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Refining Trends: The Golden Age Or the Eye of The Storm?

Part IV: Tough Choices

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REFINING TRENDS: THE GOLDEN AGE OR THE EYE OF THE STORM?

Part IV: Tough Choices

In the first half of 2008, the refining industry went from exhilaration to desperation. In fact, so many contradictory signs exist about the industry's future that it is hard to discern reality from myth, and even harder to chart a course. Where is the industry really heading? And what should smart players do? We address these questions and more in this fourth installment of our "Golden Age of Refining" series.

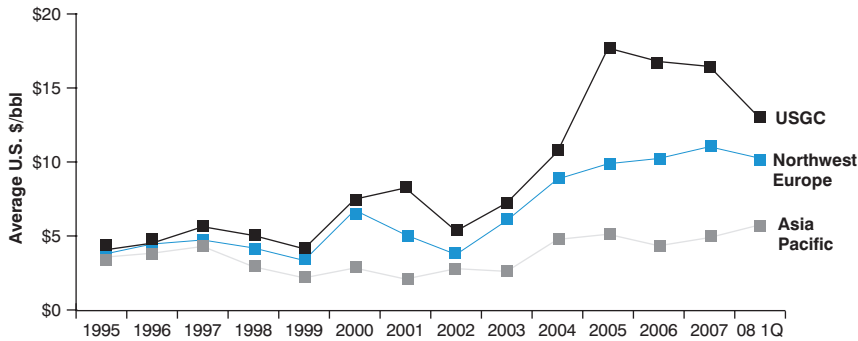
Refining is a cyclical industry with high peaks and low troughs. Since 2002, the industry has been in what industry observers have called a golden age. Margins have remained at historic highs without attracting sufficient demand and supply-side feedback to end the cycle or drive margins back down to pre-2002 levels (see Exhibit 1, page 2).

Given the capital intensity of the industry, players tend to make investment decisions that have time horizons of 20 years or more. However, present circumstances do not easily lend themselves to making assumptions about tomorrow's energy landscape. Many contradictory, game-changing signs lie on the horizon:

- Global demand that is growing despite high oil prices, together with recent evidence of demand destruction in developed economies
- New transportation technologies that threaten to displace oil-based vehicles entirely, but also ultracheap internal combustion powertrain cars that could create vast demand in developing economies such as India and China
- Growth in refining capacity, but delays and cancellations due to rising construction costs
- New legislation mandating unforeseen levels of biofuel use, but uncertain technological advances and a rising tide of popular dissent because of public debate on whether crops should be grown for food or fuel.

These signs clearly do not point to a unified direction for the future of the refining industry. But as we show in this paper, we believe that in the short-term, between 2008 and 2013, overall margin levels have already topped out and will move lower. Furthermore, a recession could end the golden age prematurely. Finally, trade flows could

Exhibit 1
Average Refining Gross Margins



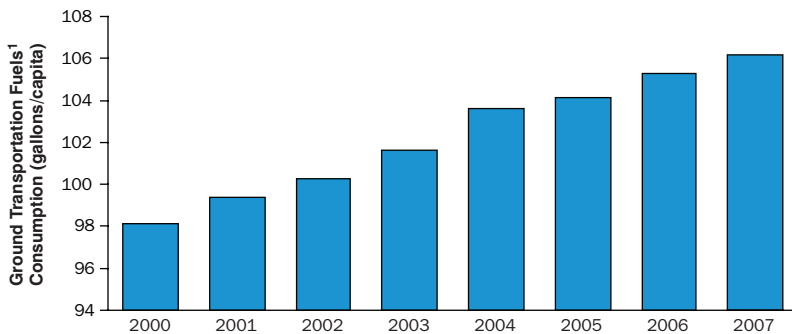
Sources: Oil and Gas Journal; Booz & Company

change, shifting margins to Asia. In the long term, through 2025, global demand for transportation fuels will continue to grow despite the emergence of alternative vehicle technology; the demand will be driven primarily by economic growth in Asia. Whether margins remain high in the long term will depend on the ups and downs of the economic growth of developing economies. This represents a shift

from the dynamics of the recent past, when margin cycles were determined almost solely by the speed at which capacity was added.

