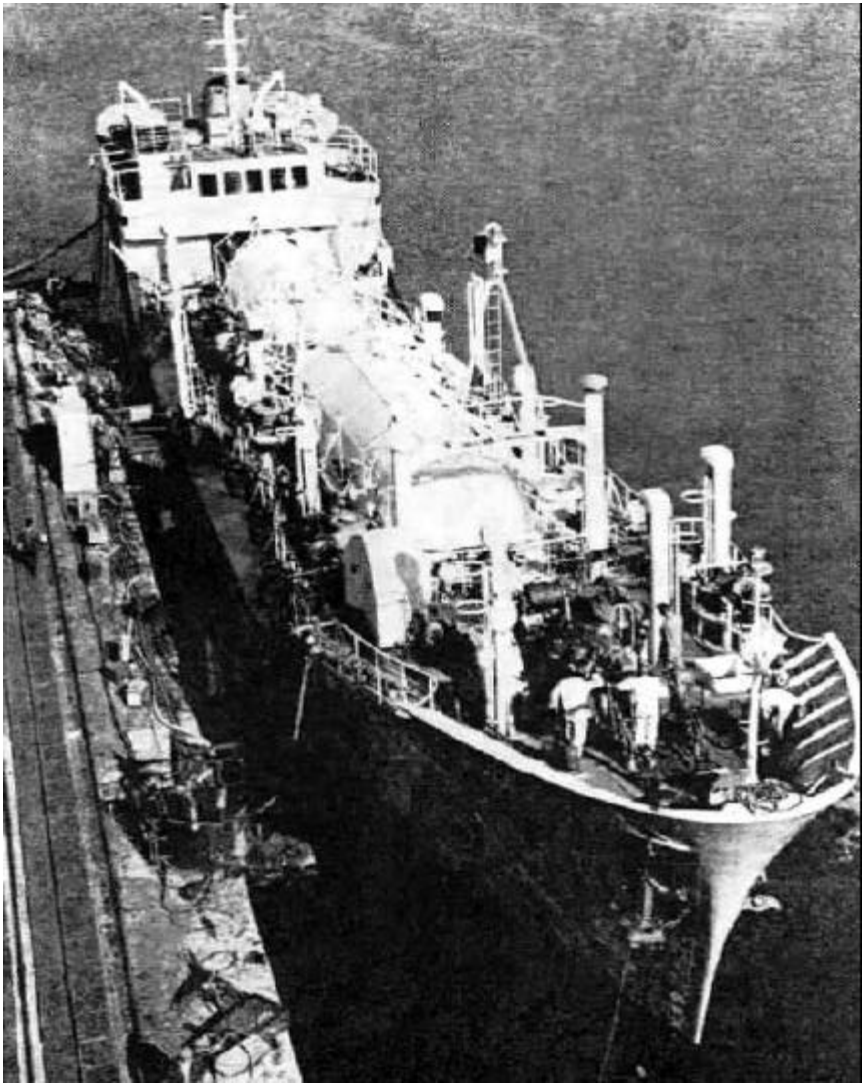


Photo: The *Descartes* – the first semi-ref LPG ship.

The early charterers, such as Gazocean, were traders and operated within the environment of a fluctuating and seasonal LPG trading market. They needed vessels with the flexibility to trade LPG out of different loadports and disports and to be able to trade other liquid cargoes such as anhydrous ammonia, butadiene, and vinyl chloride monomer (VCM), depending upon market conditions.

Properties of LPG and Other Cargoes

	Specific Gravity	Carriage Temperature (°C)
Propane	0.583	- 43
Butane	0.602	- 1
Ammonia	0.683	- 34
Butadiene	0.647	- 5
VCM	0.965	- 14

The 6,310 cubic meter *Pascal*, delivered from La Ciotat in 1967, was the first carrier to be able to load LPG either in either a "warm" (i.e. ambient temperature) or a fully refrigerated state. The vessel was one of the first to be equipped with inert gas to clean the tanks prior to changing grades.

The *Humboldt* of similar size, delivered from the same yard a year later, was designed with a flexible gas system which allowed up to six different products to be carried at the same time in its six horizontal cylindrical tanks.

The initiative then passed to Norway and the Norwegian shipbuilder Moss Rosenberg. By the early 1970's, Moss Rosenberg had under Mikael Gronner developed standardized designs for semi-refrigerated vessels in size ranges from 2,000 to 15,000 cubic meters. The company promoted their vessels aggressively to the industry, often building them on speculation for yard account without any firm charters in hand. The ships that they built formed the basis for the LPG and chemical gas trading in the Atlantic basin in the 1970's.

Around the same time, Inge Steensland through his shipbroking group had begun to generate investing interest from the Norwegian shipping community.

The Danish shipowner A.P. Moller took delivery of their first 12,000 cubic meter semi-ref ship in 1972 and became the leading operator in this segment of the fleet, controlling 15 vessels in the 12-20,000 cubic meter size category by the mid 1990's. Their 20,500 cubic meter *Hans Maersk*, delivered in 1993, has a maximum LPG carrying capacity of 12,000 tons in its four cargo tanks.

Longer-haul LPG trades required much bigger cargo payloads, however. That was the problem facing prospective importers of LPG into Japan from the Middle East and other distant supply sources in the early 1960's.

The pioneer in a new LPG vessel design was Bridgestone Liquefied Gas, a joint venture formed between Bridgestone Tire of Japan and the American oil company, Phillips Petroleum. This company under Michio Doi worked with marine architects J.J. Henry of New York, Conch International Methane, Shell Oil, and others on the design for the first fully refrigerated LPG carrier.

The new tanks to store LPG in this vessel would have to be free standing and fully insulated within the ship's hull to prevent any cold escaping and damaging the hull.[1] They consequently required construction with special low-temperature nickel steels. But the tanks did not need to be cylindrical in shape (as was the case with pressurized and semi-refrigerated vessels) and could be much more efficiently moulded to fit the contours of the ship.

The first vessel of this type, the 28,875 cubic meter *Bridgestone Maru*, was ordered at the Mitsubishi Heavy Industries yard in Yokohama and delivered in 1962. The *Bridgestone Maru II*, delivered in 1964, started the

[1] The temperature in a refrigerated tank will change during the course of a round-trip voyage. It will rise to ambient temperature during the ballast leg unless some cargo is retained within the tank to keep the tank cold. A cargo tank warmed to ambient temperature must then be allowed to expand unimpeded within the ship's hull. Similarly, when being cooled prior to loading, it must be allowed to contract. Standard refrigerated vessel design includes a double bottom, which acts as an extra precaution for groundings.

modern practice of using the inner hull of the vessel and part of its side shell as the secondary barrier to protect the hull structure.

Later designs increased the cargo carrying capacity to 50,000 cubic meters and to 75-78,000 cubic meters, the standard size for VLGC's (very large gas carriers) transporting 40-45,000 tons of LPG in long-haul trades today.

The first generation of VLGC's was built for Japanese imports. Demand for these ships in the West was to come later. Initially, fully-ref ships were employed in the ammonia trades. As longer-haul LPG trades developed in the 1970's, Mundogas, Gazocean, and the British shipowner P&O led the step-up in ship-sizes ordered. The *Monge*, completed in 1977, was the first VLGC newbuilding for Western account.

Mundogas

Two of the technological innovators in LPG transportation, Mundogas and Gazocean, were also pioneers in its trading. A third trading company, Multinational, enjoyed a meteoric rise and fall during the 1970's. These three companies were the main players in international LPG trade prior to its globalization in the 1980's.

Mundogas, an enterprise founded on a post-war alliance to supply Brazil between a US supplier (Mobil), a Norwegian shipowner (Oivind Lorentzen), and a Brazilian buyer (Ultragaz), emerged in 1956 as a separately constituted trading company in the US[1] under their joint ownership.

The first vessel acquisition was the *Natalie O. Warren* from Warren, renamed *Mundogas Oueste.* The company also traded the three Liberty ships which had been converted by Lorentzen into LPG tankers - the *Ultragaz*, *Ultragaz Sao Paulo*, and *Gasbras Norte.* Starting in 1949, these vessels transported LPG in 1,000-1,500 ton lot-sizes from Houston to the ports of Rio de Janeiro, Santos, and Caroas in Brazil. Later,

[1] In offices in Stamford, Connecticut. The company moved to Bermuda for tax reasons in 1967.

Photo: Ernesto and Pery Igel.

Lorentzen had special-purpose pressure tankers built to operate under time-charters with Mundogas.

LPG imports into Brazil were still expanding. It was not until 1955, with the startup of Petrobras's first refinery, that Brazil had a domestic source of supply.

Pery Igel of Ultragaz, Ernesto's son, oversaw the operations of Mundogas in these early years. Ultragaz had by this time become a large LPG marketer in Brazil (with a customer base of half a million in 1955). Mobil retained its investment position. Lorentzen had entered the Brazilian downstream market directly, following his acquisition of Esso's retail business in 1954.[1]

Fred Jackson, who came from Mobil, managed the company's expansion in the late 1960's. A second import market, Argentina, was opening up by then. Towards the end of that decade, Brazil and Argentina together were importing close to 800,000 tons per year, with Mundogas supplying a major share of these volumes. The principal source was now Venezuela, rather than the US Gulf.

[1] That company, then called Gasbras, is now Supergasbras. A third Brazilian LPG developer at the time was Edson Queiroz, who built up his LPG business (Nacional Gas Butano) from Fortaleza in the northeast.

Mundogas invested then in its own fleet of fully-ref ships.

The Mundogas LPG Fleet in 1970

Vessel	Size (000 cbm)	Year Built
Monomer Venture	5.7	1962
Mundogas Brasilia	7.7	1961
Mundogas Atlantic	8.5	1969
Mundogas Rio	19.5	1967
Mundogas Europe	22.0	1968
Mundogas Pacific	22.0	1969

The company pioneered industry use of re-heaters[1] in LPG shipboard operations, whereby "cold" or refrigerated LPG could be discharged into "warm" or pressurized shoreside tanks.

By this time, Mundogas was facing increasing competition from the European traders in its South American backyard. The company in fact lost out to Gazocean on the C&F contract into Brazil in 1968.

Mundogas's focus then shifted to Argentina and Chile and further afield. The Brazilian connection withered and Ultragaz and Mobil sold out their interest, the British shipowner P&O acquiring their shares. Charlie Scott, who had come from Mobil, was by then President of Mundogas, with Chris Marner handling LPG trading.

[1] The Mundogas term was "borrea."

The Mundogas organization inherited by Howard Dutemple and Sandro Bronzini[1] was in the mid 1970's a trading office of 50, based in Bermuda with branch offices in Houston and London. Thyssen purchased the Lorentzen shares in 1979 after a corporate restructure and then went on to buy out P&O in 1983.

The company moved around 1.7 million tons annually of various products, of which roughly half was LPG under its own account. Their first supply contract in the Middle East was concluded in 1974. By 1980, Mundogas was selling into Japan, into Europe (where the company also operated the Unimundo small-ship trading operation with Unigas), and into the US Gulf Coast.

Mundogas's trading activities declined in the second half of the 1980's and it was left with an asset base of its older refrigerated vessels. These assets were subsequently picked up by the LPG trader Enron and then sold on, with the Mundogas name, to the Hong Kong-based entrepreneur, Robbie Brothers.

[1] Who came over from Ultragaz and Gazocean respectively.

Gazocean

Rene Boudet started his LPG career in Italy in 1956 with a shipping company, Oceangas, a relationship with AGIP, and a small pressure ship, the *Gay Lussac*, for Italian LPG trades. The following year, a charter opportunity with Shell Maritime of France enabled him to set up Gazocean in Paris. Over the next 22 years, Rene Boudet brought technical skills, trading flair, and vision to the business and Gazocean grew to rival and surpass Mundogas in its LPG trading activities.

