

The Emerging Oil Refinery Capacity Crunch

A GLOBAL CLEAN PRODUCTS OUTLOOK

Summer 2005



ICF
CONSULTING

9300 Lee Highway
Fairfax, VA 22031
icfconsulting.com
info@icfconsulting.com

Table of Contents

Introduction.....	1
Demand for Petroleum Products.....	2-3
Supply of Petroleum Products.....	4
Refining Capacity.....	4-5
Effect of Product Specifications.....	6-7
Capacity Crunch.....	7
Infrastructure Needs.....	8
Conclusions.....	8-9
About ICF Consulting.....	9
Contact Information.....	9

Introduction

The national debate in the United States around energy has attracted widespread public attention. This focus is driven by the sustained high gasoline prices which affect all drivers and which increasingly the Public believes are here to stay. High gasoline prices are not the only issue. Increased diesel and heating oil prices are also impacting businesses and consumers. The ‘problem’ fundamentally comes down to supply and demand, except that the supply and demand involved is a global concern, not just a domestic phenomenon. There is really nothing terribly brilliant in that conclusion, but there is a concern that the world, and the United States, are well on a path that may be very difficult to correct.

In large measure the high level of energy prices today has been driven by concerns about the availability of spare crude oil production capacity to meet growing global demands for oil products, and the potential for supply disruptions in crude production. However, ICF Consulting believes that in the past year, and over the next roughly 5-year period, that the ability to meet forecast demands for oil will be driven by refinery capacity issues, not crude availability.

This paper analyzes trends in global product demands and refinery capacity, and highlights how the refining ‘spare capacity’ has eroded, in particular in the last few years. It identifies the potential need for additional capacity to meet projected global demands, and draws conclusions on the global outlook to meet those demands with expanded refinery investment.

The growth in global demand for gasoline and diesel, and the regulatory actions that are requiring lower and lower sulfur content in these products, is creating a mismatch between the demand for clean products and the availability of refining capacity to produce the products from available crude oils. This ‘capacity crunch’ will change the historical playing field for international crude and product supply and trade, and create strong and sustained margins for refiners, higher prices and potentially supply shortfalls for consumers.

Let’s start with some perspective:

Demand for Petroleum Products

Demand for petroleum products is inexorably increasing particularly in the larger developing countries such as India, China, and Brazil. Much of this demand is centered around gasoline and distillates as these countries industrialize and as the wealth effect sees a growing middle class with demands for personal transportation. Concurrently U.S. demand for products has also increased and, unchecked by government policy and regulations, is expected to keep rising.

Combined with the growth in demand is a shift in the global product demand profile towards lighter products. Demand for gasoline and middle-distillates is growing, whereas that for heavier fuel oils is declining. Exhibit 1 shows the petroleum consumption profile for the world excluding the Former Soviet Union (FSU). Exhibit 2 shows the growth rates in refined product consumption with the final column showing the annualized growth rate over the last 25 years.

The growth in demand for light products such as gasoline and diesel has been matched by the growth in concern over mobile source emissions and their effects on the environment and public health. The last five years has seen increasingly stringent environmental restrictions on product specifications, particularly the sulfur content. The drive towards ever lower sulfur content in gasoline and diesels has spread from the United States, Canada, and the European Union to Japan and other countries of the Asia Pacific region. Lower sulfur fuel oil also appears to be on the horizon for the bunker fuel market in Europe and possibly in the United States.