In addition, regulators will play a significant role in determining whether investment decisions made today yield their potential. Policies on dieselization, high-efficiency vehicles, and biofuels will all have an impact on refining margins.

Exhibit 2
World Ground Transportation Fuels Demand per Capita



¹ Transportation fuels include gasoline and distillate fuels.
Sources: U.S. DOE; World Resources Institute; CIA World Factbook; Booz & Company

Supply and Demand in the Short Term

The demand perspective:

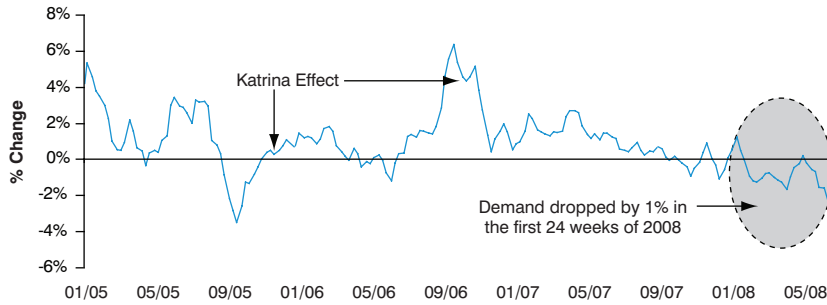
Propelled by worldwide economic growth, demand for transportation fuels has continued to grow despite sustained high prices (see Exhibit 2). In the developing world, this demand has been supported by the weak dollar and by policies of subsidizing fuel prices in places such as China. In the developed world, consumers have generally been unwilling to significantly change their driving habits, despite climbing fuel prices and the gradual introduction of smaller and alternative-fuel vehicles into a very large installed fleet.

However, as shown in Exhibit 3, there is evidence that demand has started to cool down, at least in the U.S. It seems that high prices at the pump, together with fears about the economy, prompted U.S. consumers to curb their appetite for gasoline in the first quarter of 2008. In fact, our analyses show that gasoline consumption is highly correlated with consumers' personal disposable income (PDI), which is driven by economic growth and inflation (see Exhibit 4). Increases in PDI raise gasoline consumption overall and also reduce individual sensitivity to price changes. In the last three decades, as gasoline spending as a percentage of PDI has dropped, we have seen the absolute price elasticity of gasoline in the U.S. reduced by an order of magnitude (see Exhibit 5). This dynamic has until very recently dampened the impact on demand of historically high real gasoline prices in the U.S.

Against this backdrop lies the threat of recession or—just as

Exhibit 3

Year-to-Year Percentage Change in U.S. Gasoline Demand (4-week Average)



Sources: Energy Information Administration; Booz & Company

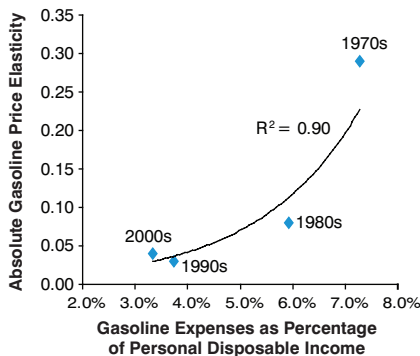
menacing—stagflation. If gross domestic product (GDP) decreases and inflation increases, then PDI will drop, and demand for gasoline will drop with it as consumers become more price sensitive. The severity of the demand decrease will depend on the price of gas: If gasoline prices are high, the demand decrease will be quite sharp; it will be less sharp if gas prices are

relatively low. A US\$4/gallon price could reduce gasoline demand by 3 percent, depending on the state of the economy (see Exhibit 6, page 4).

In terms of demand, the short-term impact of alternative fuel technologies will be limited, given how long it takes to replace the vehicle fleet. However, the long-term impact of high-efficiency vehicles is real, as discussed on pages 5–6.