The story has often been told how Rene Boudet returned by train from a visit to the La Spezia shipyard in Italy with a young technical engineer from Shell Maritime, Etienne Schlumberger. During the train journey, Shlumberger showed Rene Boudet his design plans for a new concept of refrigerating the cargo onboard. Gazocean's technical department under Jean Alleaume, subsequently Technigaz, was able to incorporate these plans into the vessel they were constructing, the *Descartes.*

Technigaz pioneered this, the first semi-refrigerated LPG vessel, delivered in 1959 and, later, the first LNG membrane-type tank, the *Pythagore*,, delivered in 1964.

Gazocean's trading started with refinery LPG out of the Mediterranean and expanded, as the fleet expanded, to handle other liquid cargoes such as anhydrous ammonia, butadiene, and vinyl chloride monomer (VCM).

The company operated in part as an LPG trading company and in part as a commercial and operational manager for those shipowners who put their vessels under the Gazocean pool. The initial relationship had been with the Italian shipping company, Oceangas. Subsequent alliances were struck with Navigas in Spain and with the British Houlder group.

Gazocean expanded into South America in the mid 1960's. First into Chile; then into Argentina; and finally, in the biggest coup of all, the C&F contract into Brazil with Petrobras in 1968. Its position was later buttressed by a joint venture with Shell, Western LPG, on Shell's LPG volumes out of Venezuela.

Gazocean was able to parlay good contacts and a ready pool of ships in successfully competing for the increasing amount business that was becoming available in that part of the world.[1]

[1] Roland Hautefeuille recounts in his book *Gas Pioneers* how, in his days with SAGA, he lost out on some business in South America. How did he lose out? "Well, we knew the terms of your offer, of course," was the response given by Gazocean. The import tender system used by buyers leaked information in those days.

Photo: Rene Boudet.

LPG trading activities grew again in the 1970's. More supplies were coming out of Libya and Algeria. Gazocean took up minority shares in two French import terminals and invested in the Sea-3 import terminal on the US East Coast. The company also established branch offices in Tokyo and Singapore to expand activities into the Far East.

By this time, the Gazocean pool controlled 12 fully refrigerated ships and a further 20 small-ship pressure vessels. At its peak in 1976, the fleet, with chartered-in tonnage, moved around 2.4 million tons of LPG.

Rene Boudet and, until the mid 1970's, Sandro Bronzini[1] handled the trading activities on very much of a personal basis (although Jim Benedict, who was brought in from Shell, did help to introduce a management structure for the company).

But there were problems on the horizon. The diversification into phosphoric acid and LNG carriers (with speculative ship orders) did not prove viable and this, combined with the LPG trading losses experienced in 1977 and 1978, caused a severe cash drain. Gazocean survived the crisis and was, with French government and Moroccan help, restructured. Nevertheless the changes led of the departure of the

[1] Who had joined Gazocean from AGIP.

company's founder, Rene Boudet, to form a new trading company, Geogas.

Gazocean was still an active LPG trader in the early 1980's, but had retrenched by mid-decade. The shipping pool was restructured in a looser pool arrangement as General Gas Carriers in 1983. This pool continued for another few years until it and Gazocean were finally dissolved.

Multinational

The first attempt at a global LPG trading company was Multinational, set up in London in 1971. Its three shareholders spanned the world - Phillips Petroleum from the US, the SAGA group from France, and Bridgestone Liquefied Gas from Japan.

Herman Sauer, who joined from Phillips, soon became General Manager of the newly formed company and Charlie Mitchell, also from Phillips, Supply Manager. Lou Oakman, another Phillips recruit, headed Multinational's New York office. Shipping came to be handled by Chris Marner (from Mundogas).

During its hey-day, the company traded over a million tons per year. Access to supplies was a critical factor, as it has been for traders before and since. Multinational bought from the oil majors in Venezuela, from Occidental in Libya and Sonatrach in Algeria, and, by the mid 1970's, from various suppliers in the Middle East.

Multinational's office in New York gave the company proximity to the Aramco partners who marketed the Saudi volumes. Chevron and Texaco would have volumes that were surplus to Caltex's requirements in supplying Nippon Petroleum Gas and other importers in Japan.

And Multinational was usually successful in securing these volumes when they were tendered.

The main outlets for their large-cargo traded volumes were Taiwan and Japan in the East, Spain in the Mediterranean, and the Gas del Estado tenders in Argentina. In support of these trading activities, Multinational was controlling a large LPG fleet by the mid 1970's, including eight fully-ref vessels.

Multinational Fully-Ref LPG Fleet in 1976

Vessel	Size (000 cbm)	Year Built
Trina Multina	18.4	1968
Norfolk Multina	25.1	1964
Amy Multina	26.5	1969
Bridgestone Multina	28.8	1962
Kenai Multina (LNG)	35.5	1975
Hoegh Multina	52.0	1971
Malmros Multina	53.4	1974
Providence Multina	53.4	1973

The major charter commitment was for the 50's with the Norwegian shipowner, Leif Hoegh.

Multinational was under-capitalized, however. Trading losses in 1977, coupled with mounting commitments on charter-hire and newbuilding payments, precipitated a cash crisis. The shareholders were reluctant to make available any additional funding and they allowed the company to go under.

7. TOWARDS A GLOBAL MARKET

Three Trading Areas

Prior to the 1970's, LPG in international trade had been essentially a regional business, with each region having its own pricing structure, shipping, and buyers and sellers.

The first regional trade, starting in the 1950's, had been from the US Gulf to South America. The ships employed were usually converted bulk carriers refitted with LPG tanks. The main destinations were Brazil and, later, Argentina; the main shipper Mundogas.

The Caribbean basin was also an outlet. Tropigas, based in Miami, expanded, first under Fred Billups and then under Dave Bayer, into an important small-ship LPG trader in this region. Apparently, the Tropigas' marketing men followed the lead given them by Singer sewing machine salesmen in identifying and developing new LPG sales prospects.

The company never traded more than 200,000 tons per year. But, like Mundogas and Gazocean, it contributed a significant number of people to the international LPG industry. The name Tropigas remains

ubiquitous in the region, although now under different ownerships in different countries.[1]

In 1960, Mundogas had begun LPG export shipments from Venezuela and, by the end of the decade, Venezuela supplanted the US Gulf as the regional source of export LPG. Mexican LPG from the Cactus plants became available later in the 1970's. The US Gulf, by this time, was becoming a significant LPG importer.

LPG Seaborne Trade in the Americas

million tons	1970	1975
Exports		
Venezuela	0.7	1.1
Elsewhere	0.1	0.2
Total	0.8	1.3
Imports		
USA	0.3	0.8
Elsewhere (Brazil, Argentina and the Caribbean)	0.5	0.5

This trade remained bigger than the LPG seaborne trades in Europe. The European coastal and Mediterranean trades never amounted to much more than half a million tons per year.

LPG Seaborne Trade in Europe

million tons	1970	1975
total trade	0.3	0.5

[1] Tropigas was dissolved in the 1980's, the Zaragoza family from Mexico taking over much of the Central American operations and Shell its Caribbean trading.

However, it was in Europe that the developments in pressure and semi-refrigerated LPG ship design had been occurring, enabling European companies such as Gazocean and SAGA to build up their trading fleets. By the mid 1960's, they were increasingly competing for LPG import business in the Americas.

The third regional trade, the long-haul shipments to Japan, had required the introduction of ships of larger fully-ref design. By the 1970's, these were being built in increasing numbers and the trade East had, in volume terms, become the most important one.

LPG Seaborne Trade in Middle East/Asia

million tons	1970	1975
Exports		
Middle East	2.3	5.0
Asia/Pacific	0.4	1.0
Total	2.7	6.0
Imports		
Japan	2.7	6.0

It had started as a partnership between the oil majors, such as the Aramco partners in Saudi Arabia or BP in Kuwait, and the Japanese importers. The former constructed the plants and made the LPG available; the latter committed to buy and built ships and terminals to move the LPG to Japan.

The LPG export volumes were potentially so large, particularly out of the Middle East, that the Western LPG traders saw the opportunity and, by the mid 1970s, had begun to compete aggressively for FOB supply contracts there.

Supply Expansion

The oil crisis of 1973 was a turning point. It made oil-producing countries very wealthy. And it changed the balance of power within the oil industry. Newly created national oil companies began to take over the oil marketing, in Venezuela, the Middle East and elsewhere.

Some of the new oil wealth went into processing and recovering the liquids from gas previously flared. Saudi Arabia began its Master Gas System. Other countries also built liquids recovery plants as they realized that the exports of LPG could generate a significant monetary return.

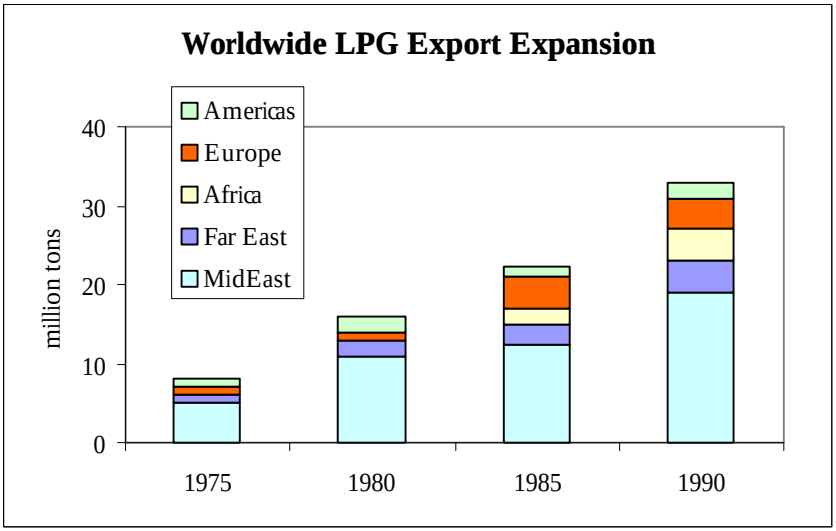
The expansion of Middle East LPG capacity which occurred over the 1975-1985 decade was truly staggering - from a total of 6 million tons of installed capacity in 1975 to 17 million tons by 1980 and 30 million tons by 1985.

LPG Export Plants in the Middle East

Country	Location	Capacity (million tons)	Startup
Saudi Arabia	Ras Tanura	4.0	1961-72
Kuwait	Mina al Ahmadi	1.4	1961-72
Iran	Bandar Mahshahr	0.8	1970
1975 Installed Capacity		**6.2**	
Abu Dhabi	Das Island	1.1	1977
Saudi Arabia	Ras Tanura	4.2	1977
Kuwait	Mina al Ahmadi	5.5	1978
1975-80 Incremental Capacity		**10.8**	
Dubai	Jebel Ali	0.5	1980
Qatar	Mesaieed	1.3	1980-81
Saudi Arabia	Ju'aymah	5.0	1980-81
Abu Dhabi	Ruwais	3.0	1981
Saudi Arabia	Yanbu	4.0	1982
1980-85 Incremental Capacity		**13.8**	

It was not only in the Middle East that LPG plants were being built. Australia, Indonesia, Algeria, the North Sea, and Venezuela were also new sources of supply.

The 1980's in fact turned out to be a period of tremendous LPG export expansion worldwide.



The LPG market became truly global at this time. Producers needed buyers, whether they be in Asia, Europe, the United States, or South America. The new export volumes had to find outlets somewhere.