**Exhibit 1: World Petroleum Products Consumption (ex FSU)
(Thousand bbl/d)**

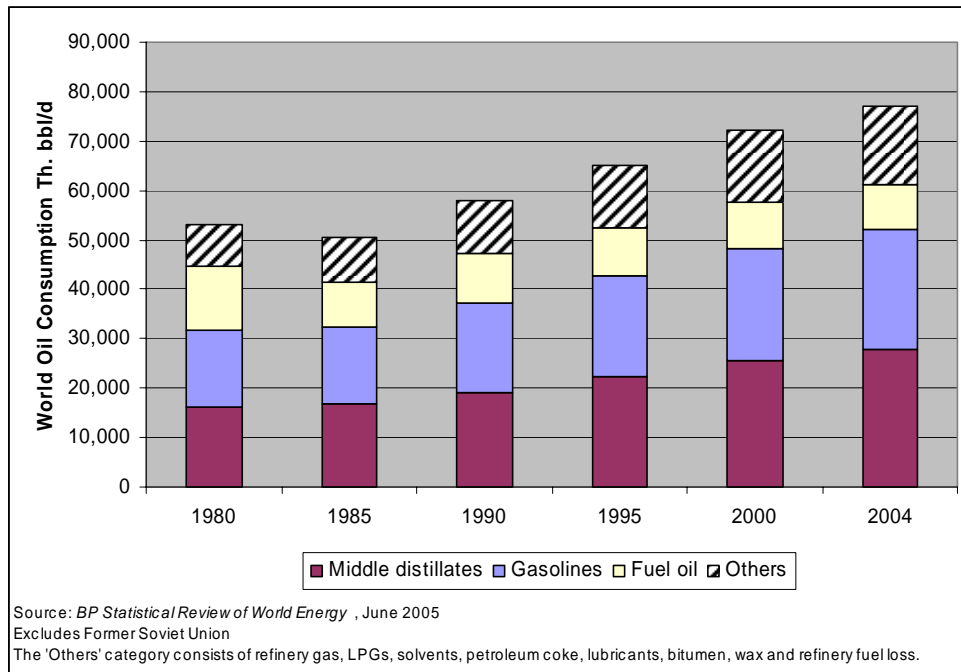


Exhibit 2: Average Annual Growth Rates in World Refined Product Consumption (ex FSU)

Product	1981-1985	1986-1990	1991-1995	1996-2000	2001-2004	1980-2004
Gasolines	0.3%	2.9%	2.2%	2.3%	1.8%	1.9%
Middle distillates	0.5%	2.8%	3.2%	2.6%	2.1%	2.2%
Fuel oil	-6.7%	1.7%	-0.3%	-0.6%	-1.2%	-1.4%
Others	1.5%	3.0%	3.3%	3.0%	2.7%	2.7%
Total Oil	-1.0%	2.7%	2.3%	2.1%	1.7%	1.6%

Source: BP, Statistical Review of World Energy June 2005

The United States is the world’s largest consumer of gasoline, consuming nearly 40 percent of the world’s total gasoline in 2004. Distillates on the other hand are more evenly distributed throughout the world, with the United States consuming 22 percent of the world’s distillate in 2004. Although the volume of distillates consumed in the United States is less than gasoline, it is growing at a faster rate. The growth is particularly strong in low-sulfur diesel used primarily for on-road highway transportation. While the increase in total oil consumption in the 2001-2004 timeframe is 1.7 percent, the increase in gasoline and distillate on an absolute volume basis represents a growth of 3,748 thousand barrels per day. Exhibit 3 shows the consumption and growth rates of gasoline and distillates in the United States, which indicates a growth of about 925 thousand barrels per day clean products (gasoline and distillate) from 2001 to 2004.

Exhibit 3: Refined Product Consumption and Growth Rates in the U.S. from 2000 to 2004 (M bbl/d)

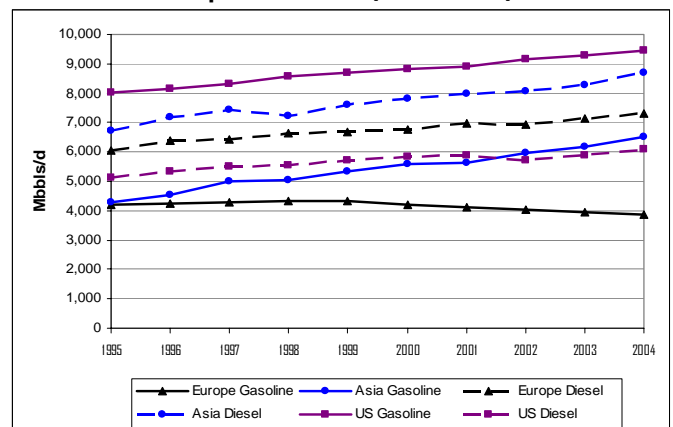
Year	Motor Gasoline	Jet Fuel	Distillate Fuel		
			Total Distillate	< 500 PPM	>500 PPM
2000	8,472	1,725	3,722	2,553	1,169
2001	8,607	1,656	3,848	2,677	1,171
2002	8,846	1,613	3,775	2,663	1,113
2003	8,932	1,578	3,930	2,802	1,128
2004	9,061	1,617	4,059	2,989	1,071
Annual Growth Rate	1.7%	-1.6%	2.2%	4.1%	-2.1%

