
THE REFINING INDUSTRY AND PETROLEUM PRODUCTS MARKETS

The oil industry commonly is viewed by the public as a monolithic entity. The public policy discourse concerning “the oils” tends to reinforce this view. In reality, refining should not be viewed as a unified “industry” or “system” but rather as an amalgamation of diverse firms and operations acting independently in a market that is highly segmented. This chapter highlights key business and market trends in the downstream and the diversity of downstream actors’ views and strategies.

INDUSTRY SEGMENTS AND BUSINESS MODELS

The U.S. petroleum industry is made up of many different actors engaged in different segments of the business:

- Crude oil exploration, production, and gathering (generally called the *upstream*)
- Refining or manufacturing of intermediate and final products such as gasoline, diesel and jet fuels, chemical feedstocks, lubricants, and waxes (this and the following areas are called the *downstream*)
- Refined product distribution and storage facilities, such as pipelines and terminals
- Marketing and retail operations, such as gas stations, home heating oil distributors, convenience stores, and warehouse clubs (also called hypermarkets).

All of these segments are supported by a range of firms engaged in engineering, construction, technology development and supply, and consulting and services provision. These enterprises range in size from large, diversified multinational operations to specialized consulting firms.

In most cases, petroleum firms are engaged in more than one business segment. The vertically integrated *majors* typically have interests and operations in all segments, including process technology development and services. Examples of vertically integrated majors that participated in this study include ExxonMobil and Shell. Nonintegrated or *independent refiners*, on the other hand, typically buy all of their crude oil on the open market and may or may not engage in refined product marketing. They also purchase most of their process technologies and services from outside suppliers. Examples of independent refiners include Tesoro and Frontier.

When I started in this business, it was different. It's more fragmented now.

—Refining executive

Industry leaders with whom we spoke noted that the industry has become less vertically integrated over the past several decades as management has sought to focus on core competencies. For instance, most majors scaled back, shut down, or spun off their process technology development divisions. Many U.S. majors also decreased marketing costs by disposing of a number of company-operated retail outlets and relying more on sales to independent retailers and to wholesale markets. Some integrated firms shed crude oil exploration and production units to focus on refinery operations (such as Sunoco) and vice versa (such as Unocal). As part of this trend, one of the more notable changes in refining in recent years has been the emergence of very large independent refining firms such as Valero and refining joint ventures such as Marathon-Ashland.

Operations within firms also have become more autonomous. In the past, refinery operations in vertically integrated oil companies commonly were managed as a means to “monetize” the crude oil discoveries and production from upstream operations via transfer pricing and other mechanisms. That is, downstream refining operations often were subsidized or financed by the upstream. Today, U.S. refining operations are generally managed as stand-alone business units accountable for their own bottom lines. Among vertically integrated firms, the upstream and downstream portions are run somewhat independently: Their refineries, for example, often process crude purchased on the open market. In addition, refineries today have more options of where to sell their products. In addition to distributing their products through networks of dedicated brand-name gas stations, refineries now sell a significant share on wholesale markets and to large third-party retailers, such as large discount clubs and convenience store chains. Often, refining firms with one brand name will sell their products through outlets with competing brand names.

ECONOMIC HARDSHIP AND RESTRUCTURING

Many different measures are used in business planning, decisionmaking, and performance assessment in refining. Not surprisingly, refining industry leaders varied greatly in their views of what contributed to business success. Some RAND discussants emphasized such operational factors as refining costs per barrel, refinery location or flexibility, or environmental and safety performance. Some spoke about their market position in a particular product segment or region. Others cited such financial objectives as profitability (either in aggregate or per barrel of crude oil processed), return on investment, return on capital employed, or total return to shareholders.

You have to have a strong heart and a tough stomach to be in this business.

—Refining executive

Regardless of the metric used, the 1990s were widely viewed by the industry representatives as a period of unprecedented difficulty for the industry as a whole. As U.S. refining operations transitioned to being managed as individual profit centers during the late 1980s to mid-1990s, the industry suffered through a period of substantial economic volatility and hardship. Refiners pointed out that during this period the downstream experienced poor profit margins as a result of substantial excess capacity across the industry, the increasing cost of compliance with environmental regulations, and unfavorable crude oil price trends. Many contended that conditions had not improved in the current decade. “This industry is in incredible turmoil,” declared an operating company executive. Referring to rising crude oil prices and intense price competition on the products side, a services provider said, “The downstream is caught between a rock and a hard place.”¹

Like many mature businesses, especially those in other process industries, the refining sector has been undergoing consolidation for many years. Starting in the mid-1990s, the pace of downsizing, restructuring, and consolidation in the downstream accelerated markedly with a wave of mergers, acquisitions, joint venture alliances, and selective divestitures aimed at cutting costs, gaining economies of scale, increasing returns on investment, and boosting profitability. The industry leaders tended to emphasize that these dramatic steps were a response to economic hardships the industry experienced in the 1990s. But other factors were also mentioned, such as the efforts of vertically integrated

¹The United States is not unique in this respect. Many discussants noted that the refining industries in Europe and Asia also were experiencing protracted economic difficulties.

firms to improve their upstream crude oil reserve and production portfolios.² Consolidation of downstream operations was, to a great extent, a result of these efforts.

Regardless of the causes of consolidation, the effect has been a much greater concentration of ownership of refining capacity. In 2002, 58 firms were engaged in refining in the United States, down from 189 firms in 1981. According to one discussant's calculations, the ten largest downstream firms controlled four-fifths of U.S. refining capacity in 2002, up from just over one-half in 1997. As a result of industry consolidation, an unprecedented number of refineries have changed hands in recent years, often leading to a sense of amazement among executives at the latest disposition of various facilities.