Shipowners had anticipated the supply growth by placing orders for large gas carriers (VLGC's) that could carry 40-45,000 tons of LPG economically on long-haul trade routes. The first vessels of this size had been built in the early 1970's for dedicated Middle East to Japan trades. Sixteen were in service by 1977. At the same time, no fewer than new 25 orders for these vessels had been placed at yards in Japan and Europe. The optimism of the time was such that many of these vessels were ordered on speculation without any firm charter commitment in hand.

Photo: LPG tanker loading at Yanbu.

An Industry in Transition

The oil majors still controlled most of the traded LPG supplies East of Suez in the 1970's. These came from two sources - the gas plants in the Middle East and the refineries in Singapore. The Middle East LPG went on big ships to Japan, the Singapore LPG on small ships to Hong Kong.

Among the majors, Esso was perhaps the most active LPG promoter at the time, owning and operating big ships to supply their customers in Japan and building propane-air plants for new housing developments in Hong Kong. All of the majors then - Esso, Shell, Caltex, and Mobil - had small-scale LPG retail operations in Asia.

By the mid 1970's, the Aramco supplies out of Saudi Arabia had started to exceed their customers' needs in Japan and the partners began to look for find new buyers.

For a time, New York became the center of the LPG trading world. Dick Kameros, Joe Christy and Ed Ross at Exxon, Chris Rout at Chevron, John Brunk at Texaco, and John Beardsley and Paul Golier at Mobil had LPG to sell to third parties. Japanese importers set up

trading departments in New York to secure their LPG. And the traders were there as well.

But the writing was on the wall for the majors in LPG, as it was for oil in general. Control was passing to the national oil companies. For LPG, the future decisions would not be made in the Aramco partners' offices in New York and elsewhere, but in the Petromin offices in Riyadh and then in Dhahran.

Petromin concluded its first sales contracts in 1978, taking the volumes away from the Aramco partners. By 1980, Petromin was marketing 35 percent of Saudi Arabia's LPG, by 1981 100 percent.

Elsewhere in the Middle East, the state oil companies were assuming the marketing of LPG as well. Kuwait Petroleum Corporation (KPC) was already selling all of Kuwait's exports. ADNOC and ADGAS[1] would be marketing new LPG production from Ruwais and Das Island in Abu Dhabi, QGPC from Umm Said[2] in Qatar, and Dugas from Jebel Ali in Dubai.

[1] Shareholding of ADNOC, BP, and Total.

[2] Now Mesaieed.

The people who moved this LPG in the 1970's were the Japanese importers and the traders; and more specifically three traders, Mundogas, Gazocean, and Multinational.

These three companies, however, barely survived the difficult trading markets of the late 1970's. Multinational went under; Gazocean and Mundogas were restructured.

In these companies were to be found a group of talented and experienced individuals who had grown up in the business and were knowledgeable about its shipping, trades, and outlets. As their companies faltered, many of them left to form new companies and alliances.

Rene Boudet departed and founded Geogas in 1979, with financial backing from a Middle East financier, Roger Tamraz, and, later, from the Norwegian shipowner, Bergesen, and Oscar Wyatt from Coastal States. Based in Geneva, the company became quickly active in large-ship and small-ship trading and, by 1981, was moving 1.5 million tons per year of LPG. On Rene's retirement from day-to-day trading, the company came to be run by Rene's son, Jacques Boudet.

Herman Sauer set up Arab International in London and traded mainly on the FOB supply position the company had established in Saudi Arabia. An associated company, Navigas, dealt with sales into Spain.

Louis Nielsen linked up with Ronald Stanton of New York-based Transammonia to establish Trammo Gas and Petrochemicals' LPG and related activities coordinated out of London. LPG trading soon built up to the 1.5 million ton per year level. An early innovation was the move into floating storage. For four years, starting in 1978, Trammo put in a floating storage and transhipment scheme off Vlissingen in Holland to supply the ARA market with LPG in winter.

Others who departed the Gazocean organization at this time were Olivier DeVictor (to Unimundo and subsequently to his own brokerage firm Gasteam), Jean Grandbesancon (to Poten), Francesco Pesenti (to Trammo and later to Stargas and Ferrell), and Jim DuPay (to Enron and then to ContiChem).

What was formed in the process was a wider grouping of LPG traders and shippers, all linked together through past associations and dealings. Add to this the LPG supply managers from the majors and from the newly emerging producer nations and the Japanese LPG importing companies and what emerged was a very distinct community of the international LPG industry.

It already had its own forum. Over drinks in New York at the end of a Gastech convention, Rene Boudet of Geogas, Michael Tusiani of Poten and Partners, and Rai Watanabe of Mitsubishi Corporation came up with a new idea for an event for the key players of this industry.

So began the bi-annual Nice LPG Conference. The first gathering, at Mas d'Artigny in the hills overlooking the Mediterranean, was in October 1977 and the conference continued to bring together the industry together until Rene Boudet's farewell appearance in 1999.

A Gap in the Market

The shipping industry has traditionally had its supporting cast of brokers and ships' agents around the world. LPG was no different. There were LPG and chemical gas shipbrokers in London (Burbank, Traffic Services, and Clarkson), in Paris (Petromar and Asmarine), Oslo (Inge Steensland and Fearnleys), New York (Poten and Seabrokers), and Tokyo (Ocean Chartering), either representing owners' or charterers' interests.

The domestic US LPG market also had its mill or penny brokers who transacted deals on the cash trading market at Mont Belvieu.

But a changing international LPG industry required something more. New players were coming to the table. They were looking for independent help outside of the confines of the existing trading companies; help in the securing or disposing of supplies and advice and guidance on future trends in this still immature trading market. There was a role, recognized by few at the time, for an independent broker and commercial advisor.

The first changes were to occur in Venezuela in 1976 when the oil industry there was nationalized. New personnel took over LPG

marketing. Michael Tusiani with Poten and Partners undertook the first international large-cargo brokerage in LPG, putting the new sellers in touch with new buyers, as the LPG export program was restructured.

The requirements for cargo brokerage and commercial advice expanded with the advent of new Middle East production and the new national marketers. How should we market? Can you find us buyers? What price do we charge? The commercial advisor played an integrating role in this still fragmented LPG trading world.

The emerging industry needed also its own guidebook at this time. Information was still very much word-of-mouth and not widely available. John Mitchell of Poten and Partners wrote his first *World Trade in LPG* in 1977. It contained the first available data on supply, demand, trades, ships, and terminals.

This is what he had to say about the industry at that time.

> "International trade will expand enormously as the oil-exporting countries exploit their resources of natural gas. The volumes moved on long-haul routes by sea may exceed, within the next three years, three times the present level.

It is impossible to foresee the future perfectly. Decisions that will profoundly affect that future have not yet been made, and critical events have yet to occur. International LPG trade is going through a period of major transition."

8. THE GLOBAL STRUCTURE

New Masters

By 1980, control in the Middle East had essentially passed from the oil majors to national oil companies. The Arab face of the industry was proud and dignified, privately hospitable, yet at times overwhelmed by the pace of change. The new LPG marketing was to be shaped by individuals such as Ahmed al Khereiji, Mohammed al Zamel, and Saleh Kaki at Petromin and Ibrahim al Mutawa at QGPC.

The LPG plants had been built by foreign contractors and started up more or less as planned (although there were some hiccups[1]).

The next challenge was commercial. How, without the oil majors, to market the new production volumes? Here, Poten and Partners was in a position to provide commercial advice and assistance; some of the producers also made use of expatriate help.

It turned out to be a sellers' market. The producers were able to set the terms and conditions for their sales, and also the price. Most opted for FOB term sales of 2-5 years duration to cover their planned production

[1] Qatar experienced considerable delays and reduced production in the early years, caused by corrosion in the pipeline linking its offshore fields to the LPG fractionators at Umm Said (now Mesaieed).

and they simply made the product available to their customers at their export terminal.[1]

Those wishing to do business with these companies generally had to be there. The main Japanese importers, for instance, established representative offices close by. They - like other hopeful buyers, contractors, and offerers of service – would often have to wait their turn.

The LPG export buildup in the region was, for various reasons, somewhat slower than had been planned. Even so, exports almost doubled between 1980 and 1990.

Middle East: LPG Exports

million tons	1980	1985	1990
Bahrain	0.1	0.2	0.2
Iran	0.1	-	-
Kuwait	2.1	1.1	1.6
Qatar	0.1	0.5	0.5
Saudi Arabia	7.9	8.0	12.3
UAE			
Abu Dhabi	0.6	2.1	3.5
Dubai	0.1	0.5	0.6
Sharjah	-	-	0.4
Total	11.0	12.4	19.1

[1] Only KPC contracted for shipping and entered into C&F sales with their customers.

They increased a further 25 percent, from 19 to 23.6 million tons, between 1990 and 2000.

Sometimes, producers might get caught out with unsold products in their storage and they would have to make quick sales, generally to traders, at discount prices. As time went by, they would issue more formal spot tenders to dispose of uncontracted volumes. By 2000, the largest producer of them all, Saudi Aramco, was successfully marketing over two million tons a year under tender and other spot sales arrangements.

Saudi Arabia - The Key Supply Source

More than half of the new export supplies globally were coming from the Middle East; and over a third from just one country, Saudi Arabia. What Petromin did, as the Saudi state marketer then, would profoundly affect the future course of the business.

Petromin had assumed the marketing from the Aramco partners in 1980. How then would Petromin place the Saudi LPG tons?

Dr. Abdulhady Taher, Governor of Petromin, decided to widen the number of buying companies. The Aramco partners had sought large volumes from Petromin to maintain their existing marketing arrangements. Exxon, for instance, had asked for a million tons a year. In the end, each partner got only 100,000 tons, far less than they had bargained for. That allocation, perhaps more than anything else, signified the changing course of the industry.

There were 36 buyers in total from Petromin under the first contracts, including many traders.

Petromin LPG Term Buyers 1980

Japanese	Other Eastern	Oil Majors	Traders / Others
C. Itoh	CPC	Exxon	Arab Int.
Daikyo	Taesung Methanol[1]	Texaco	Gatoil
Idemitsu	European	Chevron	Gazocean
Iwatani	Butano	Mobil	Geogas
Kanematsu	American	BP	Gotaas Larsen
Kyodo	Dow Chemical	Elf	Latsis
Marubeni	Northern		Mundogas
Mitsubishi	Phillips		Petraco
Mitsui	Sun		Trammo
NPGC	Tenneco		Tranship
Sumitomo	Union Carbide		

The 1981 contract volumes totalled 6.1 million tons.

Not all of these buyers lifted cargoes and not all of these buyers stayed the course. There was a frenetic period at the beginning when buyers without ships or buyers without outlets sought to team up with those who had ships or outlets. Some found the going too tough and phased out of their contracts. Others stepped in.

The early years were roller-coaster. LPG markets were still thinly traded. Traded prices zig-zagged. Wide differences emerged between contract and spot prices.

[1] Subsequently Jungwoo, Hoyu Energy, and then LG Caltex.

Photos: Dr. Abdulhady Taher and Michael Tusiani;
worker at the Mina al Ahmadi LPG plant in Kuwait.

There was one instance of a producer selling to a trader at a steep discount to the contract price. The trader then resold the stem to another producer who loaded the cargo to sell at the contract price to his contract customer. There was another instance of a Kuwaiti contract cargo arriving in Japan and being declared off-spec. It then travelled halfway around the world to the Terneuzen dock in Europe where it was sold at a CIF price which was less than the FOB posting before it had commenced its long journey.

The list of Saudi contact holders has varied over the years. By 1998, the number totalled 30 and the term sales volume 12.4 million tons. The list included 14 Japanese companies, 3 Korean, 3 other Asian, and 10 Western companies. The Eastern bias in sales is evident from this customer listing.