Exhibit 4

U.S. Gasoline Demand—Price Elasticity vs. Disposable Income



Sources: Energy Information Administration; Federal Highway Administration; Census Bureau; Science; University of California at Davis; Booz & Company

The supply perspective: Refining capacity increased between 2003 and 2007, despite public announcements of delays and cancellations in building, as well as massive increases in construction costs. During this period, refiners added 3 million to 4 million barrels per day (bpd) of distillation capacity, and more than 9 million bpd in capacity via other processes. In fact, the pace of building has significantly accelerated: Capacity under construction more than doubled from spring 2007 to spring 2008 (see Exhibit 7, page 4). Furthermore, there has been a significant increase in capacity in the engineering stage (i.e., being

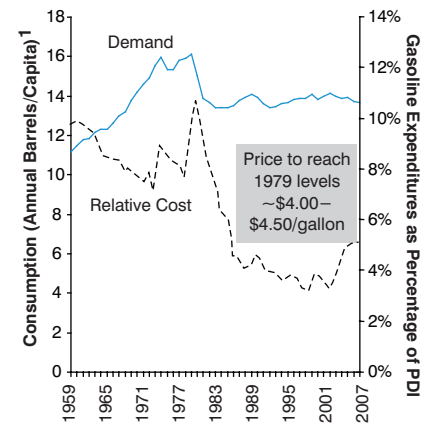
designed) and in the planning stage. As was the case in prior cycles, there is a lag between margin levels and capacity additions. Not only does it take time for refiners to start adding capacity when margins rise, but it also takes time for refiners to reduce the pace of additions once margin expectations start to drop.

Of course, we do not expect that all announced capacity will actually be added. On the basis of capacity announcements and our understanding of the different players, we estimate distillation capacity will expand by approximately 6 million bpd between 2008 and 2012.

Biofuels are also altering the short-term industry outlook by adding supply, thanks in part to the short lead times needed to add biofuel capacity, and also to a regulatory emphasis on alternative energy.

Exhibit 5

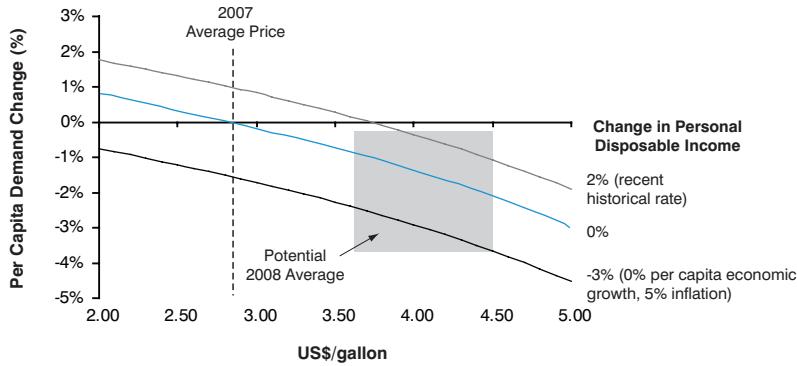
U.S. Gasoline Cost as a Historical Percentage of PDI



¹ Population greater than 16 years old.
Sources: Energy Information Administration; International Energy Agency; Booz & Company

Exhibit 6

U.S. Gasoline Demand vs. Price and Disposable Income



Source: Booz & Company

The U.S. energy bill enacted in 2008 has some aggressive targets for biofuel production, mandating 1 million bpd by 2012, and 2.3 million bpd by 2022. This new mandate represents an increase of 600,000 to 700,000 bpd of biofuels by 2012, equivalent to as much as 7 percent of the total expected U.S. transportation fuel

demand in that year, and more than the total gasoline demand growth between 2007 and 2012.

The European Union also has a mandate for biofuels, calling for them to make up 5.75 percent of the transportation fuels pool by 2010 and 10 percent by 2020. However, the E.U. is currently re-