A second related phenomenon has been the divestiture or decommissioning of marginal refining assets as the majors, in particular, have sought to cut overhead costs by focusing on their largest and most complex refineries while disposing of smaller refineries—especially if they were of low process complexity (capable of refining only a narrow range of petroleum grades). Some companies also have exited the downstream altogether, as one firm, Williams, announced shortly after meeting with RAND.

I think the industry has learned that it's okay to fall short on product. There is no reward for being long on product or production capability.

—*Industry observer*

Finally, many refiners said they were pursuing a more selective or conservative market strategy. One means is limiting their operations only to product segments or regions where they held a leading or strong position (see Regionalization, below). Second, some downstream executives asserted that management had learned a difficult lesson from the industry's recent economic hardship: Cutting costs is paramount. Increasing capacity and output to gain market share or to offset the cost of regulatory upgrades is now frowned upon. On this point, an independent refiner stated that his strategy was “cheapskate investments” and relying on his existing plant and equipment to the greatest possible extent, even if that ultimately meant curtailing output of certain refined products. Indeed, many RAND discussants openly questioned the once-universal

²Financial analyses of mergers and acquisitions and subsequent performance of the supermajors—for example, by Deutsche Bank (2002) of ExxonMobil, ChevronTexaco, and BP—also emphasize the upstream impacts.

imperative of a refinery not “going short”—that is, not having enough product to meet market demand. Rather than investing in and operating refineries to ensure that markets were fully supplied all the time, refiners suggested that they were focusing first on ensuring that their branded retailers are adequately supplied by curtailing sales to wholesale markets if needed. “The industry is a lot smarter,” said one industry representative. “The 80s and 90s were ugly for refining. [Executives] know what caused it, and they don’t want to do it again.”

In ten years, the top ten refiners—maybe it will be eight—will have 100 percent of capacity.

—Refining executive

Industry executives offered contrasting views about the terms under which consolidation has proceeded. Many executives complained about the low market value of refining assets (“pennies on the dollar”); others spoke of opportunities in acquiring and improving the management and operational capabilities of undervalued assets. “There is a lot of value you can get from investment,” said an executive of a firm that recently had acquired refineries, “We turn problems into opportunities.” Most of the individual refineries placed on the market have been bought by independent refiners, several of which have rapidly emerged as more-prominent players in the downstream sector. Foreign firms, too, have been investing in U.S. refineries: Foreign ownership of U.S. refineries rose from 19.1 percent of total capacity at the end of 1990 to 23.7 percent ten years later. More firms were said to be prospecting for the right opportunities. Foreign investment in U.S. refining signals investors’ favorable opinion about the sector and “infuses vitality into the industry,” observed one discussant. “As globalization continues, marginal operations will be picked up,” said a supplier executive. This point of view coincides with the general expectation among refining industry leaders that restructuring and consolidation will continue for the foreseeable future.

IS THE DOWNSTREAM ENJOYING AN ECONOMIC RECOVERY?

The consolidation of the downstream, combined with companies’ ongoing internal efforts at cost-cutting, appears to have had the salutary effect executives intended. Data gathered by the Energy Information Administration (EIA) indicate that between 1991 and 2000, mid-size and large refiners (accounting for 92 percent of refining capacity in 2001), aided by falling crude oil prices, were able to reduce per-barrel operating costs by over \$2.50, or one-third (Figure 2.1). This enabled them to gradually recover their profit margins,

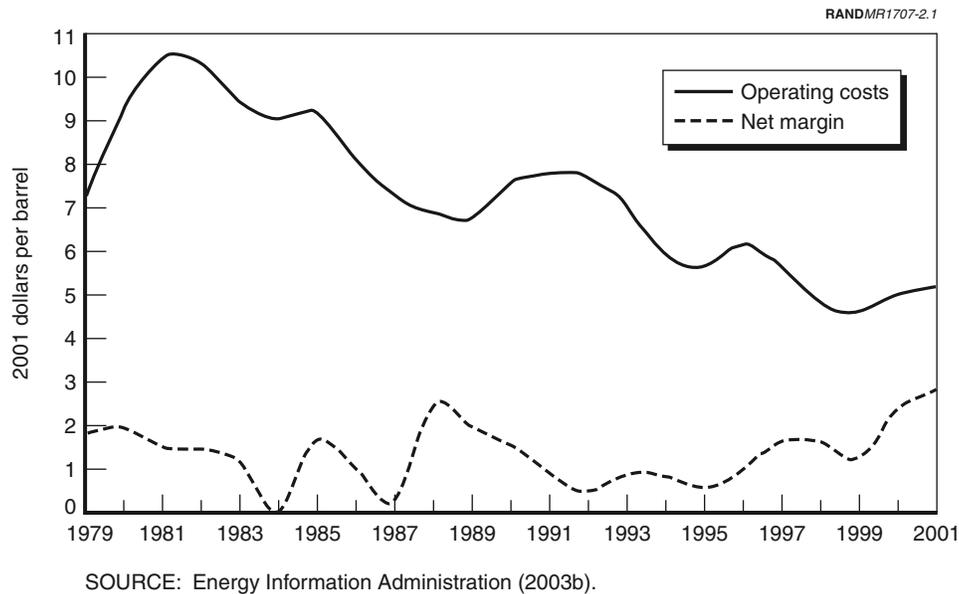


Figure 2.1—Operating Costs and Margins for Mid-Size and Large U.S. Refiners, 1979–2001

despite such burdens as mandated regulatory investment. In 2001, profit margins, at \$2.78 per barrel, were the highest since the EIA started tracking industry performance in 1979. Aggregate return on investment (ROI) for larger refiner-marketers reached 14.5 percent, making 2001 nearly a record year and signaling what the EIA (2003a) termed a “golden age” in refining.