Source: Energy Information Administration, 2005

While gasoline demand in the United States is growing, in Europe it has actually declined since 2000 (See Exhibit 4). Europe is showing increasing preference for diesel as its automotive fuel and is moving away from gasoline. Currently diesel powered vehicles constitute the bulk of the new cars being sold in Europe. Consequently, gasoline demand in Europe has declined at an average 2.1 percent per year since 2000 and the diesel demand has increased by 2.0 percent. The decline in European demand for gasoline can be a boon for the United States as it makes more gasoline supplies available on the world market. However, the developing economies of the world (including Asian countries like India and China) are showing a strong demand for gasoline. With the recent strides in economic growth in the Asian countries and increased wealth among the population, there is a growing demand for cars—resulting in a 3.9 percent increase in demand for gasoline since 2000. Moreover, the penetration of car ownership is a magnitude or two lower than in the United States giving ample opportunity for growth.

On the other hand, the increasing demand for diesel in the European Union means that there is intense competition for this fuel on the world market. In the short term additional increased demand for diesel from the Asian developing countries imposes further strains. This latter demand is expected to ease when these countries resolve the bottlenecks affecting coal distribution to electric generating plants and large numbers of back-up diesel generators are no longer needed. In Asia, diesel demand has grown at the rate of 2.7 percent since 2000. The gasoline and diesel demand growth rates in Asia are much higher than the overall world average growth rates shown in Exhibit 2.

Exhibit 4: Gasoline and Diesel Demand Trends in the U.S., Europe, and Asia (1995-2004)



Source: BP, *Statistical Review of World Energy* June 2005

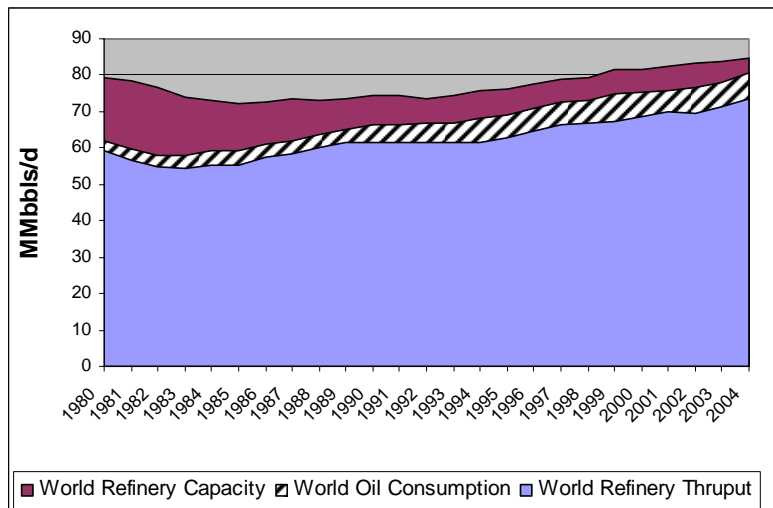
Supply of Petroleum Products

On a macro level petroleum product supply depends on the availability of crude oil and refining capacity. More specifically, adequate supplies of clean products depend on the optimal alignment of types of crude oils and refinery complexity.

Refining Capacity

Historically refining has been the low margin sector of the petroleum industry. Investment in refining, particularly upgrading existing simple refineries, has been conservative, especially so outside the United States. Exhibit 5 shows historic global capacity and throughput from 1980 to 2004. The key takeaway from this chart is that the 1980's and early 1990's resulted in the reduction of surplus global refinery capacity. This trend has been reversed since the mid 1990's, with recent years showing some net capacity growth to keep pace with higher demands (primarily capacity 'creep'). The question of the hour is, however, can capacity continue to keep pace with demands, even as more and more pressure is placed on refiners to meet lower sulfur specifications worldwide?