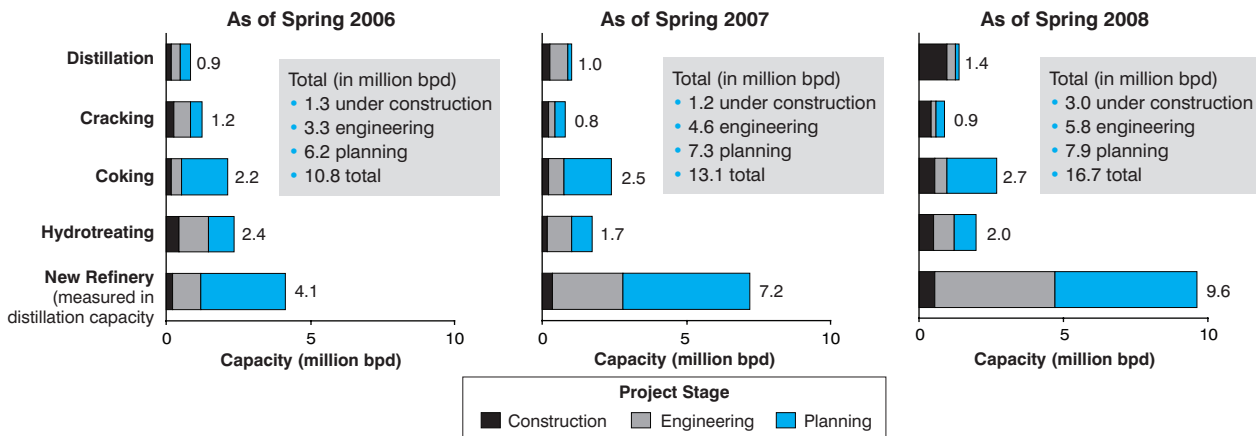
viewing the environmental impact of biofuels, and that mandate may change if they are found to have negative effects on the environment.

Of course, there is a limit (typically 10 percent) on how much ethanol can be blended into the gasoline pool without the need for modifications to existing vehicles. However, with just a small penetration of vehicles accepting E85 (a blend of 85 percent ethanol and 15 percent gasoline), the U.S. could meet its biofuel target by 2012. The E.U. is avoiding the need for E85 by setting a target as a percentage of total transportation fuels supply that is below the 10 percent threshold.

Putting all this information together, what just a few months ago looked like an imminent, albeit modest, global supply crunch has now turned into a situation of oversupply. Furthermore, it has opened up the possibility that the U.S. will become long in gasoline (i.e., a net exporter, rather than a

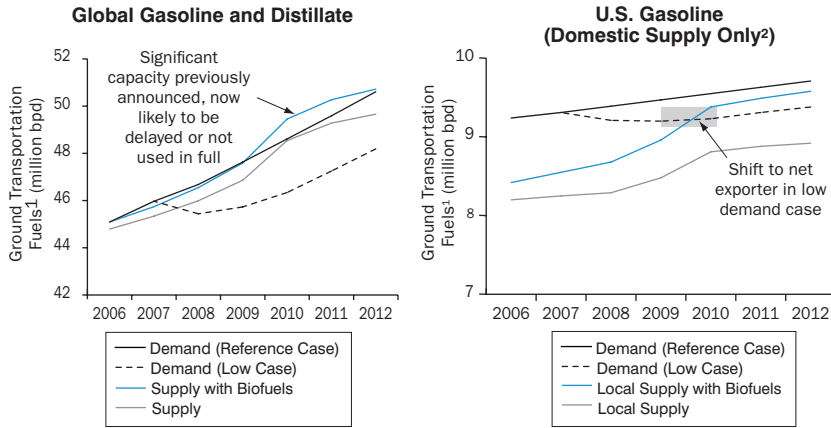
Exhibit 7

Evolution of Refinery Capacity Addition



Sources: Oil & Gas Journal; Booz & Company

Exhibit 8
Short-Term Supply/Demand Balance



¹ Transportation fuels include gasoline and distillate fuels
² Supply is domestic supply; rest of the demand is fulfilled with imports
 Sources: Energy Information Administration; International Energy Agency; Booz & Company

net importer). This is particularly likely if demand is reduced by an economic slowdown or a recession (see Exhibit 8).

Such a shift will lead to changes in regional supply/demand balances, affecting global trade flows and refining margins (see Exhibit 9). In particular, on top of North America's reducing its need for gasoline, Europe will get shorter in diesel, and Asia will continue to be thirsty for fuels in general.