Saudi Arabia, as well as being the dominant producer, was the only producer to sell in all market regions, Japan and the Far East, and Europe, the USA and South America as well. This enabled Petromin, as the LPG marketer at the time, to post prices for LPG which became the markers for LPG prices in the Middle East. And also the benchmark prices for all LPG sales East and many of the LPG sales West.

What Price?

Crude postings were the order of the day in the early 1980's and Petromin set a GEP[1] as well for its LPG. Petromin and its marketing successors, Samarec and Saudi Aramco, have maintained this monthly posting since that time - even though the basis for establishing the price has changed as market conditions have changed.

The CP, as it is now called, has been the reference price for almost all FOB term LPG export sales in the Middle East and for almost all CFR term LPG import purchases East of Suez. Term sales and purchases (of one year or more) have accounted, on average, for 80-90 percent of all cargo transactions in the region.

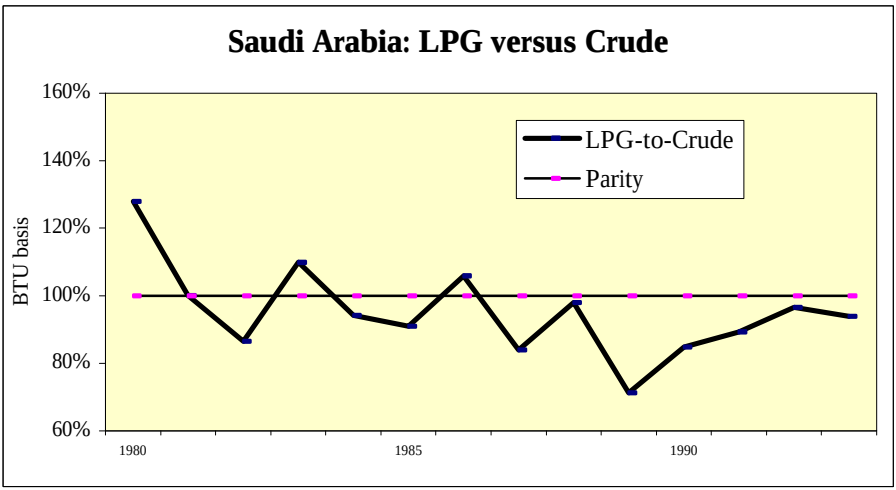
The balance, around 10-20 percent sold or resold on the spot market, has also mostly been priced, at premiums or discounts, in relation to this reference price.

The Saudi problem in price-setting has been that there is no stable price relationship between LPG and other hydrocarbon prices over the course of a year (or from year to year) to act as a reliable guide. And

[1] Government Established Price.

LPG trading markets themselves were thin and not readily transparent. So the LPG price trajectory ranged widely.

The chart following shows the trend in monthly LPG prices set by Petromin and its successor Samarec, in relation to the marker price of crude oil, from 1980 to 1993.[1]

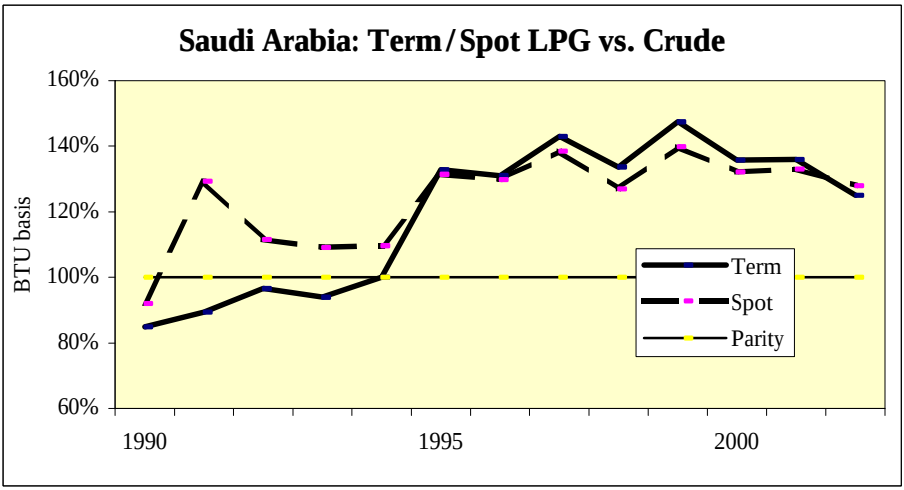


After the tight markets of 1979-80, LPG prices weakened in relation to crude over the 1980's as the supply/demand balance eased; and this put pressure on postings. Petromin responded by introducing a direct crude oil price linkage in its price, with adjustments, in 1983.

[1] The crude price basis here is Arab Light crude. The comparison is done on a heat-value BTU equivalence.

The supply/demand balance tightened in the 1990's and the formula was changed again, first to one combining the price awards under spot tenders with the crude oil price linkage and then to one related to tenders only.

More often than not, the Saudis came close in their formulas to what might be considered the market price; at times they did not. The next chart shows the relationship between spot prices, contract prices, and crude prices from 1990 to the present.



The chart shows both spot premiums and discounts, suggesting that the Saudis may have been too generous at times and less-than-generous at others. The main discrepancy occurred in the period immediately

after the Iraqi invasion of Kuwait. Market premiums then approached $20 per ton for those reselling contract tons. Saudi Aramco, who took over the LPG marketing in 1993, felt that "this was leaving money on the table."

While the Saudi pricing system for LPG (now the CP) may have had its shortcomings, it has probably provided over the past twenty years a uniform pricing mechanism and one generally accepted by its contract buyers.

That is not to say that the CP will necessarily remain as the price-marker in the future. Its frame of reference has become more limited.

With hardly any Saudi LPG tons moving West post-2000, it no longer serves as a price reference point in the Americas or Europe. Mont Belvieu has increasingly become the basis for LPG prices in North and South America; *Argus and Platt's*, as well as the BP and Sonatrach monthly prices, for LPG prices in Europe.

In the East, Japan and Korea have continued to be tied to the system for their contract tons. But China, being spot-oriented, has purchased more on a fixed price basis.

Buyer complaints have ranged from the short-term volatility of the CP price, which has made it difficult to hedge or inventory-manage, to the tender process under which traders, rather than the contract buyers, have tended to determine the price.

Whether the CP will lose relevance or even be superseded in the future will depend on the course of the trading market East. There is still a reluctance to use price-reporting services such as *Argus* or *Platt's* as a pricing benchmark. But if length should appear on the market and the balance of power shift from seller to buyer, then the pricing basis is likely to move from FOB Middle East to CFR Asia.

9. GLOBAL TRADING

Trading and Traders

The LPG trading markets in the 1980's developed an established pattern - a seasonal upswing in demand to meet winter requirements in Japan and Europe and a search for buyers during the slacker summer season. The Gas del Estado tender in Argentina was an early outlet. The US Gulf Coast was another. Then came Brazil and the European petrochemicals such as Dow.

Traders would look for term CIF outlets to place the FOB volumes that they had secured from producers or from third parties. Japan was always the prime candidate. Leading importers there would be regularly canvassed. The traders' access to cheaper shipping than the Japanese importers could give them an advantage at certain times. Their CIF sales into Japan did expand in the second half of the 1980's (before tapering off in the 1990's). Term sales into Europe have tended to be winter-only; while those to the US have been limited to the East Coast.

Shipping control also allowed traders to offer those buyers not wishing to get too deeply involved in the international market options of FOB and CIF exchanges and shipping contracts of affreightment. CPC[1] was

[1] Chinese Petroleum Company, the state oil company of Taiwan.

Caption: Trading and shipping (thanks to GasLink).

a candidate for these services in the Far East, Repsol Butano and AGIP in the Mediterranean, and Petrobras (until the 1990's) in Brazil.

The list of traders in the business changed during the 1980's. Mundogas and Gazocean faded away. Others came in. The table following shows the traders by approximate ranking according to the large gas ships that they controlled or operated.

LPG Traders

in 1981	**in 1986**	**in 1991**
Trammo	Geogas	ContiChem
Gazocean	Trammo	Trammo
Mundogas	Mundogas	Geogas
Geogas	ContiChem	Enron

ContiChem, a division of Continental Grain, had become a major trader East of Suez in the late 1980's.

LPG trading margins improved in the second half of the 1980's, to such an extent that oil companies took notice. Some set up their own LPG trading departments and began to take forward shipping positions. Shell and Texaco had already become trading presences by the early 1990's. Sonatrach and Statoil, with their Algerian and North Sea tons, were to follow.

Not all traders stayed the distance. Mistakes on shipping caused Texaco to retreat and Trammo to exit from LPG trading in the late 1990's. Other casualties over the years were Arab International, Avant, Enron, Norelf, and Stargas. But there were new entrants into the large-cargo LPG trading business as well; such as Dynegy, Ferrell (backed by Jim Ferrell of US Ferrellgas), Glencore, Petredec, and Vitol. The Enron fallout in 2002 resulted in other US corporations Aquila and El Paso closing their short-lived London trading offices and Dynegy Gas Liquids being sold to Ronald Stanton and the resurrected Trammo Gas. At the same time, ContiChem was bought by the Greek-based Swiss Marine.

Company turnover meant less change in trading personnel. Some simply moved on. The demise of Louis Nielsen's Trammo Gas prompted a similar migration to what had happened at Gazocean fifteen years earlier; Deacon Shorr and Jim Oakes went to Ferrell; John Cugley to Dynegy, and Nils Breivik to Statoil. Others in the industry stayed put; Olry Desazars at Geogas, Andreas Justesen at ContiChem, J.C Heard at Naftomar. The LPG trading community continued. They and their suppliers and buyers could be found at the various industry get-togethers, at the bi-annual Nice Seminars, at the Purvin & Gertz conferences in Houston and Singapore, and, more recently, with the

China market assuming greater importance, at the China LPG conference organized by GD Gas.[1]

Overall, the number of LPG trading companies did increase in the 1990's. The following is the approximate trader ranking, according to the same categorization as before.

LPG Traders

in 1991	**in 1996**	**in 2001**
ContiChem	Geogas	Naftomar
Trammo	ContiChem	Dynegy
Geogas	Naftomar	Geogas
Enron	Trammo	Ferrell
	Ferrell	ContiChem

The new entrants intensified competition, squeezing margins in the process. The successful traders needed distinctive strategies to survive. Some, like Naftomar, were "asset-heavy," building a system around inexpensive shipping. Others, like Ferrell, were "asset-light," reliant more on short-term trading acumen. Not surprisingly, Ferrell has been the main spot charterer of VLGC's in recent years. Glencore and Vitol represent a more recent phenomenon for LPG, multi-commodity traders.

[1] The Guangdong Gas Trade Association.

Incidents and Alarms

In the spot trading market, the LPG price swings over the course of a year can be dramatic, both in absolute terms and in relation to posted prices. In 1980, for instance, a turbulent year, the Middle East spot price ranged from a $70 per ton premium over the posted price to a $65 per ton discount. In 1997, another turbulent year, the price range was plus $25 to minus $45 per ton.

Positions taken in a smallish market can therefore have major repercussions, both positively and negatively. It has not been unknown for a trader to lose $2 million on a single cargo. The market itself has been intensely physical. A distressed cargo is indeed a distressed cargo. There were no hedging or other paper strategies available in the 1980's.

Some of the crisis situations that have affected the market - like the revolution in Iran in 1980 and the Iraqi invasion of Kuwait ten years later - have been common to the oil market in general. Others have affected LPG in a specific way.