Exhibit 5 – World Refinery Capacity, Throughput and Oil Consumption (Million bbl/d)



Source: BP, *Statistical Review of World Energy* June 2005

ICF Consulting has examined recent global demand forecast data from the International Energy Agency (IEA) from 2000 through 2020 (see Exhibit 6), and compared it to the current and estimated growth in refining capacity. During the period from 1990-2000, when the refining margins were less volatile and relatively low as compared to the period after 2000, the global refining capacity was on average 9 percent more than the global oil demand. Since 2000, this percentage has dropped to as low as 3 percent above global oil demand in 2004. The IEA estimates that the global oil demand in 2010 will be about 90 million barrels per day, an increase of nearly 8 million barrels per day over the 2004 number. This increase is about 30-40 world scale refineries, and the net impact on the marketplace, even if that much refinery capacity could be made operational by 2010, would simply be maintaining today's high margins and volatility.

For the refining capacity to keep pace with this increase and also maintain the 9 percent surplus capacity over demand that occurred in 1990-2000, it would need an additional 13.9 million barrels per day capacity to be built between now and 2010. This would be 50-70 refineries of world scale size.

According to the 2005 Oil & Gas Journal Worldwide Refining survey and Construction reports, the total new worldwide atmospheric crude distillation capacity under construction or engineering is about 250,000 bbls/d. Since that publication, there have been some noteworthy announcements, including a large Saudi export refinery in Yanbu and other Saudi expansions, an ExxonMobil GTL facility and Condensate refinery in Qatar, and some China capacity. However, even with these announcements, *it is clear that the number of new refineries needed, or major expansions, is significant, and, more critically, these additions should, right now, already be in the engineering phase to be operational by 2010.* While some of that demand growth before 2010 may be met by capacity creep, and some could be met by upgrading existing refineries with lower current utilizations, the need for timely investment in capacity to sustain the demand outlook is compelling.

Exhibit 6: Global Oil Demand and Refining Capacity (M bbl/d)

	1990	1995	2000	2001	2002	2003	2004	2010*	2020*
Global Oil Demand	66,200	70,000	76,600	77,300	77,900	79,400	82,300	90,400	106,700
World Refining Capacity	74,532	76,509	81,961	82,840	83,562	83,930	84,592	98,536	116,303
Incremental Oil Demand		3,800	6,600	700	600	1,500	2,900	8,100	16,300
Incremental Refining Capacity		1,977	5,452	879	722	368	662	13,944	17,767
Refining Capacity as % of Oil Demand	113%	109%	107%	107%	107%	106%	103%	109%	109%

Sources:

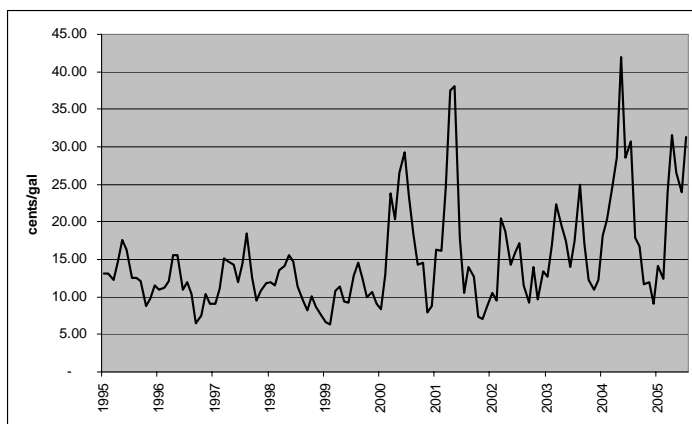
1990-2004 Oil Demand from IEA *Annual Statistical Supplement* for 2003, 2010-2020 Oil Demand is as projected by IEA, *World Energy Outlook* 2004.

1990-2004 Refining capacity from BP *Statistical World Energy Review*, June 2005

*2010-2020 Refining Capacity is estimated as the capacity required to make the refining capacity to Oil demand ratio at 109%. This was the average ratio from 1990 till 2000.