More and more gasoline from Europe, and possibly from the U.S., will flow into Asia. Demand in Asia will be able to absorb this supply, but margins in Europe and, especially, the U.S. will be affected. In the case of Europe, exporting over longer distances to Asia will mean lower gasoline netbacks relative to exporting to the U.S. In the case of the United States, this change could mean

gasoline would be priced at export parity rather than at import parity, reducing gasoline crack spreads by approximately \$4 to \$6 per barrel.

Given the way refinery economics work, a reduction of relative gasoline prices would, for the same

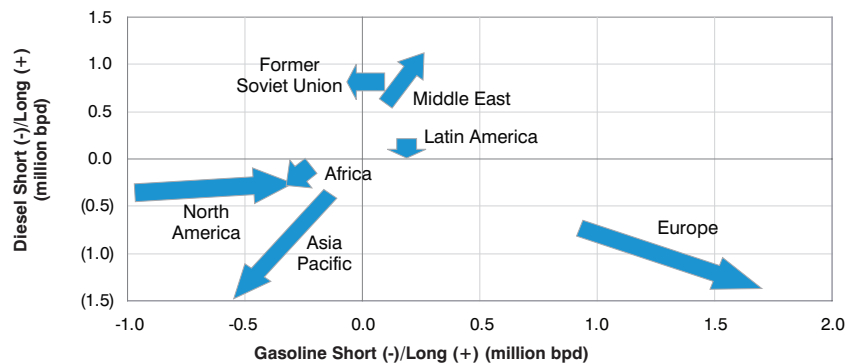
crude price, reduce the differential between light and heavy products, thereby reducing refining margins. Refiners will have a choice: ship, shift operating mode to produce more diesel, or reduce runs.

In the short term, then, it appears that the refining industry in the U.S. and in the E.U. is ready for a shake-up, even if the industry continues to do fine in Asia.

Supply and Demand in the Long Term

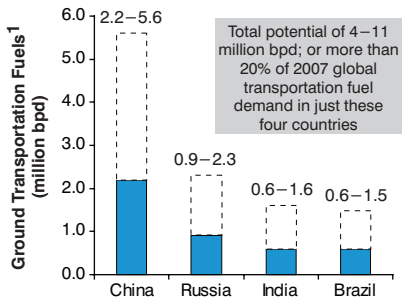
The demand perspective: The long-term picture is plagued with uncertainty as several game-changing, and sometimes contradictory, drivers come into play. For starters, small changes in economic growth in emerging markets could significantly change future demand. In fact, an additional 1 percent annual growth in the GDP of the BRIC countries (Brazil, Russia, India, and China) would add 3 million bpd of demand for ground transportation fuels by 2025.

Exhibit 9
Changes in Regional Supply/Demand Balance (2007 to 2012)



Source: Booz & Company

Exhibit 10
Impact of Ultracheap Cars on Demand
 (by 2015)



¹ Transportation fuels include gasoline and distillate fuels. Source: Booz & Company

Similarly, the advent and adoption of ultracheap vehicles (such as Tata’s recently announced \$2,500 car) may bolster conventional fuel demand by unprecedented amounts (see Exhibit 10). This may result in a marketplace with vastly increased demand for transportation fuels as vehicle ownership suddenly becomes affordable and attractive to millions of people in developing economies.

Another potential scenario, however, represents the absolute opposite. Entirely new auto technologies such as plug-in hybrids may threaten absolute demand destruction for ground transportation fuels, marking the end of the hydrocarbon era as we know it and ushering in the era of electrified transportation (see Exhibit 11). The speed at which this shift could happen depends on the pace of advancements in battery weight-to-power ratios and reductions in battery costs, both of which have been occurring at 5 to 10 percent per year. Consumers’ vehicle purchase decisions

will be determined by how the different technologies compare in performance and cost. The latter will be affected, positively or negatively, by government incentives, depending on how various governments choose to structure those incentives.

In addition, any new vehicle technology will take several years to penetrate and eventually replace the fleet. For example, even after years of being commercially available, hybrids still account for less than 3 percent of total new vehicles. It also takes about 15 to 20 years to replace the vehicle fleet, significantly delaying the impact of new technologies.