Although many RAND discussants were still deeply pessimistic about the fortunes of the downstream in general, especially with respect to regulations, most were sanguine about the current economic performance and future prospects of *their own firms*. This dual view may stem from the proposition often put forth in the discussions that regulation is undesirable. This phenomenon may also be the result of discussants’ fuller understanding of conditions in their organization, such as their initiatives to reduce energy, labor, marketing, and other manufacturing and business costs. These individual assessments, taken in aggregate, suggest that the vitality of the industry is greater than often portrayed.

As consolidation has proceeded, many in the industry believe that smaller refiners are at a greater economic disadvantage. Yet the executives of small and mid-size refining firms with whom RAND spoke were optimistic about their firms’ ability to comply with regulatory requirements, maintain profitability, and stay independent. A critical asset of many smaller refiners is their location

in interior markets where a lack of pipeline access protects them from competition from large coastal refineries. “We have two very profitable little refineries,” said an executive of a smaller refining firm. “I am not terribly concerned about staying in business,” asserted another. Yet having a protected market was not the only reason for success. In particular, executives of smaller companies noted favorable opportunities to be realized through strategic acquisition of smaller refineries, no longer seen as attractive to the super-majors. “The independents have done nicely with them,” one executive said.³

The public has a number of misunderstandings about the refining business. People think that it is a highly profitable business that gouges the public. In fact, some refineries make money, and some don't. You need to have a whole industry that is profitable to have a stable energy supply in this country.

—*Refining executive*

While they spoke of the economic hardships the refining industry faced, the RAND discussants were also cognizant that the public and parts of the government often view the industry with skepticism and may maintain unfavorable views of the sector's status. “Joe Q. Public believes this industry is raking it in [and] the books are cooked,” said one operating company executive.⁴ Many noted that the occasional surges in refined products prices have yielded extra revenue for some favorably positioned refiners, but they added that the benefits tend to be short-lived and attract public outcry and government scrutiny.⁵ “If things don't go right, our industry gets nailed,” said one observer. For members of the downstream, an executive stated, “The best PR is no PR.” To this point, another predicted that public scrutiny would get more intense should supply disruptions and price spikes occur more frequently in the future, as some predict. He added, “To be in the refinery industry you have to be a bit thick-skinned.”

The history of low margins was not the only economic problem cited: Discussants also pointed out that the fortunes of the downstream, like many other sec-

³Throughout this report, we make an important distinction between small refineries (i.e., small operations) and small refiners (firms whose total refining capacity and business operations are small in comparison with the industry as a whole). Large refiners often manage both large and small refineries. Small refiners typically operate smaller refineries.

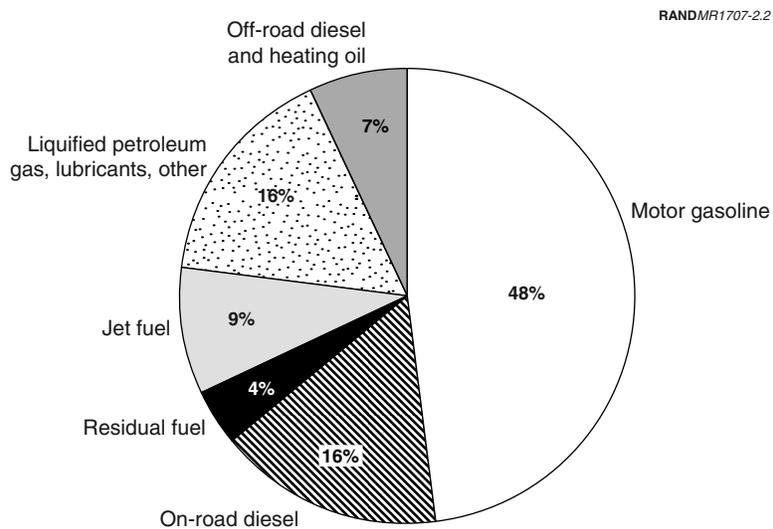
⁴According to a 2002 *Wall Street Journal* poll, three-quarters of Americans believed that recent price fluctuations were the result of “industry manipulation” (Harwood, 2002).

⁵In 2001 and 2002, for example, the Federal Trade Commission (2001a, 2001b) conducted an investigation and held public conferences to examine issues concerning prices of refined petroleum products. The investigations did not find evidence of collusion, market manipulation, or anticompetitive behavior.

tors, are cyclical—a condition evident in Figure 2.2. Over the long term, many executives asserted, economic volatility and uncertainty weigh on an industry that has substantial fixed capital assets and extended planning horizons. To assure reliable and adequate supplies of petroleum products, they said, reliable earnings at respectable levels are required—earnings somewhat higher than the recent average. “Price is not a problem, but a solution,” said one refiner representative. The questions of how enhanced economic sustainability was to be achieved and what constituted an appropriate balance of interests of both producers and consumers were not stipulated in comments made to RAND.

PRODUCT SLATE

Figure 2.2 breaks out the products refined from the average barrel of crude oil in 2001. Gasoline and on-road diesel accounted for almost two-thirds of the total. Approximately 60 percent of diesel fuel produced is low-sulfur fuel produced for the on-road (highway) market, and 40 percent is higher-sulfur fuel for the off-road market (e.g., construction, farming, locomotives, shipping, and mining). Refineries also produce a number of other products, such as kerosene, home heating oil, industrial fuels, liquefied petroleum gas, lubricants, waxes, road oil, asphalt, and coke. Executives noted that in response to falling market demand, the refining industry has been gradually shifting production away



SOURCE: Energy Information Administration (2002a).