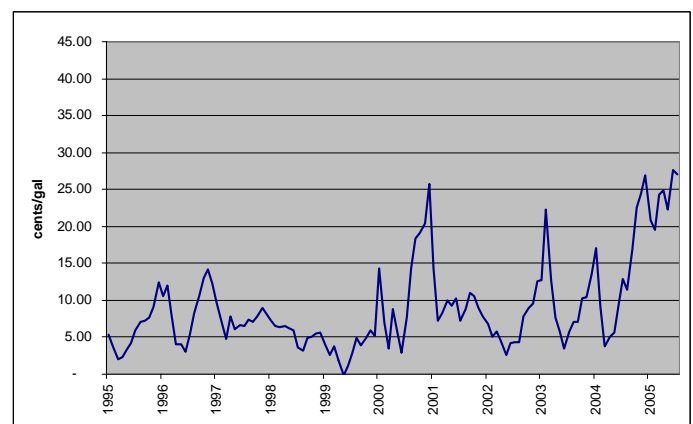
As capacity growth lags demand, small events can have a grossly magnified effect. This leads to increased upward pressure on prices, refining margins, and volatility. Over the past year, refining margins in the United States have been very strong, with distillate in particular enjoying a sustained period of high margins versus WTI (See Exhibit 7). The pull of higher global distillate demand and reduced diesel specifications are keeping margins high. High gasoline demands, and margins, are impacting the ability of refiners to swing to higher distillate production. These high margins are indicative of a tight market overall, and it is difficult to predict when this pattern will end. Note that Exhibit 7 shows a sustained high margin since mid-2004 as spare refinery capacity narrowed.

Exhibit 7a: Price Spread between NYMEX Gasoline and NYMEX WTI (cents/gal)



Source: Energy Information Administration, 2005

Exhibit 7b: Price Spread between NYMEX #2 Heating Oil and NYMEX WTI (cents/gal)



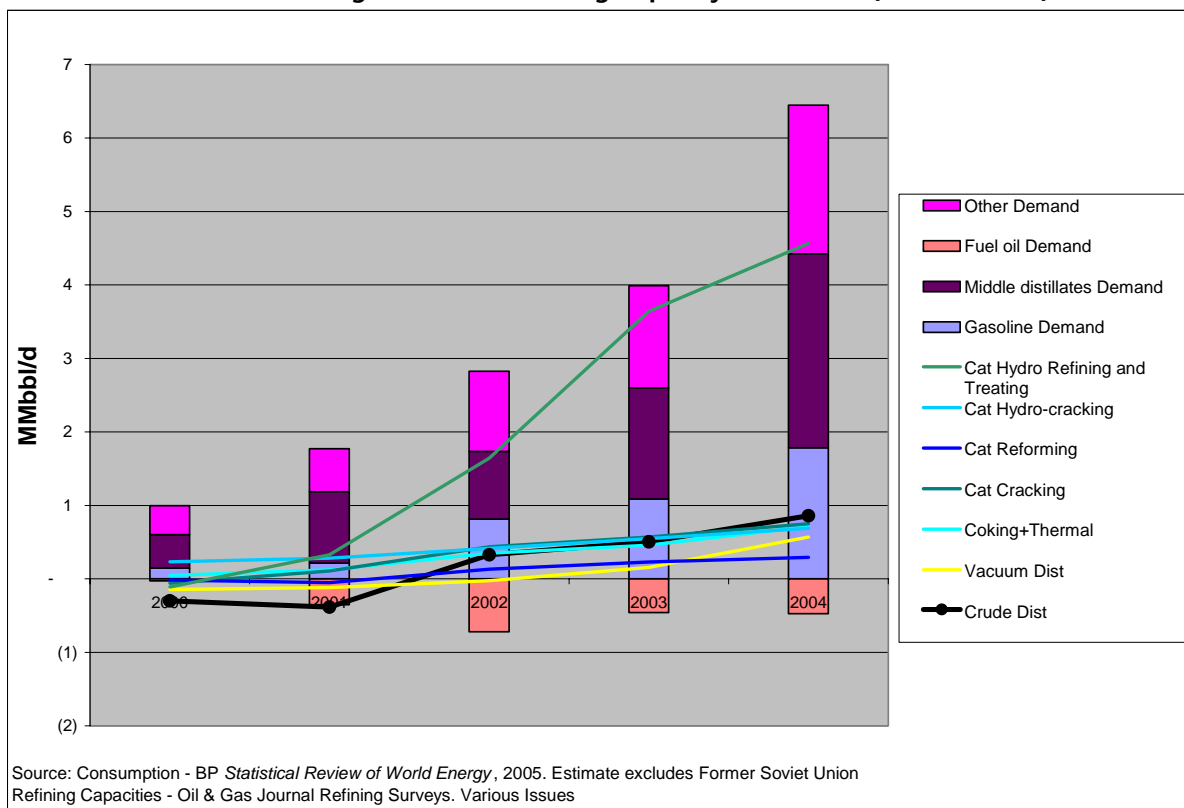
Source: Energy Information Administration, 2005