The supply problems in 1983, for instance, stemmed from long crude oil markets. Saudi Aramco had adjusted downwards its own crude

production in an attempt to balance supply and demand. By February, output had slipped below four million barrels per day.

The relationship between crude and LPG was slow to be realized, but soon hit home. Many lifters in Saudi Arabia had their March LPG nominations rejected completely or curtailed sharply. The cutbacks continued in April and May and created a huge hole in the Japanese LPG import program.

An *adhoc* remedy was found. The supplier of last resort was the US Gulf Coast. But terminals there were not yet equipped with chillers to outload refrigerated product. The expedience that the industry discovered was to outload the LPG warm into semi-ref tankers, which would then shuttle to waiting large refrigerated ships sitting off the Cayman Islands. Here the product would be transhipped and then shipped onwards to Japan.

A number of quick-thinking traders got into the act. The shuttle cost was expensive, costing around $50 per ton, but some 250,000 tons of spot US Gulf LPG were able to be supplied to Japan during this critical period.[1] Those who acted too late got caught with expensive supplies

[1] The highest priced cargo from the US Gulf at this time arrived into Japan at a CIF import cost of $420 per ton.

on their hands. Import prices into Japan tumbled by $100 a ton as spot buying interest evaporated.

Crude marketing problems in 1986 had a different impact. Middle East producers liberated themselves from crude oil quota restrictions, thereby bringing down prices, but in the process releasing more LPG for export. Only Saudi Arabia had some capacity to store LPG. The other producers, when they came to tank tops, had to sell. The spot volumes started to become available in March and exceeded a million tons for the year as a whole.

A major share ended up on the US Gulf, most of the cargo arrivals being bunched in a four-month period between June and September. The strong demand for ships at the time doubled freight rates out of the Middle East and reduced the producers' netback price to less than $50 per ton FOB.

Two years later, it was Saudi Arabia with a surplus problem. Texaco loaded around 400,000 tons in June and July for the US Gulf on a market-related price formula. The policy was not very successful and was stopped in August. News of these cargoes had brought down the Mont Belvieu market and, with it, the FOB netback price.

War in the Middle East had its impact on LPG markets. On the morning of October 12 1984, the 40,000 cubic meter *Gaz Fountain* was stalked by Iranian aircraft in the Gulf and strafed with Maverick rockets. Three of these rockets hit the vessel directly.[1] There was another strike on an LPG vessel in May of 1987.

After the second attack, war risk premiums on vessels entering the northern Gulf escalated sharply. A number of Japanese vessels would not venture that far. Instead, they received cargoes from other vessels transhipped outside of the Straits of Hormuz. Kuwait was the most exposed during the crisis. Their four LPG ships were re-registered under the US flag and steamed out under US convoy protection.

In 1988, there were further attacks on LPG vessels in the Gulf before a ceasefire was agreed between Iran and Iraq, the two warring parties.

Iraq invaded Kuwait on August 2, 1990. Ten days later, the first LPG export cargo shipment from Iraq's 4 million ton per year plant at Khor-al-Zubair was due to take place. The vessel was already enroute. The loading did not occur of course. And the plant has remained inoperative since that time.

[1] The resulting explosion blew upwards the deck and tore open a hole in the butane sloping tank roof. The fire blazed for about an hour. The accommodation area was gutted. But the remaining two LPG tanks survived intact.

The invasion also shut down Kuwait's LPG production.[1] The loss of three million tons of exports tightened up the international market (although Saudi Arabia was to supply some make-up volumes) and resulted in spot shortages.

LPG prices soared. Spot LPG had sold at $70 per ton FOB in the Middle East in July. By February 1991, after the war had begun in earnest, this spot price had escalated to $350 per ton FOB. One small propane cargo was sold as high as $625 CIF in Europe. The winter was cold in Europe that year.

Spot freights also shot up. For a while, Japanese shipowners, under union pressure, would not let their vessels go into the Gulf. The Middle East to Japan spot rate for the Western ships which would load there hit $60 per ton. These vessels were being fixed on short-term charters at rates in excess of $2 million per month.

By March, however, this supply tightness was over and prices crashed. Traders then were busy cancelling the ship-charters that they had arranged for US Gulf LPG export cargoes.

Falling crude markets and the Asian financial crisis precipitated the price collapse of early 1998. In December 1997, spot Middle East LPG

[1] Kuwait LPG was not to return to the market until March 1992.

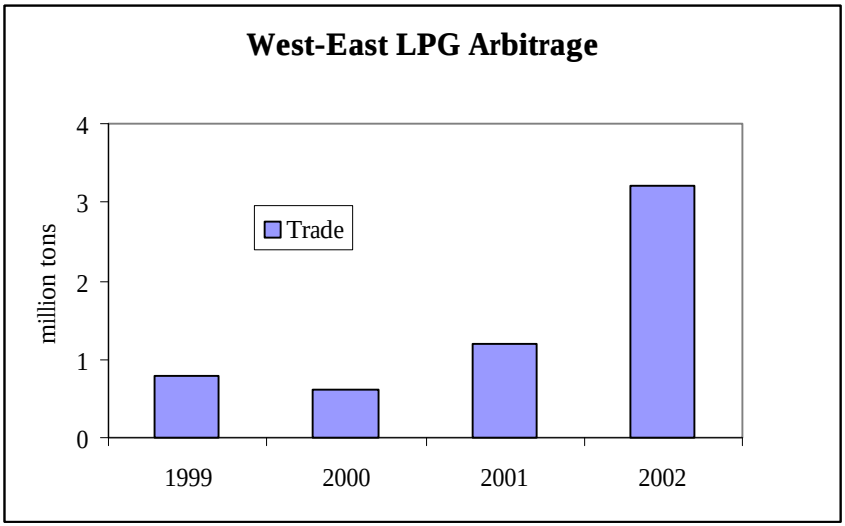
had sold at $240 per ton FOB. By late January of 1998, the price had crashed to $110 per ton FOB. Payments problems caused Korean buyers to suspended liftings on many of their contract volumes, leaving a surplus in producers' hands. These cargoes ended up on the spot market and helped bring down prices in Europe and then elsewhere.

This price collapse was particularly painful because it defied the traders' usual logic of rising LPG demand and prices in wintertime. Exactly how much the demand would be or how high the prices would go might be difficult to predict. But some sort of demand upswing and price surge was on the cards. Traders would plan and take forward positions on this basis. The unexpected turn of events in early 1998 turned these positions into losses.

Despite this crisis, Asia – and in particular China – remained the focus for spot LPG trade in the following years. It was the trader Ferrell which first capitalized on West-East arbitrage trade in 1999. They fixed six VLGC's out of Algeria for spot sales East during the summer window.

In 2002, this trade exceeded three million tons, with cargoes heading East from Algeria, Nigeria, the North Sea, Venezuela, and the US Gulf and West Coasts. The price discrepancy between Eastern and Western markets widened to such an extent that, in November, a North Sea

producer could, if he were able to assemble a VLGC cargo, make $40 per ton more by selling that cargo all the way to China than nearby to NW Europe.



The Gulf War, which started in March 2003, might have provided another kick-start to the arbitrage trade. The Japanese Shipowners' Association was again reluctant to send their ships through the straits of Hormuz. Their VLGC's did load at Ras Tanura, although not for a time at the northern Gulf ports. Traders instead bought the producer spot FOB tons that were available. But the market circumstances were quite different than in 1991. Winter demand had run its course and import prices were falling not rising.

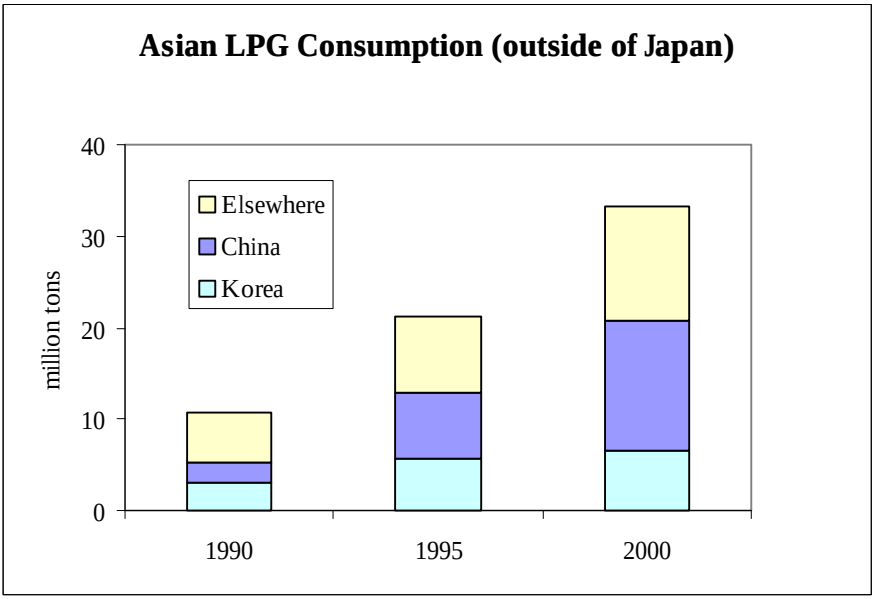
New Outlets East

The growth in LPG sales in Asia (outside of Japan) was one of the principal factors which kept international markets buoyant through most of the 1990's.

The oil majors had developed some small-scale LPG retail and bottling businesses in a number of countries during the 1960's and 1970's. Increasing urbanization and rising living standards brought about a demand for LPG which soon outstripped these existing distribution systems. Consumption growth in the region was particularly rapid in the 1990's. Usage in 1995 were almost double that of 1990. And 2000 was 60 percent above 1995.

LPG Consumption in Asia

million tons	1990	1995	2000
Korea	3.0	5.7	6.5
China	2.2	7.3	14.2
Taiwan	1.3	1.5	1.6
Philippines	0.4	0.7	1.0
Thailand	0.9	1.5	1.9
Malaysia	0.5	1.0	1.7
India	2.4	3.5	6.4
Total	10.7	21.2	33.3



Most of the LPG was supplied in cylinder form, displacing dirtier fuels, for cooking purposes. Piped gas from LPG tanks, pioneered in Hong Kong, spread to a number of Chinese cities.

In many countries, the growth outpaced local LPG supplies and required imports.

Korea was the first case. The Government there had done little to encourage LPG use until the 1980's. Any surplus refinery LPG was exported.

But the Government changed tack when a nationwide gasification program was introduced. Households were encouraged to switch from polluting coal-briquette stoves to LPG cylinders because of their greater cleanliness and ease of use.

The program proceeded slowly at first because of the restrictions on the number of retail outlets allowable, high selling prices and resulting payments problems. Nevertheless, by the end of 1981, there were 400,000 customers. This number grew quickly once the dealer restrictions were removed. LPG was used for cooking and, later with the spread of gas boilers, for space heating by some households as well. Demand soon outstripped the local refinery supplies available.

Korea applied the same organization and efficiency to LPG import development as had Japan. Fewer companies were involved, however. The Government licensed just two companies to build the LPG infrastructure and be the importers of record. These companies were Taesung Methanol and Yukong Gas.[1]

Term imports of LPG from Saudi Arabia commenced in 1982 through a VLGC stationed as floating storage off Yosu. Large cavern storage was completed later there and at Ulsan. The imported LPG was stored there or redistributed around Korea by coastal tankers.

[1] Now known as LG Caltex and SK Gas.

Photo: Coastal distribution in Korea.

By 1997, Korea was importing 4.5 million tons of LPG.[1] Each of the importers was taking over 2 million tons annually, giving them considerable clout in the international market. This has enabled them in recent years to diversify their sources of supply through swaps, exchanges, and spot purchases. Shipping was handled first through contracts of affreightment, and then through time-charters and owned tonnage.