Since it seems clear that numerous questions regarding the long term remain unanswered, we have assembled four demand scenarios (see Exhibit 12):

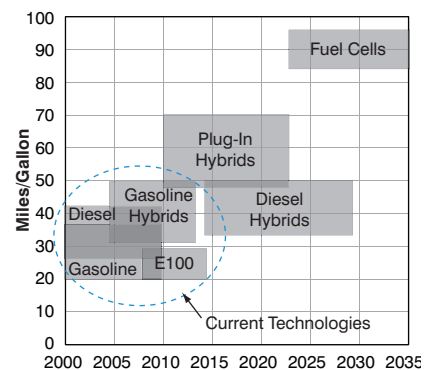
- Robust economic growth with continuous fleet efficiency improvements
- Robust economic growth with high penetration of alternative vehicle technologies
- Moderate economic growth with continuous fleet efficiency improvements
- Moderate economic growth with high penetration of alternative vehicle technologies.

In all cases, we have taken a consumer-back approach to sizing total demand for liquid ground transportation fuels. In other words, we have purposely left biofuels out of the demand-side scenarios, and we will consider them as part of the supply side of the equation.

The likelihood that a given demand scenario will materialize depends on future fuel prices. At one extreme, high prices would likely deter global economic growth while favoring a high penetration of alternative technologies. At the other extreme, low prices would favor global economic growth and reduce the attractiveness of alternative vehicles. Then, of course, the price of oil will be affected by crude oil availability; limited availability will support high prices.

Our demand forecast, presented in Exhibit 13, highlights the emergence of two centers of demand moving in opposite directions. On the one hand are the developed economies where growth in demand is slow, and will eventually be negative as new technologies become entrenched. On the other hand are developing economies, particularly in Asia, that will drive significant demand growth even after new technologies become available. This is not only

Exhibit 11
Vehicle Technology Evolution—
Expected Timeline



Sources: International Energy Agency; Booz & Company

Exhibit 12
Long-Term Demand Scenarios

Scenario		Economy	Alternative Technologies	
			Hybrids	Plug-In Hybrids
Robust Growth	Continuous fleet efficiency improvement	Strong real GDP growth across the world: U.S. 2.4% p.a. • Europe 1.9% p.a. • China and India at 8.0% p.a. fading down to 3% p.a. • Other: 1-4% p.a.	Continuous limited penetration	Continuous limited penetration
	High penetration of alternative vehicle technologies		From 1% of new vehicles in 2008 all the way to 25% of new vehicles by 2032	From 0.1% of new vehicles in 2012 all the way to 25% of new vehicles by 2042
Moderate Growth	Continuous fleet efficiency improvement	75% of Robust Growth GDP CAGR	Continuous limited penetration	Continuous limited penetration
	High penetration of alternative vehicle technologies		From 1% of new vehicles in 2008 all the way to 25% of new vehicles by 2032	From 0.1% of new vehicles in 2012 all the way to 25% of new vehicles by 2042

Note: All cases include the impact of ultracheap cars in a similar way
 Source: Booz & Company

because of their high economic growth rates but also because any percentage of GDP growth in those countries has a larger relative impact in fuel consumption than it would in developed economies.

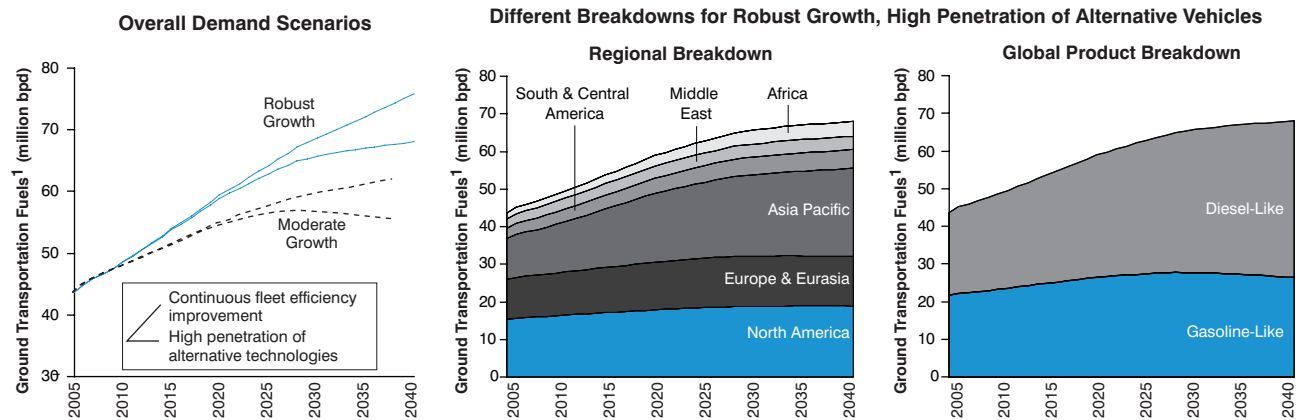
The developing world's economic growth means that global demand for transportation fuels is poised to continue growing. For the