Effect of Product Specifications

The outlook for capacity investment is hampered by the reality that the need to meet sulfur regulatory changes has been a primary pull on refiner's capital. Exhibit 8 shows clearly that hydroprocessing has been far and away the most significant processing investment over the past 5 years. The bulk of this extraordinary growth is the continued pressure to meet lower sulfur specifications. Refiners have had to add secondary unit capacity and modify existing hardware and catalyst to sustain and expand their capacity to meet lower sulfur standards with their historic crude slates.

Reduced sulfur targets in global products, including potentially residual fuels and heating oil, will increase competition and premiums for sweet crude oils. Europe's base sweet crude refinery capability and the relatively weak sour refining ability in the Asia Pacific region will also pull sweet crude away from the United States.

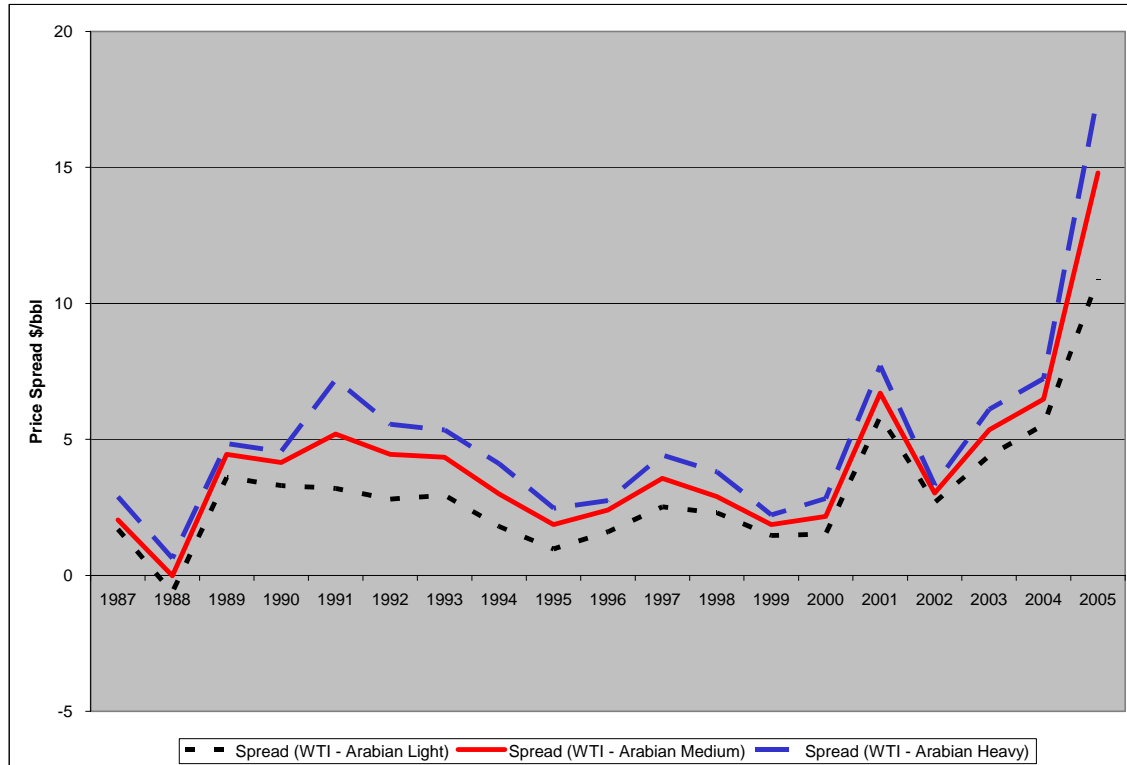
Exhibit 8 – Change in World Refining Capacity Since 1999 (Million bbl/d)