China has been the other important new outlet. LPG imports were 50,000 tons in 1990 and 6.2 million tons in 2002. But development there proceeded in a very different way.

Early offshore suppliers to China were the Singapore refineries and Shell's break-bulk terminal at Tabangao in the Philippines. As the import market developed, traders put in floating storage vessels off the Chinese coastline to provide additional LPG under open credits. This could be risky. Getting paid was often a problem when Western concepts such as term obligations for supplies and demurrage costs for shipping were not readily understood.

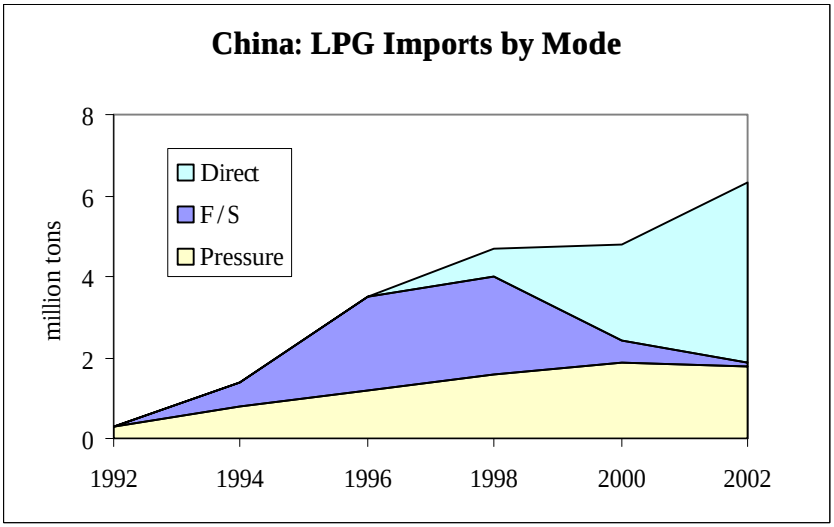
[1] By then, LPG had penetrated to 80 percent of all homes in Korea and was approaching saturation point. City gas had begun to take away sales. The gas grid, based on imported LNG, extended to most big cities.

Photos: LPG import storage in China; floating storage at Zhuhai (BP Zhuhai) and onshore storage at Zhangjiagang (ZOUEC).

The main concentration of these floating storage vessels was in and around the Pearl River Delta, supplying the special enterprise zones in Guangdong province. Another focus was further north, between Shanghai and the mouth of the Yangtze river. From these vessels, sourced from the Middle East and elsewhere, pressure vessels redistributed the LPG to the small terminals along China's coastline.

A logistical change occurred as large shoreside terminals in China started to get completed. The first of these, the BP Amoco joint venture project at Taicang on the Yangtze river received its first cargo in late 1997. The Marubeni-backed SinoBenny terminal at Shenzhen started up in mid 1998. Another eight were operational in 2002, by which time the floating storage vessels had all been displaced.

For a time, it seemed that too many import terminals might have been built. Tank turnovers for those in operation averaged only once every 50-55 days in 2000 and 2001. Competition from domestic producers was fierce, particularly in East China, and margins were squeezed. Some investors were looking to sell out. The year 2002, however, saw a significant improvement in throughputs for most of the large terminal operators.



Unlike Japan or Korea, the new terminal operators in China have been a mix of companies, Chinese and Western, Japanese, Taiwanese, and Hong Kong companies as well.

Some Chinese companies have been able to put into place well financed and successful LPG terminal projects, such as that of PetroChina Zhejiang Huadian on Xiaomen Island. The company is now seeking to duplicate that success at Panyu on the Pearl River Delta. Others Chinese companies have been less successful. A number of the small terminal and ship operators have suffered from the competition from the large LPG terminal operators; whilst there have been reports of individual entrepreneurs running into trouble because of suspected tax avoidance.

Overall, the company with the largest LPG import terminal capacity in China has turned out to be the Western oil company, BP.

China: Large LPG Receiving Terminals in 2002

Location	**Operator**	**Storage Capacity** (thousand tons)
East China		
Jiangsu		
Taicang	BP Huaneng	31
Zhangiajang	ZOUEC (Unocal/CITIC)	31
Shanghai		
Jinshan	Golden Conti	53
Zhejiang		
Ningbo	BP Ningbo	250 (cavern)
Wenzhou	PetroChina Zhejiang Huadian	46
Fujian		
Quanzhou	CPDC (Fujian/CPG)	31
South China		
Guangdong		
Shantou	Caltex Ocean	110 (cavern)
Shantou	Chaozhou Huafeng	40
Shenzhen	SinoBenny	90
Zhuhai	BP Zhuhai	40 (vessel)

As the Chinese LPG market has grown, it has also matured and become more price-transparent. A number of publications now report on market transactions and cover refinery, terminal, and import prices at various locations on a daily basis.

10. SHIPPING TRENDS

VLGC Fortunes

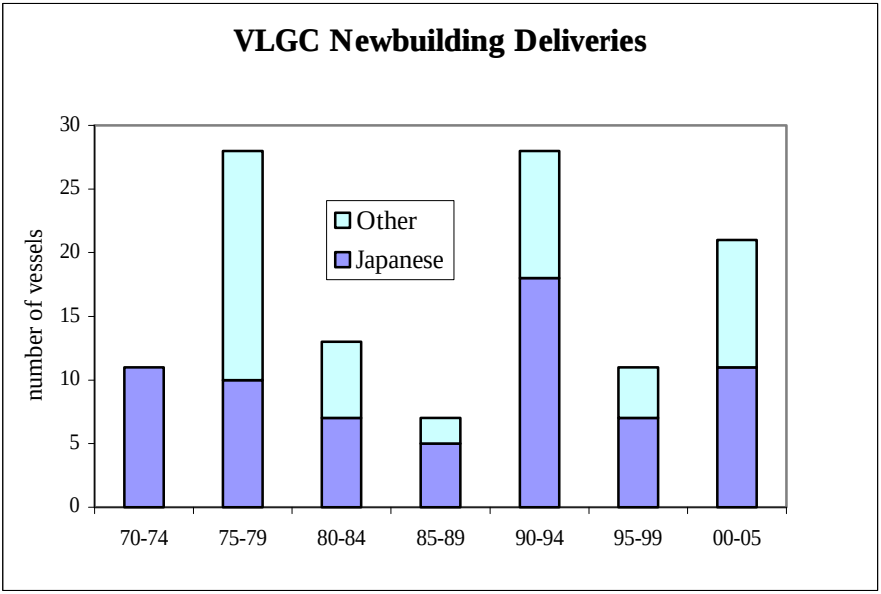
The close connection between LPG shipping and trading has continued since its earliest days. In the case of the long-haul trades from the Middle East and elsewhere, the relevant ship-size for trading has been the VLGC.[1]

This fleet has traditionally divided into two segments - that controlled by Japanese charterers and shipowners and dedicated to Japanese import trades and the rest operating under a variety of trades and ownerships.

The chart following shows that there have been three spates of VLGC newbuilding deliveries:

- one in the late 1970's
- a second in the early 1990's
- and a third, which commenced in the late 1990's.

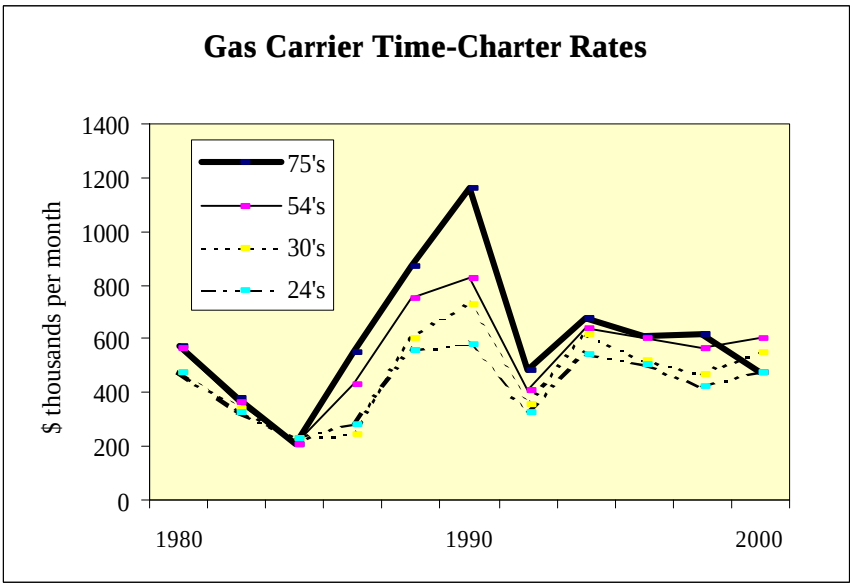
[1] Very large gas carrier. The typical carrying capacity ranges from 75,000 to 84,000 cubic meters, or 40-48,000 tons of LPG. LPG ship-sizes increased to this size in the 1970's. They have not increased much since that time. The vessels trade to many disports. Most of these have been built only with sufficient draft or storage capacity to accommodate a VLGC-load.



The two yards specializing in VLGC construction have been Mitsubishi (MHI) and Kawasaki (KHI) Heavy Industries in Japan, with competition from Korean yards. The competition has been sufficient that yard prices quoted in 2002 were not that much higher than what they had been twenty years earlier. The modern vessels are more fuel-efficient and recent innovations, such as KHI's Sea Arrow (sharp entrance angle bow), are expected to improve performance even more.

The ordering by Japanese shipowners has tended to be on a more consistent basis over time than that by other owners. These vessels, once delivered, have usually operated under long-term charters to Japanese importers at fixed rates which have been relatively immune

from fluctuations in the short-term market. And when these charters expire, a replacement vessel will be ordered.



As the chart above suggests, the revenue base for other owners, being market-related, has been more variable. This shows the trend in realizable short-term time-charter rates (in $ thousand per month) for the various segments of the refrigerated gas carrier fleet.

The VLGC fleet - which totalled 97 vessels at the end of 2000 - has led the market up and down over this period.

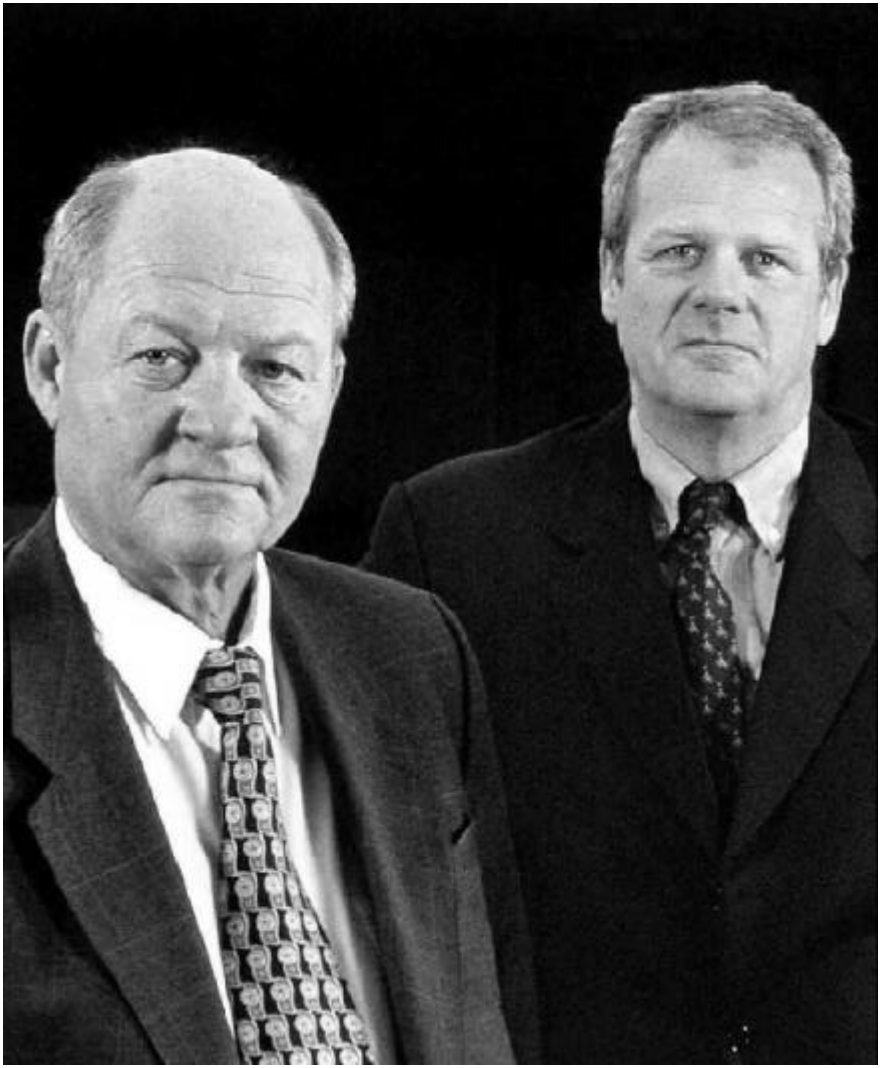


Photo: Petter Sundt and Morten Bergesen.