Figure 2.2—U.S. Refining Industry Product Slate

from home heating oil and residual fuels in favor of higher-value transportation fuels. Refiners saw this trend continuing.

Several discussants observed that the product slate in the European Union has experienced a significant shift away from gasoline consumption in favor of diesel fuel. Dieselization of the passenger vehicle fleet in Europe has been a priority of energy policy, undertaken to depress fuel consumption and reduce greenhouse gas emissions. Many executives pointed to recent advances in diesel engine technology and touted the superior energy efficiency of diesel compared with gasoline engines. However, most did not see dieselization of the passenger fleet in the U.S. as likely, given the public's lingering unfavorable perception of diesel engine performance kindled in the 1970s and 1980s; current automobile emissions regulations; and the opposition of environmental advocates.⁶ One question raised by some discussants was whether European refineries, which have excess gasoline production capacity because of the shift in demand to diesel, would be increasing their gasoline exports to the U.S. market in the future.

HIGHER-PERFORMANCE FUELS

Although demand for petroleum products has grown slowly over the past 25 years, the quality and performance of petroleum products have changed substantially. Oil companies actively advertise the unique performance characteristics of their products (such as higher octane and special additive packages), but the refiners with whom RAND met noted that the performance enhancements they mentioned were mandated by regulations, not consumer preferences.⁷

Gasoline is not gasoline anymore. It is a specialty chemical.

—*Technology and services executive*

In the 1980s, after placing emissions controls on motor vehicles, the United States turned its transportation air quality agenda to mitigating the environmental and public health impacts of fuels themselves. One goal has been to re-

⁶Some environmental advocates' positions on dieselization of the passenger fleet are evolving as they place greater priority on reducing greenhouse gas emissions and in their recognition of the potential to reduce emissions of particulates, sulfur oxides, and nitrogen oxides through improvements in diesel engines and fuel.

⁷The situation is similar in other highly regulated sectors, such as pharmaceuticals and utilities, and to a lesser extent, automobiles.

duce environmental degradation caused by fuel handling, such as the release of smog-forming volatile organic compounds and toxics (e.g., aromatics such as benzene), and by MTBE, which in some instances has leaked from underground storage tanks and entered the water table. A second goal has been to reduce air emissions from fuel combustion. Fuel desulfurization helps reduce sulfur oxides emissions, and ultra-low-sulfur fuels would facilitate the operation of advanced emissions control devices on future vehicles. Automobile and truck manufacturers have pressed for improvements in the engine performance characteristics of gasoline (measured in terms of the Drivability Index) and diesel (higher cetane content) for upcoming higher-performance engines. Table 2.1 lists principal fuel specifications.

The RAND discussants consistently cited desulfurization of transportation fuels (primarily gasoline and diesel) as the most pressing issue, given the required capital investments and system reliability hurdles. But they saw continued

Table 2.1
Summary of Major Fuel Specifications

Goal	Current	Mandated	Proposed or Under Discussion
Reduce sulfur content	Low-sulfur gasoline (300 ppm maximum)	Tier 2 gasoline (30 ppm average), 2004–2007	Low-sulfur diesel for off-road uses, 2007, transitioning to ultra-low sulfur in 2010
	Low sulfur diesel (500 ppm maximum)	Ultra-low-sulfur (15 ppm maximum) diesel for highway uses, 2006–2010	Sulfur reduction for home heating oil, jet fuel
Reduce smog-forming compounds released during fuels handling			Reduce vapor pressure
Reduce smog-forming emissions from motor vehicles	Reformulated gasoline in high-pollution areas		
Reduce toxics and other chemical exposures during fuel handling and storage	Mobile Source Air Toxics rule for gasoline	Caps or bans on MTBE use in 17 states (e.g. California ban, 2004)	MTBE bans and caps in other states
Improve engine performance	Drivability Index		Increase Drivability Index
			Increase diesel cetane content
Use non-petroleum-based feedstocks			Renewable fuels standard (5 billion gallons per year by 2012)

desulfurization as inevitable and, in many discussants' minds, a positive trend that would continue well past the current regulatory cycle.

Looking farther into the future, refiners felt that incremental changes to gasoline, diesel fuel, and, to a lesser extent, jet and other fuels, would continue. They did not foresee the emergence of fundamentally different ultra-clean "transition" fuels, such as oxygenates, compressed natural gas, and synthetic liquid fuels derived from natural gas—except as blending components or in niche applications. They generally viewed such fuels as not within the planning horizon of most refineries and believed they had fundamental economic and technical shortcomings that would preclude deep market penetration.

REGIONALIZATION OF PRODUCTS MARKETS

The refining industry is dominated by legacy assets. In many cases these are century-old sites, chosen because they were near major population centers or crude oil supplies (e.g., major producing fields, crude oil pipelines, and ports) of that time. As a result, most major refineries are clustered along the coasts. Because of demographic shifts, the movement of industry, and changing crude oil supplies in the intervening years, this hardware legacy no longer matches current supply-and-demand patterns for many regions and communities.