As the tighter specifications come into effect for both gasoline and distillates, and demand continues to grow, there will also be an increasing strain on the system as both low-sulfur gasoline and ultra-low sulfur diesel compete for the best crude oils available. This will place a premium on the light sweet crude oils versus the heavy sour crude oils. Currently this can be seen in the historically high price spread between sweet and sour crude oils. Some refineries are adding coking, cracking and hydrotreating capacity to increase their flexibility in handling heavier and more sour crude oils. However, these capacity additions may not have kept pace with the demand growth as evidenced by the high differentials between sweet and sour crude oils. Refiners who have not made the investment to upgrade will have no option other than to purchase the higher cost sweet crude oils. In some cases, even running sweet crude will not be enough to extract the required sulfur to meet low or ultra low sulfur specifications for some marginal refineries worldwide.

Exhibit 9 shows the price spreads between West Texas Intermediate (Sweet) and Saudi Arabian (Sour) crude oils. ICF Consulting believes that the market will continue to reflect a much wider than historical premium for sweet crudes.

Exhibit 9 – Price Spread between WTI and Saudi Arabian Crude Oils



Source: Energy Information Administration, International Energy Annual 2003, Table 7.1 updated July, 2005

The Capacity Crunch

Exhibit 6 showed a trend of less and less surplus global refining capacity through 2004. Based on the forecast demands through 2010, an additional 8 million barrels per day of global refinery capacity is needed to maintain the same narrow surplus capacity as 2004. With IEA predicting another 17.6 million barrels per day demand by 2020, the refinery capacity need will grow even more. There will be some capacity creep every year, and some new refineries will be built and operational over the period, however there could also be some capacity lost as marginal refineries must either invest to make marketable clean products or be forced to close.

The oil industry has worked to wring out surplus capacity since the mid 1980's that had depressed margins and profits, and industry obviously prefers a tighter ratio of capacity to demand. The magnitude of the need for additional capacity over the next 5 years is, however in stark contrast to the relatively few significant projects currently underway to expand global refining capacity. In cases where industry is evaluating or has announced capacity increases since the Oil & Gas Journal survey was released, the location of those projects are planned for China and the Middle East, and none are in the engineering stage. The Energy Bill provides some accelerated depreciation guidelines to encourage U.S. refining investment; however locations outside the United States may still be more economic due to costs of labor and environmental infrastructure needs. It is also significant that the Energy Bill contains provisions that are likely to accelerate the elimination of MTBE from the U.S. gasoline supply as refiners see inherent risk in blending MTBE on an economic basis versus a mandated need. This alone may *reduce* gasoline supply by as much as 140 M bbls/day or about the equivalent yield of gasoline from a 250 M bbls/day refinery.

Moreover, the tighter product specifications in the United States versus the emerging Far East region will make it more cost effective for refiners with export capability in the Middle East, or even Europe, to manufacture and ship product to China or India. Where the product goes will depend on who is willing to ante-up to pay for the volume, and the ramifications for both the 'winner' and the 'loser' in that battle are significant.

Infrastructure Needs

As demands increase and refinery capacity additions lag, the fragility of the distribution infrastructure will become more visible. In the Far East, the ability to import products is already there, but it likely will need to be expanded, and the downstream distribution systems will need extensive development. The United States also currently imports, but tankage for imports will need to be increased, and the strong existing product pipeline system will require investment to meeting growing demand and possibly integrate with new sources of imported supply.