Shipowners who had invested in VLGC newbuildings in the late 1970's experienced a very difficult trading market in the early 1980's. Because of crude and LPG cutbacks in the Middle East, the supply of ships outpaced demand and market rates fell to lay-up breakeven levels. Few charterers were willing to fix forward. Most preferred to simply take advantage of the pool of spot ships that were available.

Starting in 1978, a number of shipowners - among them Fearnley and Eger, Leif Hoegh, Gotaas Larsen, Northern Liquid Fuels, and (in the 50's class) P&O – who had bet on this market, decided to sell out.

It was the Norwegian shipowner, Sig. Bergesen, who acquired their ships and, together with the company's own newbuilding program, became the leading shipowner and operator in this segment of the fleet. Sigval Bergesen, the founder of the company, had by then retired and had handed over management to his two grandchildren, Morten Bergesen and Petter Sundt, who oversaw the subsequent fleet expansion. In LPG, by the end of 2001, Bergesen was operating in its pool almost half of the 70 non-Japanese VLGC vessels trading.

Bergesen initially followed the conservative tanker chartering policies – the policies which had helped the company through the shipping crises of the 1970's - in their LPG chartering. Vessels were normally fixed

forward under one-to-two year time charters. Karl Sten-Hagen found takers as chartering interest began to revive.

Traders who took forward positions on these ships in the rising shipping market of the late 1980's and early 1990's were able to realize significant shipping profits. Short-term rates surged during the period of the Iraqi invasion of Kuwait and the resulting Gulf War. Bergesen would allow his vessels into the Straits of Hormuz while others would not.

The rewards for charterers in the flatter shipping market post-1992 have been more mixed. The late-1990's saw two generations of VLGC's trading - the older 1970's generation and the newer more fuel-efficient[1] 1990's models. An age rate differential opened up. Some oil companies would only consider chartering vessels within a certain age range.

Employment prospects for the older vessels might have been bleak had it not been for the trader-initiated move into break-bulk floating storage operations off China. During 1998, as many as eight VLGC's were being deployed at one time to supply this booming import market. The lead company in this activity was the Mediterranean-based

[1] A modern 78,000 cubic meter vessel would consume 40-50 tons per day of bunkers while at sea, as against 65-70 tons per day for older vessels.

trader, Naftomar. Through an acquisition program of older tonnage, the company had built up a fleet of nine VLGC's, many of them at the time stationed as floating storage off China.

That market, however, disappeared in 1999 and, with newbuildings being added to the trading fleet, there was potentially a large overhang of unchartered VLGC ships. Would rates crash again?

Bergesen, with the participation of some other owners and charterers, notably Mitsubishi and Dynegy, formed a pool to try to manage the surplus. The pool established a uniform fixing rate for spot charters,[1] even though there were idle vessels, mainly in the Bergesen pool, on the water. Average idle time for the pool was 25-30 percent over 2000. Nevertheless pool fixing rates were maintained.

Some luck came at the end of the year. An alternative market appeared, that for transporting clean petroleum products such as naphtha. Normally, these are much lower-paying cargoes. But a combination of factors caused rates in this sector to skyrocket.[2]

[1] Initially, $40 per ton for the marker Middle East to Japan trade.

[2] They hit Worldscale 400 in January 2001, equivalent to $60 per ton for the marker AG-Japan LPG trade. The contributing factors were mainly short-term and did not last that long.

Suddenly, Bergesen had spot-chartered ten of its vessels in this trade and the vessel length had disappeared.

That luck ran out in 2001. Rates in the clean market fell back while spot demand for LPG cargoes proved very weak. Vessels outside of the Bergesen pool were being fixed at rates AG-Japan down to $15 per ton, which was setting the market rate. By year-end, Bergesen had to abandon its pool fixing levels and follow the market.

The low rates obtainable over much of 2002 did have one salutary effect. It persuaded owners to start scrapping their older VLGC's that were now approaching thirty years of service. Six were scrapped over the year. This and the developing West-East arbitrage trade, with its longer steaming distances, provided Jens Ismar and his team at Bergesen with some grounds for future optimism.

Initially, the Gulf War, which broke out in March 2003, was of more benefit to the VLGC's that traded in clean than in LPG. But, as in 1991, the Japanese Shipowners' Association was reluctant to send their VLGC's through the straits of Hormuz. Their ships did load at Ras Tanura, but not in the early going at the northern ports. And, as in 1991, Bergesen vessels would and did load there.

The VLGC trading fleet has always had a relatively enviable safety record. Serious incidents have been few over the years. But, on the morning of November 24 2002, a fire broke out in the engine room on the *Gaz Poem*, carrying a part-cargo of LPG in Chinese territorial waters and could not be controlled. The 34 crew members had to abandon ship. The fire burned for four days before it was eventually extinguished. Fortunately, the vessel was stationed 38 kilometers offshore, a sufficient distance not to endanger the shoreside population.

The prevailing winds did appear to keep the flames away from the cargo area. The tanks remained intact and the stricken ship was eventually able to transship its cargo.

Photos: VLGC's – the *Djanet* (trading for Sonatrach) and the *Gaz Poem* (pictured after an engine-room fire).

And Other Ship Sizes

History and trade routes determined that the LPG shipments East would be dominated by the VLGC-sized vessel. Not much LPG moves in that market between the 40-45,000 ton VLGC lot-sizes and the 2-4,000 ton pressure cargo trades for regional distribution.

The European experience, however, has been different. LPG shipping grew up with a mix of trade routes and a trading interest in other cargoes, such as ammonia and the various chemical gases, which also require refrigerated or pressurized transportation.[1] European owners built and operated LPG vessels in a variety of ship sizes and for a variety of different employments. As of 2002, their fleet included:

- 76 mid-sized fully-refrigerated vessels (between 20 and 60,000 cubic meters in size)
- 57 semi-refrigerated vessels (over 10,000 cubic meters in size)
- and 20 specialized ethylene carriers (over 10,000 cubic meters in size)

as well as smaller pressurized carriers in various ship-sizes.

[1] The Americans, by contrast, although they may trade, finance, and charter LPG ships, have rarely been owners and operators.

Photos: Semi-ref and ethylene ships
– the *Maersk Holyhead* and the *Igloo Tor*.

Many owners invested in this segment of the business. But difficult trading conditions for single vessel operators meant a concentration over time of fleet control - through ownership, charters-in and pooling arrangements - with a few ship operators. In part, these measures were defensive, to maintain revenues during periods of slack demand and vessel overcapacity. In part, they also reflected a desire by the leading operators to expand their service through contracts of affreightment as well as the more traditional term and spot vessel charters.

To help their cause, each company pool has concentrated in a particular vessel size. Thus the Bergesen pool accounts for 80 percent of the 50-60,000 cubic meter fleet, the Exmar pool 35 percent of the 20-40,000 cubic meter fleet. A. P. Moller consolidated their position in the semi-ref market with the formation of the Scandigas pool in 1999.

The small pressure LPG fleet (under 5,000 cubic meters in size) totals some 600 and is active in coastal and short-haul international trades in three main geographic areas, Europe, Japan and China coastal and SE Asia, and the Caribbean. Because of the size of the fleet and the regional focus of the trade, the degree of fleet concentration is not so apparent as in the other sectors.

11. A SPECIAL INDUSTRY?

“The world of LPG, in which I have lived this past 40 years, is a very special world, resting as it does on the human dimension; whilst many of the other activities of this modern world have grown so colossal and even beyond an individual’s comprehension.”

La Joie d’Entreprendre
Rene Boudet

A Special Industry?

Many of those who have worked in the international LPG industry consider it to be a special industry. The reasons may be difficult to find. But the feelings are there.

Part of this relates to the product itself. A byproduct of the oil and gas industry, it has appeared at times to be something of an unwanted child. The "wild" light ends, as the early pioneers called it. A specialty product, just two percent of the barrel, were the dismissive terms used by some refiners when faced with the problem of marketing the stream.

Major oil companies did not develop the industry. Instead, the early technical and commercial challenges presented by LPG were met by a few enterprising individuals. Andrew Kerr in West Virginia. Frank Phillips and W. K. Warren in Oklahoma. Ernesto Igel in Rio de Janeiro. Rene Boudet in France. Mikael Gronner in Norway. And Michio Doi with Bridgestone Liquefied Gas in Japan.

International trading began with Mundogas and Gazocean, the companies who had pioneered the early technological developments in LPG ships. Neither of these companies survived. But these companies did nurture a set of talented individuals who went on to

form the nucleus of a small but now more widely dispersed LPG trading fraternity. Information on tenders, deals, and market gossip would pass through this closely connected network of buyers and sellers, traders, brokers, and shipowners.

Between 1980 and 2000, international trade in LPG grew from 17 to 48 million tons. There were now many more players in the business and some of the early selectness had gone. Information was much more widely available from a variety of outside sources. Yet LPG, with its specialized shipping and storage requirements, still had the semblance of a distinct trading community.

Some have argued that LPG has no particular specialness; as a commodity it can be bought and sold just like anything else. Merchant traders in the US saw it as an interesting but small adjunct to their gas and power trading business. The physical infrastructure of the LPG industry, the plants, terminals, pipelines, ships, and inland distribution systems, could be taken for granted. What was more important was the evolving electronic trading infrastructure, whereby LPG could be bought or sold or hedged against any other traded commodity.

For the time being, that view has had to take a back seat. The Enron debacle put paid to that. What might emerge in the future will need a very different model upon which to develop.

In these more risk-averse times, traders will still play a role to, as Jacques Boudet expressed it, “balance risk with service” - whether they be short-term or long-term minded, shipping focused, paper traders, or just plain gamblers. For some, LPG trading still retains a mystique. When asked to explain LPG trading by Purvin & Gertz for their Houston conference, J. C. Heard preferred to show his holiday snaps instead.

Meanwhile, the physical challenges of the LPG industry go on. Oil and gas development will mean more LPG to sell. Traded volumes will probably be in excess of 65 million tons by 2010. Where will this incremental LPG go?