most part, that will be true even if alternative vehicle technologies achieve a high penetration rate. In fact, only in the case of long-term moderate economic growth and high penetration of alternative vehicles does the total global demand stop growing before 2040.

To be sure, demand will peak much sooner in developed

economies. This is particularly the case for gasoline (with ethanol) consumption in the U.S., which will likely peak within the next 15 to 20 years. Diesel will probably continue growing for another decade or so after that. This trend toward diesel is a global one, with the global gasoline/diesel mix poised to move from 50/50 in 2007 to 45/55 in 2030.

Exhibit 13
Ground Transportation Fuels Demand Outlook



¹ Transportation fuels include gasoline and distillate fuels.
 Sources: Oil & Gas Journal; Booz & Company

The supply perspective: In addition to demand-side uncertainties, there are significant unknowns on the supply side. Chief among them is the emphasis on alternative sources of transportation fuels. Biofuels have garnered a good deal of interest in many different forums. However, a number of parties are raising questions about whether government targets for biofuels can be achieved: Various interest groups are concerned about the fuels' environmental impact, and the United Nations and the news media have raised worries about biofuels' effect on food prices. Specifically at issue are the economics of emerging technologies and the ultimate environmental impact of biofuels' cultivation and use (i.e., the amount of water consumed and carbon dioxide generated at each step of the process). This increased scrutiny could slow biofuels' penetration of the mainstream, substantially limiting their adoption while issues concerning their deployment are worked out by the government and the public.

For our analyses, we are assuming both E.U. and U.S. biofuel mandates will be met.

When pairing our demand forecast with our expectations for additions to refinery capacity, creep, and biofuels production, we find that in the case of moderate economic growth, the world will need 3 million bpd in distillation capacity by 2025 beyond what is already in the pipeline (see Exhibit 14). And if the global economy experiences strong growth, there will be a need for 16 million bpd of additional distillation capacity.

However, there is a significant regional imbalance, with two areas worth pointing out. On one end, the Middle East is adding more capacity than is required for local demand. On the other end, Asia will fall short.

The actions of the Middle East should not come as a surprise. In fact, oil-rich Middle East countries have made it clear that

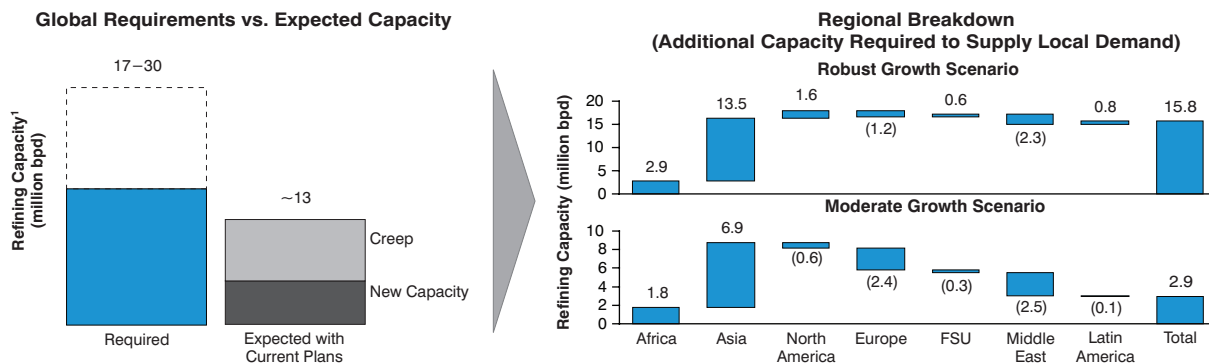
these investments are part of their overall economic and domestic industrial plans.