In response to the changing geography of consumption, a complex network of refined-products pipelines has evolved. Nevertheless, discussants pointed out that pipeline service, too, is uneven across the United States, as Figure 2.3 illustrates. The Pacific Northwest, Rocky Mountains, and Intermountain West, where populations have grown rapidly, rely largely on local capacity—typically from small and mid-size refineries. They have only limited pipeline access from large Gulf Coast and California refineries. California, Nevada, and parts of Arizona are largely walled off from the rest of the country by both geography and stringent local environmental regulations. Given rapid population growth in those regions and stringent air quality standards in California, the West was repeatedly cited as having a tight market. The East Coast and the Midwest, while having relatively few refineries given the size of their population, obtain approximately 40 and 20 percent, respectively, via pipeline and water carriers from Gulf Coast mega-refineries. The Northeast also relies on a large increment of refined products (17 percent in 1999) imported from abroad, giving that region a measure of additional market liquidity. One solution put forth by several discussants to improve the liquidity of markets in the West was the construction and expansion of products pipelines to provide more access to the region from large Gulf Coast refineries.



SOURCE: Association of Oil Pipe Lines (2002).

Figure 2.3—Major Refineries and Refined-Products Pipelines

With the restructuring of the refining industry that started in the 1980s, refinery operations have become more concentrated both regionally and nationally. Most shut-down refineries have been smaller operations. Between 1985 and 2001, the mean throughput of a U.S. refinery increased by over one-third—from 80,000 to 109,000 barrels of crude distillation capacity per day. To cut costs, operating companies have sought to concentrate their activities in markets in which they hold a leading market share. Only a few large firms today have a national refining reach or a nationwide refinery system. Participants in the RAND discussions conveyed the sense that, although more refining assets have been brought under common corporate roofs, the facilities' diverse hardware make-ups, dispersed locations, different relationships to the supply chain, and unique operating histories and cultures have made the creation of integrated systems a complex, long-term proposition.

[Our firm] makes a lot of money by being flexible and making boutique fuels. It's a benefit for us, not for everybody.

—Refining executive

As with many other businesses, refining is experiencing increased market and product segmentation. This phenomenon has been driven largely by an increase in the number of fuel-performance specifications. The 1990 Clean Air Act Amendments allow states and localities to establish their own fuel-quality specifications to meet national ambient air-quality goals. This has led to the proliferation of transportation fuels. According to one estimate, at least 15 distinct formulations of gasoline are required throughout the United States in the summer months, not including the three grades of gasoline normally sold. As Figure 2.4 shows, many of the United States' largest fuels markets—northern and southern California, Las Vegas, Phoenix, Houston, Denver, Chicago-Milwaukee, Atlanta, Miami-Fort Lauderdale, and the Eastern Seaboard—have unique fuel specifications. The proliferation of “boutique fuels,” compounded by regulations mandating that refiners in many regions produce different formulations in the summer and winter, adds complexity and rigidity to refiners' operations and to the market and thus can increase upward price pressures.⁸ Only a handful of suppliers—or even fewer—service many boutique fuels markets (such as the Chicago-Milwaukee area), giving rise to the possibility of market control, said several industry observers. Moreover, when a production or supply disruption occurs, fuels cannot be easily moved from one region to another without violating air quality regulations. “It's a crazy quilt” that makes it difficult for the industry to respond, asserted one executive.

The industry representatives with whom we spoke were divided on the subject of boutique fuels. Several discussants called for harmonization of fuel specifications and mentioned Environmental Protection Agency (EPA) efforts to this end. One discussant stated that greater homogeneity in the fuels supply would eventually return as more states and regions adopted the stringent California standards. Two discussants asserted that many refining firms have an economic interest in local specifications. Despite the aforementioned supply chain complexities, some refiners benefit because boutique fuels help create higher hurdles for entry to regulated markets. Harmonization could eliminate more-marginal refineries that produce for such niche markets. Thus, the real industry concern behind boutique fuels is not clean air objectives but competition between refiners already in protected markets and those who wanted access to them. “Every place with a boutique fuel has had an interface with industry,” asserted one discussant, suggesting that refiners often lobby for fuels specifications. “[This] is really an argument between competitors in the oil business. People from the outside want to get in.” Refiners approach the issue according to their “individual interests” or “on a case-by-case basis, depending on whose ox is getting gored at the moment,” said another executive.

⁸A simple analogy for local fuels specifications is the use of different railroad gauges, which once hampered the movement of people and freight.