LPG has always been appreciated as a clean portable fuel. As long as piped gas is not available and there is an aspiring middle class somewhere in the world, then the LPG will be needed. Over time, the geographic arena for demand has kept shifting. First it was America. Then Brazil. Then Europe, Japan, and Korea. Today it is China. Tomorrow it may be somewhere or something else. Auto-fuel perhaps? Or new petrochemical applications?

Gas marketing has tended to be the prerogative of the big boys, those with the funds to invest in new gas grids and gas-for-power projects. LPG, by contrast, has offered and will continue to offer scope for

individual entrepreneurs, those with smarts or cunning who can see market opportunities. These opportunities stretch from sizeable projects to even the smallest of operations, as the recent news clipping from Nepal attests.

> "Although the Government has made it compulsory for LPG-operated vehicles to install original gas tanks, more than fifty three-wheelers in Birganj are using subsidized cooking gas cylinders - due to the lack of refuelling stations outside of Kathmandu."

Will the opportunities lie in new geographic areas such as India, the Black Sea, or Africa? Or in a new trading platform? Or in new technology such as power cells?

History has shown that some will fail. Some may succeed for a time and then fail. And some may build enduring businesses.

STATISTICAL APPENDIX

LPG Consumption in Selected Countries

	1950	1960	1970	1980	1990	2000
million tons						
United States	6.0	21.0	37.4	36.9	41.1	51.1
Brazil	0.1	0.6	1.3	2.4	4.7	7.0
Europe	0.3	3.3	11.5	18.2	25.3	31.2
Japan	-	0.4	6.4	13.9	19.0	19.1
Korea	-	-	-	0.4	3.0	6.6
China	-	-	-	0.2	2.2	13.4
thousand bbls/day						
United States	200	680	1,220	1,200	1,340	1,670
Brazil	5	20	40	70	150	220
Europe	10	100	360	570	730	970
Japan	-	10	210	450	620	620
Korea	-	-	-	10	100	220
China	-	-	-	5	70	420

LPG Seaborne Exports

million tons	1960	1970	1980	1990	2000
Middle East					
Saudi Arabia	-	1.5	7.9	12.3	12.6
Elsewhere	-	0.8	3.1	6.8	11.0
Asia/Pacific	-	0.5	2.1	4.0	4.4
Africa					
Algeria	-	0.1	0.3	3.5	7.2
Elsewhere	-	0.2	0.1	0.1	2.0
Europe					
North Sea	-	-	1.3	3.8	6.7
Elsewhere	0.2	0.3	0.5	0.8	0.4
North America					
USA	0.1	-	0.2	0.2	1.2
Canada	-	0.2	-	-	-
South America					
Venezuela	0.2	0.7	0.8	0.6	1.4
Elsewhere	-	0.1	0.7	1.2	0.9
Total	**0.5**	**4.4**	**17.0**	**33.3**	**47.8**

LPG Seaborne Trade East

million tons	1960	1970	1980	1990	2000
from					
Middle East	-	2.3	11.0	19.1	23.6
Asia/Pacific	-	0.5	2.1	4.1	4.4
West (net exports)	-	0.2	-	-	-
Total	**-**	**3.0**	**13.1**	**23.2**	**28.0**
to					
Japan	-	2.9	10.0	14.5	14.8
Korea	-	-	0.1	2.1	4.7
China	-	-	-	-	4.8
Elsewhere East	-	0.1	0.4	2.2	1.8
West (net imports)	-	-	2.6	4.4	1.9
Total	**-**	**3.0**	**13.1**	**23.2**	**28.0**

LPG Seaborne Trade West

million tons	1960	1970	1980	1990	2000
from					
Middle East	-	-	2.6	4.4	1.9
Africa	-	0.1	0.4	3.6	9.1
Europe	0.2	0.3	1.8	4.6	7.2
Americas	0.3	1.0	1.7	1.9	3.5
Total	**0.5**	**1.4**	**6.5**	**14.5**	**21.7**
to					
Europe	0.2	0.4	4.7	10.1	14.8
USA	-	0.3	1.4	2.6	1.2
South America	0.3	0.5	0.4	1.8	5.7
East (net imports)	-	0.2	-	-	-
Total	**0.5**	**1.4**	**6.5**	**14.5**	**21.7**

Leading LPG Seaborne Exporters and Importers in 1980

Company	Country	Volume
Exporters		
(million tons)		
1. Petromin	Saudi Arabia	7.9
2. KPC	Kuwait	2.1
3. BHP	Australia	0.7
4. Esso	Australia	0.7
5. Pemex	Mexico	0.7
6. ADGAS	Abu Dhabi	0.6
7. Corpoven	Venezuela	0.4
8. Phillips	UK	0.4
9. Pertamina	Indonesia	0.4
10. Sonatrach	Algeria	0.3
Importers		
(million tons)		
1. Butano	Spain	1.3
2. Nippon Petroleum	Japan	0.9
3. Idemitsu	Japan	0.9
4. Mitsui LG	Japan	0.8
5. Noretyl	Norway	0.7
6. TEPCO	Japan	0.7
7. Dow Chemical	Netherlands	0.6
8. Mitsubishi	Japan	0.5
9. Esso Sekiyu	Japan	0.5
10. Marubeni	Japan	0.5

Leading LPG Seaborne Exporters and Importers in 2000

Company	Country	Volume
Exporters		
(million tons)		
1. Saudi Aramco	Saudi Arabia	12.6
2. Sonatrach	Algeria	6.2
3. ADNOC	Abu Dhabi	3.5
4. KPC	Kuwait	2.8
5. Statoil	Norway	1.6
6. ADGAS	Abu Dhabi	1.5
7. PDVSA	Venezuela	1.4
8. Pertamina	Indonesia	1.3
9. PCC	Iran	1.2
10. QP	Qatar	1.0
Importers		
(million tons)		
1. TUPRAS	Turkey	3.0
2. Petrobras	Brazil	2.4
3. SK Gas	Korea	2.3
4. Idemitsu	Japan	2.3
5. LG Caltex	Korea	2.2
6. Nippon Petroleum	Japan	2.0
7. Pemex (PMI)	Mexico	1.6
8. Cosmo	Japan	1.5
9. Mitsui (MOGC)	Japan	1.3
10. Mitsubishi	Japan	1.2

Leading LPG Producers and Marketers in 1980

Company	Country	Volume	
Producers			
(000 b/d and million tons)			
1. Aramco	Saudi Arabia	260	8.1
2. Pemex	Mexico	110	3.4
3. Warren Petroleum	USA	100	3.1
4. Phillips	USA	70	2.3
5. KPC	Kuwait	70	2.2
6. Shell Oil	USA	60	1.9
7. Dome Petroleum	Canada	50	1.7
8. BHP/Esso	Australia	50	1.6
9. Koch	USA	40	1.3
10. Cities Service	USA	40	1.2
Marketers			
(000 b/d and million tons)			
1. Butano	Spain	80	2.3
2. Petrolane	USA	50	1.6
3. Iwatani	Japan	50	1.5
4. Shell	UK/Neth	40	1.3
5. Suburban Propane	USA	40	1.2
6. AGIP	Italy	40	1.1
7. Calor	UK	30	0.8
8. Ferrellgas	USA	20	0.7
9. BP	UK	20	0.7
10. Totalgaz	France	20	0.6

Leading LPG Producers and Marketers in 2000

Company	Country	Volume	
Producers			
(000 b/d and million tons)			
1. Saudi Aramco	Saudi Arabia	530	16.5
2. Sonatrach	Algeria	230	7.2
3. Pemex	Mexico	220	7.0
4. Duke Energy	USA	200	6.2
5. Koch	USA	170	5.4
6. Enterprise	USA	170	5.2
7. PDVSA	Venezuela	140	4.5
8. BP Amoco	Canada	120	3.8
9. ADNOC	Abu Dhabi	110	3.5
10. Williams	USA	110	3.5
Marketers			
(000 b/d and million tons)			
1. SHV/Primagaz	Neth/France	200	6.0
2. Shell	UK/Neth	130	4.1
3. Repsol YPF	Spain	120	3.6
4. Iwatani	Japan	100	3.0
5. Indian Oil (IOC)	India	100	3.0
6. Totalgaz	France	70	2.5
7. AmeriGas/UGI	USA	70	2.4
8. Zeta Group	Mexico	70	2.3
9. Ferrellgas	USA	70	2.0
10. AGIP	Italy	70	2.0

LPG Shipping Fleet in 1965

Vessel	Owner	Size (000 dwt)	Type
Gohshu Maru General	Kaiun	46.2	crude/LPG*
Esso Puerto Rico	Esso	32.9	crude/LPG
Bridgestone Maru	Bridgestone/NYK	25.6	refrig. LPG
Bridgestone Maru II	Bridgestone/NYK	25.0	refrig. LPG
Toyosu Maru	Tokyo LPG	23.0	crude/LPG*
Nisseki Maru	Nippon Pet. Gas	22.9	crude/LPG*
Paul Endacott	Phillips Petroleum	22.1	refrig. ammonia
Iridina	Shell Francaise	18.0	pressure*
William R. Grace	Oswego Chemical	9.8	refrig. ammonia
Joseph R. Grace	Oswego Chemical	9.8	refrig. ammonia
Mundogas Brasilia	Oivind Lorentzen	8.5	pressure
Mundogas SaoPaulo	Oivind Lorentzen	7.2	pressure*
Mundogas Norte	Oivind Lorentzen	5.5	pressure*
Mundogas Oueste	Oivind Lorentzen	5.3	pressure*
Lavoisier	Gazocean	5.1	pressure
Nordfonn	Bergesen	4.7	pressure
Sydfonn	Bergesen	4.2	pressure
Texaco Cristobal	Texaco Panama	4.1	crude/LPG*
Petrobras Oeste	Petrobras	2.7	pressure
Petrobras Nordeste	Petrobras	2.7	pressure
Petrobras Sudoeste	Petrobras	2.7	pressure
Uranus	CFP/Total	2.6	pressure
Kegums	USSR	2.6	pressure
Kraslava	USSR	2.6	pressure
Fred H. Billups	Marine Carib.Lines	2.2	pressure

Fleet shown above are all vessels of 2,200 dwt size and above at that time.

* Tanker or dry cargo ship subsequently converted for LPG (or partial LPG) carriage.

LPG Shipping Fleet Development

# of vessels	1965	1970	1980	1990	2000
Fully-ref Carriers					
VLGC (60+) *	-	3	47	59	97
40-60 *	1	6	19	19	22
20-40 *	2	10	30	33	48
10-20 *	6	14	14	12	7
Semi-ref Carriers					
10-20 *	-	10	27	40	64
Ethylene Carriers					
10-20 *	-	-	2	7	20

* Carrying capacity (in thousand cubic meters).

Modern Gas Carriers

Type	**Pressure**	**Semi-ref**	**Fully-ref**
Vessel Name	*Gas Tabangao*	*Hans Maersk*	*Berge Clipper*
Carrying Capacity			
in cubic meters	3,500	20,500	78,500
in tons (LPG)	2,100	12,000	45,700
Dimensions (in meters)			
LOA	95	160	224
Beam	16.6	25.6	36.0
Draft	4.5	8.9	11.2
Max. Pressure			
in kg/scm.	18	6.5	0.3
Cargo Tanks/Handling			
Tanks	2	4	4
Pumps	2	10	10
Compressors	2	3	4
Reliquefaction units	-	3	4
Performance			
Speed (knots)	13	18.5	16.8
Bunkers (tons/day)	10	50	49.5

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INDEX OF PEOPLE

INDEX OF COMPANIES

Many companies have changed their names over the period of this history. Those companies which have changed their names are shown below with their current names first and their former names following. Companies that have subsequently been acquired or are now part of other companies are identified wherever possible.