In addition, the globalization of products and phase out of single hull tankers will require larger investment in product vessels to handle the long range movement of products.

Within the United States, several areas will likely show signs of infrastructure issues earlier than others. California is already tight on tankage and pipelines to import and move products. In other areas, the boutique fuels issue has tankage held captive that could be better used with a more fungible product mix. Reductions in tankage in markets such as Long Island can leave millions of consumers exposed, particularly in winter, despite having adequate supplies nearby in North Jersey and New York Harbor.

Conclusions

- The share of clean products like gasoline and diesel has increased in oil consumption and it is likely to increase further although the distribution between gasoline and diesel increasingly varies according to region. At the same time these products are subject to tighter environmental constraints requiring substantial downstream capacity in refineries to be able to extract the maximum amount of light products at low sulfur levels from every barrel of crude oil. Worldwide refinery investment for these units has not kept pace with the speed at which mandates are taking effect, and outright crude capacity growth is lagging global oil demand growth.
- With refinery utilization in China at high levels already, the Chinese will have to increase imports of finished products to satisfy the growing demand unless new refinery capacity is quickly added. This will increase competition for any extra processing capacity in the world again putting upward pressure on refining margins. Moreover, China and India's growth may pull gasoline being exported from Korea and Taiwan away from the U.S. West Coast, further impacting either supply or price to West Coast consumers.
- Barring a radical and immediate initiation of major refinery projects, there will be a competition for available supply as the decade draws to a close. The 'winning' bidders will pay a premium for products which could make today's prices look very reasonable; the 'losers' may be required to slow down economic growth. The overall effect of both may be that global economies will suffer until refinery capacity gets back in alignment with demand.
- The price differential between sweet and sour crude oils is at a historical high. It is likely to stay substantially higher than historical levels given the continued pressure of sulfur mandates, and the fact that any incremental Saudi production to meet global crude demands is likely to be sour crude.

- The positioning of new refinery capacity will be directed more to the Far East and Middle East regions due to perceived cost advantages. The U.S. market, despite strong refining margins, may be a less economic choice due to higher environmental costs, and a less welcome view of new refinery construction in many areas of the country. This places the United States at even greater risk of supply disruption as the volume of imports becomes a greater percentage of product supply.
- The overall refining capacity crunch looks like it will be difficult to reverse given the long lead times necessary for construction. Continued high utilizations, increased investment focused on sulfur management, and continued just-in-time inventory planning likely mean high refining margins are here to stay.

All these factors lead ICF Consulting to believe that the global oil product market will remain tight in the near future. Refinery capacity and capability will play a major part in maintaining high product prices as new environmental regulations come into effect and refiners scramble to catch up. It is more important than ever to look at the fundamentals and determine a long-term strategy to reduce or slow down the growth of petroleum demand, and to prepare for the future. The 2005 Energy Bill provides some good investment initiatives, but our concern is that they may not be enough, and the MTBE impact works against supply. And counting on 'capacity creep' (especially secondary unit capacity creep) in an ultra low sulfur product environment where marginal refineries may be forced to close is not an answer.

If nothing is done, the best that could happen is that consumers will have to pay a much higher price to live in a cleaner world and yet continue to maintain their lifestyles. The worst that could happen is a world of higher prices, supply shortages, and slower global economic growth.

About ICF Consulting

ICF Consulting (<http://www.icfconsulting.com>) is a leading management, technology, and policy consulting firm. Drawing upon extensive industry knowledge, distinguished professionals, and innovative analytics, the firm develops solutions to complex defense, homeland security, energy, environment, social program, and transportation issues. ICF Consulting's approach to these issues is strengthened by its expertise in information technology, organizational improvement, program management, and communications. Since 1969, ICF Consulting has been serving major corporations, government at all levels, and multinational institutions. More than 1,200 employees serve these clients from key business centers in the Americas, Asia, and Europe.

For Information Contact

Zeta Rosenberg
+1.703.934.3949
ZRosenberg@icfconsulting.com

Thomas O'Connor
+1.703.218.2768
TO'Connor@icfconsulting.com

ICF Consulting Global Headquarters
9300 Lee Highway
Fairfax, Virginia 22031 USA