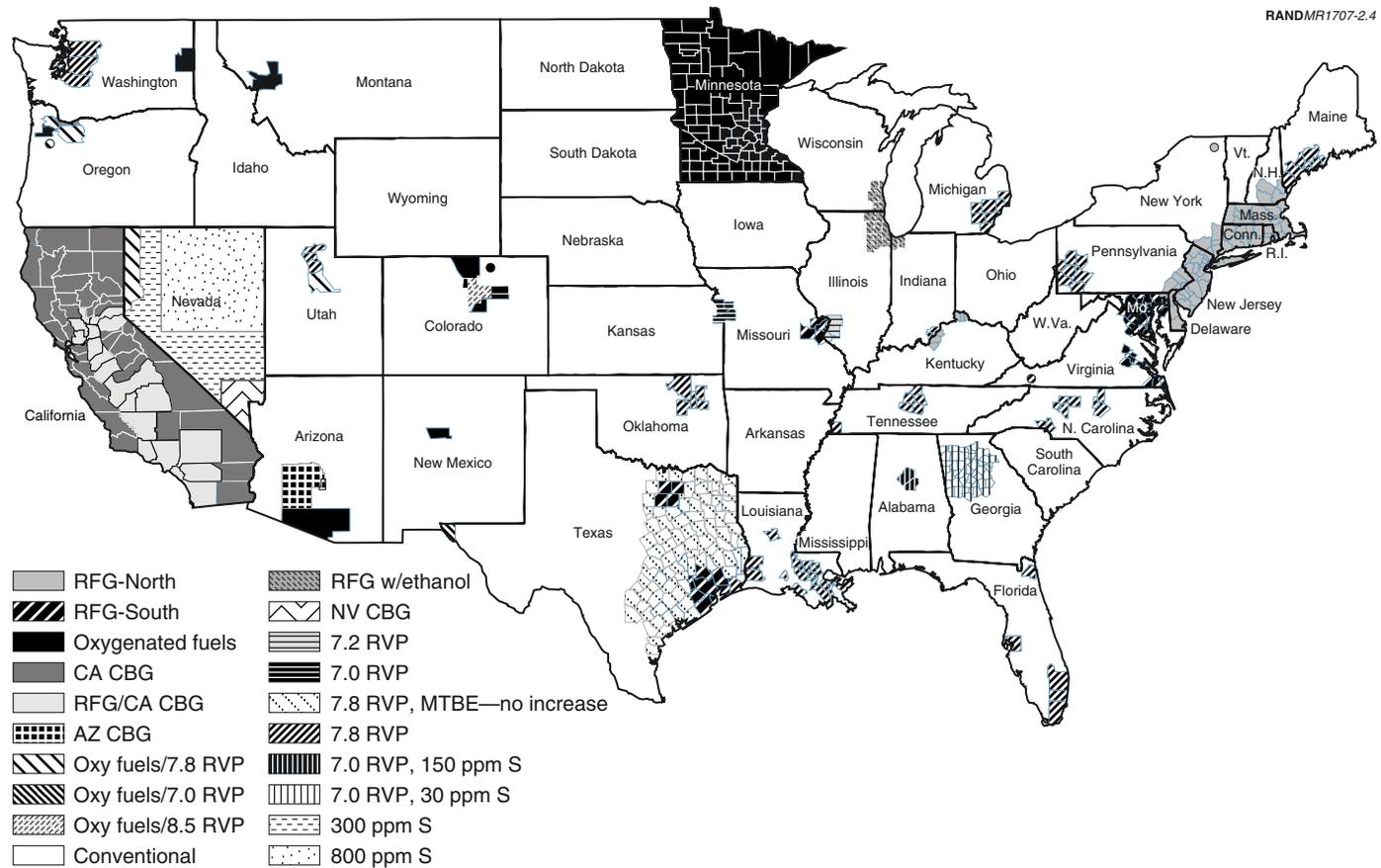


Figure 2.4—U.S. Gasoline Requirements, January 2003

Harmonization of standards would go a long way toward solving volatility issues, but every boutique fuel has [support in] the refining industry—often individual companies lobbying. But when a problem arises, you cannot move fuel into the region.

—*Refining executive*

In sum, while transportation fuels and other refined products are supplied nationwide, often under nationally known brand names, the downstream is best viewed not as a national industry or market but rather as an agglomeration of regional, even refinery-specific markets, partially connected by marketing agreements and the distribution infrastructure. Discussions of supply and demand in particular must be viewed at a regional level. While warnings have been sounded about potential supply shortfalls (National Energy Policy Development Group, 2001; National Petroleum Council, 2000; Federal Trade Commission, 2001b), industry discussants said that only two regions are extraordinarily exposed—California and, to a lesser extent, the Upper Midwest—largely because of regional fuel specifications and distribution infrastructure constraints.

FUTURE DEMAND

Among refining industry executives, expectations about future trends in demand diverged greatly. Most refinery executives felt that, after the current slowdown in growth, the total demand for petroleum products would continue increasing in the foreseeable future, given demographic trends, increasing per-capita miles driven, and consumer preference for heavier passenger vehicles with greater horsepower. Fuel efficiency, several discussants added, was not a priority of automobile buyers. Furthermore, even if efforts to boost the efficiency of new vehicles, such as Corporate Average Fuel Economy standards, were implemented, they would not significantly affect aggregate demand for at least five years because of technology diffusion lead times and the slow turnover of the vehicle pool. Such views are in accordance with forecasts made by the Energy Information Agency (2003b). In the agency's reference (business-as-usual) scenario, total petroleum product demand is projected to increase 38 percent—from 19.7 million barrels per day in 2001 to 23 million barrels in 2010 and 29.2 million barrels in 2025, or 1.7 percent annually. Between 2001 and 2010 the average annual increase in demand is projected to be 366,000 barrels per day—equivalent to the output of a large refinery. Executives questioned whether the industry could meet this demand given various technical, economic, and regulatory barriers they faced.

In contrast, several refining industry executives said that total demand, including demand for gasoline, could taper off in the foreseeable future, although