Very different circumstances will develop in Asia, with the region's capacity becoming significantly shorter thanks to the sheer size of the expected growth in demand. In a way, this situation is not unique to the refining industry in Asia, as the region overall struggles with adding the infrastructure required to continue supporting its economic growth.

We are experiencing a dramatic shift within an inherently cyclical industry. We believe the peaks and valleys of the industry will be determined by the combined effect of two drivers. The first one is the speed at which capacity (both biofuel and refining capacity) is added. The second one is the ups and downs of economic growth in developing economies. This is different from the past, when cycles were determined mainly by overbuilds of refining capacity

Exhibit 14

Additional Required Distillation Capacity by 2025¹



¹ Assumes E.U. and U.S. biofuels mandates are met.

² Based on typical refinery yields

Source: Booz & Company

against a backdrop of consistent and predictable demand growth. However, as demand growth is now underpinned by developing economies, it is therefore highly dependent on their more volatile economic growth.

Implications

The refining industry is on course to experience a severe dislocation as the regional supply/demand balances change, affecting global trading flows and therefore refining margins. As never before, the whole industry depends on demand growth in Asia.

Furthermore, although the outlook for global demand is positive for the next 20 years, there is the possibility that refining margins will drop and never recover; the potential for demand destruction and alternative supplies is real. The future scenario depends on how different refiners and regulators worldwide react.

Refiners will have to consider:

- Pulling the plug or delaying investments on expansion projects in developed economies
- Expanding into Asia if they want to grow
- Adjusting refinery configuration to favor diesel, or at least gain more flexibility
- Finding a material way to play in biofuels
- Improving operational excellence at the plant level to maximize the value of their existing assets.

Canceling or delaying investments in capacity addition in developed economies is advisable, at least until the biofuel supply situation

becomes clearer. In these countries, it is wise to carry forward only investments related to improving the competitive advantage of specific refineries. Furthermore, there could be an opportunity to drive consolidation in mature economies. Some players may wish to reserve some of the significant cash flows of recent times to lead the consolidation wave that could be required when the industry hits bottom again. U.S. players will be forced to consider this if the market moves from short to long, driving margins down and opening opportunities for acquisitions.

On the other hand, as Asia and emerging economies will play a large role in the increasing demand for transportation fuels (and energy more generally) in the future, there exists a clear need for refiners to have a firmly established presence in these regions to increase the likelihood of solid returns. Currently, local players are the ones capturing most opportunities in Asia, to the degree that local price regimes allow them to be captured. Refiners based in the developed world should redouble their efforts to participate.

In addition, regardless of the geography, when investments are made in refinery capacity, it will be wise to favor diesel over gasoline production. At the very least, refiners should aim for increasing operational flexibility.

Refiners must also consider expanding their energy portfolio to include biofuels, as this could give them the opportunity to benefit from the increased emphasis on this area. In addition, several of the skills required to succeed in biofuels, such

as process engineering, transportation, optimization, and marketing, are core downstream competencies.

With these strategic points in mind, however, it is all too easy to overlook the fundamental operational elements that are still the backbone of a successful refining system, regardless of external circumstances. There should remain a deliberate focus on improving efficiency and reliability, taking the time and effort required to examine processes to ensure that they are as lean as possible in order to maximize profit and minimize unnecessary expenditures.

On the policy side, regulators face some interesting dilemmas:

- Faced with the threat of increasing diesel price premiums, will Europe push back emphasis on dieselization?
- Faced with increasing concerns about biofuels' environmental friendliness and increasing food prices, should U.S. and E.U. regulators reverse course?
- Faced with the rest of the world being long in refining capacity, will China continue to favor the import of crude over final products?

Given the impact of regulatory changes in the refinery industry, it is important for refiners to monitor the signposts of impending change, remain strategically flexible, diversify portfolios, and be aware that yesterday's planning may not suit the world that sits before us. Though the golden age is under threat, significant opportunities still beckon for those willing to look at the world differently than in the past.

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