



**Center for Strategic and International Studies**

**Arleigh A. Burke Chair in Strategy**

1800 K Street, N.W. • Suite 400 • Washington, DC 20006

Phone: 1 (202) 775-3270 • Fax: 1 (202) 457-8746

**Saudi Arabia's Upstream and  
Downstream Expansion  
Plans for the Next Decade:**

**A Saudi Perspective**

**Nawaf Obaid  
Adjunct Fellow, CSIS**

**Nathaniel Kern  
FOREIGN REPORTS INC.**

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## **Introduction**

Much is being said and written about Saudi oil production and export capabilities and plans that pay little attention to the details of Saudi plans. Saudi Arabia is, however, reacting to the changes in the world oil market with major efforts to maintain and expand its present upstream oil production capacity and to expand its downstream capacity to deal with the shortage of world refining capacity.

If Saudi plans are successful, these plans to expand its crude oil production capacity and its refining capacity will help ease the growing strains on world oil supply. Under some market conditions, they may do more. They may be able to create enough spare capacity in both sectors to prevent the kind of price spikes that have hit energy markets during the past two years.

This is particularly likely if moderately high prices limit rampant demand growth between now and the end of this decade. All forecasts of energy supply and demand are predicated on assumptions about energy prices.

Prior to 2004, most reputable forecasters assumed that oil prices would hover around \$25 in constant dollars and projected that the world would require steady increases in crude oil supply from Saudi Arabia over the next two decades, gradually doubling the demand for Saudi crude. A combination of low actual prices and such forecasts then, however, created only a limited incentive for exporting countries to invest in new oil production and export capacity.

The world market has changed drastically over the last few years, and Saudi Arabia has reacted accordingly. When crude oil prices exceeded \$40 per barrel in mid-2004 as a result of unexpected growth in world demand, the Kingdom of Saudi Arabia accelerated its two-prong strategy aimed at expanding both its crude production capacity and its refining capacity around the world.

Saudi planning now appears to be based on the estimate that prices that at least average close to \$40 per barrel will be sustained over the coming decades, and on the impact this will have on world demand. Recent forecasts from the U.S. Government's Energy Information Administration take into account the effect of higher prices on supply and demand over time. In its new 2005 forecasts, the EIA has a scenario where world crude oil prices are assumed to average \$48 in constant 2003 dollars (i.e., some \$10 below the current OPEC basket price) through 2025. In this scenario, the EIA projects no increase in demand for Saudi crude between now and 2010 and only a 10% increase by 2025.

There are no certainties in the energy business, but a detailed review of Saudi expansion plans suggests that the Kingdom's intended and ongoing investments in both the upstream and downstream capacity over the next five years will not only ensure the proper expansion and development of Saudi oil reserves, but help create the spare capacity that world oil markets need to overcome the effects of supply disruptions, such as have occurred during this year's hurricane season.

The concentration of spare capacity in Saudi Arabia does, of course, increase the world's vulnerability to the potential of catastrophic loss of Saudi supply due to terrorist attacks, political instability or acts of war, which could only be partially offset by consumer

nations' strategic stocks and demand restraints. This, however, has been a facet of energy security for several decades. The more pertinent question is whether Saudi Arabia can move over the next few years to restore the effectiveness of its spare capacity, not whether spare capacity will be more highly concentrated in Saudi Arabia.

### **Integrating Upstream and Downstream Expansion Plans**

Over the past 25 years, Saudi Arabia's spare crude production capacity enabled it to ensure oil market stability through a variety of world supply disruptions—from Iraq's invasion of Kuwait in 1990, to the crippling 2002 strike in Venezuela, unrest in Nigeria, and the U.S. invasion of Iraq in 2003. As a result of Saudi Arabia's using its spare crude production capacity, world oil prices at the peak of each of these physical disruptions were lower than they were at their onset.

This has not been the case in 2004 and 2005, largely because the rapid growth in world demand for oil products led to a disparity between the quality of Saudi Arabia's spare crude production capacity and the ability of the world's refining industry to turn lower quality crudes into the products the market demands.

This has led to a Saudi strategy designed to improve the quality, as well as the quantity of Saudi oil exports.

On the upstream side, the Saudi strategy is aimed at increasing its capacity to produce the higher quality crudes, which match the ability of the world's refining system. On the downstream side, Saudi Arabia is investing in new and upgraded refineries to handle lower quality crudes.

As these new capacities come on stream between now and 2009, their impact should combine with that of the impact of higher prices on world supply and demand. As a result, the world's oil markets should be in better shape to overcome disruptions in the supply chain.