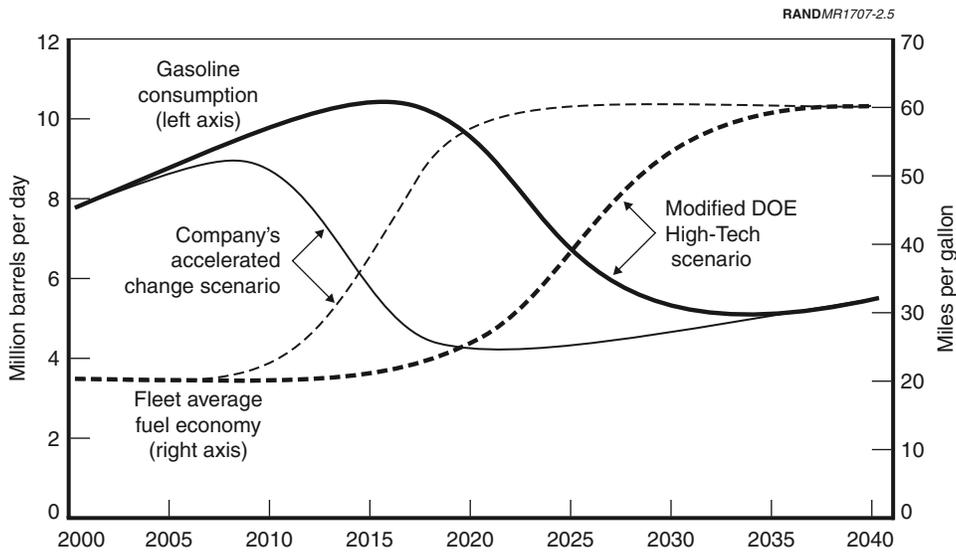
such a scenario runs counter to the EIA forecasts noted above. These executives saw the diffusion of hybrid (gasoline-electric) vehicles as a critical factor. One executive reported that he had driven a hybrid car and thought the technology impressive. Other potential developments that could affect fuel demand were diesel-electric hybrid and high-efficiency diesel engines, and changing tastes in vehicle size and use. One operating company manager added that, although U.S. car buyers are generally indifferent to fuel economy today, in 10–15 years, public awareness of and opinion about climate change and energy security issues might swing significantly toward greater fuel efficiency: “We are in the energy business, but to be in it, you have to have your eyes open to what might happen.” “Traumatic supply situations” (i.e., interruptions in crude oil flows from exporting countries as in the 1970s) were seen as another potential driver of efforts to achieve greater fuel efficiency, according to another operating company manager.

Some executives viewed greater fuel efficiency and reducing greenhouse gas emissions in a positive light. The following are the views of executives from two mid-size refining firms.

—Consuming less fuel is the way we have to go to reduce emissions. Of course it impacts our business, but we have to be concerned about the environment and future generations.

—I am not supposed to say this, but we need higher CAFE [Corporate Average Fuel Economy] standards. We are importing a lot of oil. Why are we doing this as a nation? I am not terribly concerned about my job, about the viability of my facilities. You have to be realistic about what are the best interests of the country as a whole. We are here to serve the public.

Another operating company executive acknowledged the potential for a moderation of demand: “It’s on our radar screen. We have a concern.” He had discussed with his firm’s leadership a motor vehicle technology and gasoline demand scenario significantly more aggressive than the most optimistic fleet efficiency and alternative fuels power plant scenario developed by the Department of Energy’s Office of Transportation Technologies (2001). Assuming the rapid diffusion of 60 miles-per-gallon vehicles, he estimated that gasoline demand could peak by 2008 and then rapidly fall by over one-half by 2020 (Figure 2.5). Another executive at a major refiner was thinking on a similar scale: “Maybe a third of gasoline demand will fall off within 15 years because of advanced vehicle technologies.”



NOTE: High-Tech scenario modified from work by the DOE Office of Transportation Technologies (2001).

Figure 2.5—One Company's View of Potential Gasoline Demand

Looking at the longer term, many RAND discussants spoke of the advent of fuel cell vehicles, which could also affect the demand for petroleum fuels. Several petroleum companies have partnered with automobile manufacturers, fuel cell developers, and the federal government to develop and test fuel cell vehicles, with the expectation that they will start to become available on the U.S. market by 2010.⁹ Nevertheless, refining industry representatives with whom RAND spoke were less sanguine about the prospect for fuel cell technology and its ability to affect fuel demand in the mid- to long-term. These views were largely based on an assessment of the alternatives. Hybrid vehicle technologies were already a proven technology that could utilize the existing refueling infrastructure. Moreover, they have familiar road performance characteristics attractive to the general consumer and a reasonable price premium. According to one technology supplier, “why go to fuel cells if [auto manufacturers] are already working on second generation hybrids?” An independent refiner echoed this sentiment, “Not a cent should be spent on fuel cells until hybrids and diesel engine options are explored.”

⁹In January 2003, after the RAND discussions were conducted, the Bush Administration announced a major initiative to develop hydrogen-powered fuel cell vehicles.

Our goal is to have petroleum remain the fuel of choice.

—Operating company manager

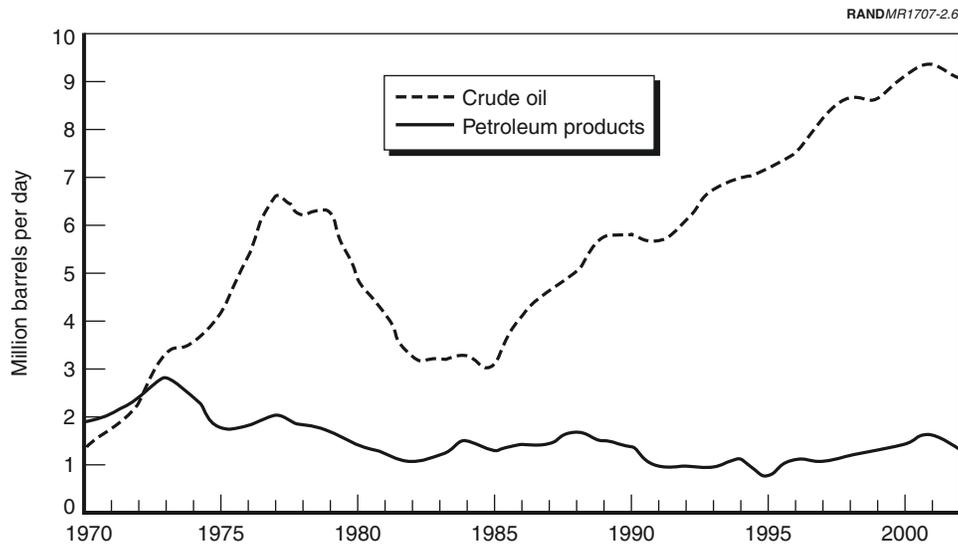
Industry discussants were unanimous in the opinion that when fuel cell vehicles come to market, they should be powered by petroleum-based liquid fuels using an onboard reformer as opposed to hydrogen. They noted the advantages of the existing manufacturing, distribution, and retail infrastructure for liquid fuels, and handling and safety issues associated with hydrogen. Accordingly, many felt that the enthusiasm for a “hydrogen economy” was premature and that the automotive industry and fuel-cell advocates were fostering unrealistic expectations.