## Upstream

At present, Saudi Arabia's national oil company, Saudi Aramco, reports 260 billion barrels of proven recoverable reserves of crude oil. The company has developed, and is currently producing from, one-half of those reserves. Saudi Aramco has said that its aggressive oil exploration program, and the future use of enhanced oil recovery techniques, may provide another 200 billion barrels worth of such reserves.

Saudi Aramco's expansion plans do not, however, depend solely on increasing its proven reserves. In order to maintain the current capacity, the Kingdom has adopted a "reservoir management strategy" to further maximize recovery prospects in the fields and maintain long-term sustainability.<sup>1</sup> This reservoir management strategy includes applying state-of-the-art diagnostic capabilities that incorporate surveillance programs to assure the accuracy of field forecasts and maintain maximum operational efficiency.<sup>2</sup> For example, using this advanced technology to increase the recovery rate by only 10% would amount to an added 70 billion barrels of recoverable reserves. The Saudi reservoir management team is not only aiming at the next few decades, but also looking into development production strategies 50 years from now.<sup>3</sup>

### **Oil Field Depletion Rates & Capacity**

Saudi Aramco has 85 oil fields, 320 reservoirs within those fields and approximately 1,000 producing wells. More than 50% of reserves are located in eight fields.

Saudi Aramco's total depletion rate to date is estimated to be between 28-30 percent. Currently, Saudi Aramco crude oil production capacity is approximately 10.65 million b/d, which would bring Kingdom-wide capacity to more than 10.9 million b/d when its share of the Neutral Zone is included.

Saudi Aramco is confident that it can produce up to 15 million b/d in the future and continue that level of production for the next 50 years. In June 2005, Aramco's senior vice president of gas operations, Khalid al-Falih, indicated that Saudi Aramco would increase production capacity to more than 12 million b/d by 2009, or more if demands required. Moreover, Falih stated that Saudi Aramco would have 90 drilling rigs operating by early 2006. That is more than twice the number in operation in 2004, and three times the number in operation during the previous decade.

These plans reflect a major change in Saudi strategy. Up until 2004, Saudi Aramco operated under the assumption that maintaining maximum sustainable capacity (MSC-90) of 10 million b/d provided an ample cushion of capacity, given that market conditions since 1990 rarely warranted Saudi Aramco production much above 8 million b/d and sometimes dictated lower production. In fact, although world oil consumption rose by 12.5 million b/d between 1994 and 2004, Saudi Arabia's production in 2002 was more than 100,000 b/d lower than it had been in 1994, thanks to competition from other suppliers and Saudi Arabia's leading role in supply management. It is only in the past two-and-half years that Saudi Arabia has been able to regain some of the market share it lost in the previous decade.<sup>4</sup>

Accordingly, it was not until mid-2004 that Saudi Aramco began to reclassify one of its increments of new production—Qatif and Abu Safah—as an addition to capacity rather

than a replacement for previous production declines. In September 2004, Petroleum Minister Naimi announced that henceforth Saudi Aramco would resort to intensified drilling in currently produced reservoirs to make up for past declines—the equivalent of repairing what they had rather than completely replacing it.

### **Projected New Production Capacity**

By 2009, Saudi Aramco now plans to have completed new production capacity, which will bring the company's total to 12 million b/d, with Kingdom-wide capacity at 12.5, an increase of 1.5 million b/d.

In addition to adding this 1.5 million b/d of new production capacity, 800,000 b/d of new capacity is earmarked to replace older capacity, both under and above ground. Unlike some other producers, Saudi Aramco's definition of capacity is *maximum sustainable capacity*, not "stream-day" capacity, which is a measure of how much can be produced without taking into account shut-downs for scheduled or unscheduled maintenance.

### **Current Saudi Production Grade**

Currently, Saudi Aramco produces a variety of crude oils ranging from heavy to super light. About 70% of Saudi production capacity is considered light gravity. The balance is medium and heavy. Almost all of Saudi Aramco's current spare capacity of around 1.5 million b/d is heavy crude from the offshore Safaniya field. Heavy crudes have been the most difficult for some refiners to handle, as consumer demand is increasing for light products (mostly used as transport fuels) and as more stringent environmental regulations restrict the amount of sulfur permitted in fuels. Heavy crudes used to be more in demand because the demand for light products was proportionately lower. All of Saudi Aramco's investments to increase crude capacity will result in more light, extra light, and super light.

### **Mega-Projects**

#### ***Abu Safah and Qatif***

Abu Safah and Qatif were completed late in 2004 at a cost of \$4 billion. Abu Safah had long been in production as a joint Saudi-Bahraini field, operated entirely by Saudi Aramco, at rates of up to 150,000 b/d of Arab Medium crude.

Qatif, which produces Arab Light, had not been produced for some time, in part because the crude contains relatively high levels of hydrogen sulfides. These must be removed from crudes before they are transported in ocean vessels because, in combination with water, they produce a highly corrosive acid. All of the wells in the offshore Abu Safah field were renovated and refitted with submersible pumps, new ones were drilled, and the old gas-oil separators and other crude handling facilities which had been located on offshore platforms were replaced with new facilities which are co-located with the handling facilities for 500,000 b/d of the Qatif crude stream.

When Abu Safah's new capacity of 300,000 b/d is added to Qatif's capacity, the central processing facility for both crudes handles 800,000 b/d at the state-of-the-art plant, with triple-redundant power back-ups and top-of-the-line security. The net increment from this project has added 650,000 b/d to the company's MSC. The efficiency and the reliability of the 150,000 b/d of previous Abu Safah capacity has been enhanced and its useful life

has been extended. In many ways, this project can be seen as providing 800,000 b/d of brand-new, robust capacity, while retiring 150,000 b/d of worn-out assets.

### ***Haradh***

The next increment of new production capacity, which Saudi Aramco is to bring on stream early in 2006, is the Haradh Increment-III project. This project is to produce 300,000 b/d of Arab light crude and approximately 160 million cubic feet per day of associated gas. Haradh III is located in the southernmost portion of the Ghawar field. The project makes use of quad-lateral wells with smart completions. At 300,000 b/d, its depletion rate is to be 1.7% per year.

In late 2004, Saudi Aramco accelerated this project by negotiating generous bonus payments to the contractors for early completions. On its original schedule, it was not expected to come on stream until July 2006.

### **AFK: The Abu Hadriya, Fadhili, and Khursaniya Project.**

These three oil fields were discovered in 1940, 1949 and 1956 respectively, but were shut-in when the demand for Saudi crude plummeted in the first half of the 1980s from over 11 million b/d to less than 3 million b/d. They were included in the planning for an ambitious Crude Expansion Plan inaugurated in the late 1980s, but the plans remained on the shelf when Saudi Aramco decided instead to develop the remote Shaybah field. As part of a new project, for which engineering, procurement and construction contracts were signed in March 2005, production from these three fields will be 500,000 b/d of Arab Light, beginning in 2007.

### ***Khurais***

The Khurais field, which lies close to Riyadh, was discovered in 1957 and originally developed to provide crude oil to the Riyadh refinery (which has a current throughput of just under 100,000 b/d) and crude for direct burn in the capital's electric power plants. Crude from Khurais was never sold for export—there are no pipelines from the field to the export grid—and neither was seawater for artificial lift ever piped inland as far as Khurais.

When Saudi Aramco built its major East-West crude oil pipeline to Yanbo, a spur line was built to Riyadh to supply the refinery, while most of Riyadh's power plants now have their base-load fueled with natural gas. Khurais, therefore, was shut in, in favor of more optimal operations elsewhere.

The field, which is also a producer of Arab Light, is to have a capacity of 1.2 million b/d. Project management consulting contracts for the field and to add capacity to the Qurayyah Seawater Treatment plant were awarded earlier this year, with a major water pipeline to be laid to Khurais as well as a crude pipeline to the company's export facilities at Ju'aymah. Construction contracts are to be awarded in early 2007. This project is scheduled to be completed in 2009.

### ***Shaybah***

The remote Shaybah oil field and its ancillary surface equipment and facilities came on stream in July 1998, some two-and-half years after the project received Board approval

from Saudi Aramco. It currently produces 500,000 b/d of Arab Extra Light, for a depletion rate of 1% per year. The Shaybah development was designed primarily to replace other ageing production, but it also set a benchmark for Saudi Aramco's ability to bring mega-projects on line in record time.

Aramco now has plans to increase production capacity at Shaybah to 1 million b/d, but the current increment of new capacity at the field is for 300,000 b/d to come on stream in 2008.

### ***Nuayyim***

The Nuayyim field is one of the central Arabian fields which currently produce 200,000 b/d of super-light sulfur-free crude oils. The Nuayyim increment is to add another 100,000 b/d of production from the field by 2009.

### ***Post-2009 Capacity Increase: Manifa***

The launch of this phase will focus on the Manifa oilfield, which is on hold until the Kingdom builds refineries capable of handling the content. Officials from producing and consuming nations alike agree that the shortage of oil refining capacity is driving the prices of petroleum products such as gasoline higher.

According to Aramco, Manifa will produce an extra 1 million b/d of heavy crude when it is developed.<sup>5</sup> The combined costs of fitting this field and the lack of refining capacity for the heavy crude it produces, however, is responsible for the delay in putting this field online, which was discovered in 1957. This situation is expected to continue until these issues are resolved. Meanwhile, massive investments have been diverted downstream. Hence, the faster the downstream projects are completed, the more quickly the viability of this enormous field can be realized.