IMPORTS

The U.S. imports a variety of intermediate and final petroleum products, of which gasoline is the most common. The subject of imports was a prominent theme in the RAND discussions, particularly for operating company representatives, and they expressed strong and diverging views about the economic and strategic significance to the United States of imported petroleum products.

Over the past 25 years, intermediate and finished petroleum product imports have averaged about 1–2 million barrels net a day (refined product imports minus refined product exports) (see Figure 2.6). In 2001, motor gasoline and motor gasoline blending components accounted for 29 percent of imports to the United States. Petroleum coke accounted for over one-third of all exports, measured in barrels of crude-oil equivalent. Although U.S. dependence on imported crude oil has increased substantially since the 1970s, all the increase in demand for intermediate and finished products has been supplied by domestic manufacturing. In other words, to meet increased energy demand over the years, the United States has been importing more crude but refining it domestically rather than buying refined product abroad. As a result, the share of net imports of *refined products* of total consumption has fallen significantly over time, from 12.6 percent in 1970 to 7 percent in 2002.

Imports add flexibility and liquidity to the market, especially when local markets tighten, and thus serve as a price-setting mechanism that contributes to lower prices and a more reliable supply. In the winter of 1999–2000, for instance, imports from Europe helped dampen a major increase in home



SOURCE: Energy Information Administration (2002a, 2003c).

Figure 2.6—U.S. Net Imports of Crude Oil and Intermediate and Finished Petroleum Products, 1970–2002

heating oil prices in the Northeast that resulted from high demand due to cold weather.

Nevertheless, many refining industry representatives in the RAND discussions spoke about “unfair foreign competition” and the need for duties and other measures to restrain imports. Some refiners asserted that foreign refiners do not have to contend with the increasingly stringent plant-level emissions controls and complex permitting processes they face. “Exporting countries are able to land product from facilities abroad, but they are not subject to the same environmental regulations,” said a technology and services executive. “If we are really serious about cleaning the air, we have to put on an import duty,” said another discussant.¹⁰ One claimed that reliance on foreign-source refined products was worse than reliance on imported crude oil, adding, “The provision and distribution of refined fuels are very important strategic interests of the United States.”

¹⁰About 50 percent of product imports come from Canada, the U.S. Virgin Islands, and the European Union, where environmental regulations are roughly on par with those in the United States.

At some time we need to really start worrying about finished goods independence. If we lose that, security and economic consequences abound.

—*Technology and services executive*

However, more-exacting fuel specifications, especially boutique fuels, help create a protected market for domestic refiners. “We island ourselves off,” said one executive, despite a surplus of capacity around the world. Fuel specifications are “regulating product imports out of the market,” said another, since a refinery must be uniquely configured to meet such requirements. This is especially true for the California market, which has the most stringent specifications. Consequently, discussants said, when imports do rise, it is usually a response to niche and short-term (spot) opportunities, when domestic fuels prices rise significantly above world market prices for more than a couple of months. This is the period of time it typically takes to stimulate traders’ interest in procuring foreign product and securing and transporting it to the target market. This helps European refiners that produce a surplus of gasoline, given the rapidly growing demand for diesel fuel there. “People who export to the U.S. are trying to take advantage of a temporary situation,” and are not in for the long haul, asserted one operating company executive.

Most refineries in Latin America and Asia were viewed as not having sufficient complexity to be significant players in the U.S. products market, even though many suffer from overcapacity in their local markets. Moreover, many discussants asserted that refiners in these countries cannot muster the large investments required to produce cleaner fuels in a consistent manner for the U.S. market. “From what I am seeing, Mexico and Indonesia are not shipping to the U.S. except for some blend stocks,” said one engineering and construction executive. “We don’t see a deliberate effort to manufacture gasoline offshore to import” into the United States, said another engineering and construction firm executive.

Rather than produce finished products, several downstream leaders suggested that foreign producers in the future would focus on production of intermediate products for finishing in the United States. Examples cited were the rapidly increasing output of synthetic crude (*syncrude*) produced from tar sands in Canada and growing capabilities for heavy crude upgrading in Venezuela, Mexico, and the Caspian Basin. There are already “very complex refinery pieces on top of wells” at fields producing heavy, high-sulfur crudes, one discussant noted. Such a two-stage refining strategy could help U.S. refiners increase capacity while avoiding regulatory and permitting constraints.

It should be noted that industry expectations about the likelihood of increased imports differ significantly from mid- and longer-term forecasts made by the Energy Information Agency (2003b). To meet anticipated shortfalls in domestic refinery output relative to demand, the EIA estimates that intermediate and finished product imports will have to grow significantly: from 1.27 million barrels a day in 2005 to 2.25 million barrels a day in 2010 and 5.06 million barrels a day in 2020, when net imports are projected to satisfy an estimated 18 percent of domestic demand. This suggests that a significant change in strategy will occur for some foreign refiners—from opportunistic to sustained exports to the United States.