Manifa will eventually serve as a launchpad for two other similar projects. These could bring another 600,000 barrels to Saudi production capacity of heavier crudes. Again, however, these schemes are dependant upon the success of downstream projects to create more refining capacity as well as demand conditions in the global petroleum market after 2010.

### ***Total Net New Increments***

The total of these new increments of production from Haradh III through Nuayyim is 2.3 million b/d by the end of 2009. As pointed out earlier, Saudi Aramco says that it is earmarking 800,000 b/d of this new production to make up for natural declines in production.

“Natural declines” should not be confused with depletion. Individual producing wells experience declines in production for a variety of reasons, some of which result from problems within the well-bore itself. In some structures, like Safaniya, these problems may be associated with wells being clogged with sand; in other areas there may be problems with excessive water production. At times, it may prove expedient to relocate wells in different locations within the producing structure.

In Saudi Arabia proper, as opposed to the Neutral Zone, wells are not placed closer than 1 km to each other. In other cases, new technologies have resulted in greatly enhanced well

productivity. The first horizontal wells drilled in South Shaybah in 1996, for example, had 1 km of reservoir contact and produced 3000 b/d. By 2002, new maximum reservoir contact wells, which resemble a fishbone, achieved 12 km of reservoir contact and produced 10,000 b/d. While the phenomenon of natural decline cannot be dismissed lightly in Saudi Arabia as its producing fields mature, neither should it be exaggerated as a harbinger of Saudi Arabia's approaching "peak oil" production.

The Kingdom's massive recoverable reserves are, by definition, recoverable.<sup>6</sup> As a conservatively managed country, the Kingdom has followed conservative depletion rates for all of its fields, far lower than the depletion rates for many other major fields elsewhere. Twenty years ago, when Saud Aramco production dipped to 3 million b/d, it would have taken the company 237 years to deplete its reserves. At production levels of 10 million b/d, the reserves will be depleted in 71.5 years absent any new discoveries, or additions through new delineations or enhanced recovery.

When projections are made that the demand for Saudi crude will exceed 20 million b/d, however, that rate would deplete known proven reserves in 36 years. While Aramco's geophysicists may be confident that new discoveries will be made and that past trends in increasing recovery rates will continue, they cannot offer absolute assurances that these will occur or that problems not now understood will materialize.

For that reason, the assumptions made in pre-2004 forecasts that the Kingdom will wish to produce at 20 million b/d or more in order to maintain prices at \$25 per barrel for the indefinite future have merited some skepticism. But, it can also be understood that, in the pre-2004 oil market environment, none of the major government-backed forecasting institutions—the IEA, the EIA, and OPEC itself—would have felt it politic to forecast even \$60 crude prices for 2025.

Saudi Arabia's current capacity expansion program, especially when coupled with its downstream expansion program, is clearly designed for prices to be substantially lower than they are today and to restore the kind of cushion of spare capacity which, prior to 2004, gave the Kingdom the power to promise and to deliver oil market stability under a variety of supply disruption scenarios.

It has to be emphasized, of course, that the Saudi expansion program will by no means be the sole factor in restoring market stability. Other producers will also be adding crude production capacity. Alternative and unconventional sources of energy will also be tapped. But the incremental Saudi capacity can be developed faster and more reliably than most others

## **Downstream**

Saudi Arabia is primarily a producer of crude oil, but in recent years it has been moving steadily to expand its refining capacity to meet growing demand. Shortages of refining capacity in the U.S. and world-wide have played a major role in driving up the price of crude oil in 2005.

While Saudi Arabia produces 12.5% of the world's total oil supply, refineries wholly or partially owned by Saudi Aramco now refine 4.7% of the world's crude oil. However, Saudi Aramco is in various stages of increasing its refining capacity by more than one-third over the next few years. This refining expansion program will increase capacity from the last year's throughput level of around 3.9 million b/d to over 6.0 million b/d helping to alleviate the worldwide refining bottleneck.

Ultimately, the amount of new capacity added will depend in part on definitive agreements with joint venture partners, but the overall magnitude of the expansion program suggests that Saudi Aramco, on its own or through its partially-owned refineries, will be able to process greater quantities of its spare heavy crude capacity when the refinery expansions are completed than it has been able to do this year and last—the key factor in providing more flexibility in responding to unscheduled disruptions.

Saudi Aramco's refining capacity can be broken down into three sectors:

- Wholly-owned domestic refineries aimed at supplying the Saudi market (with 1.2 million b/d of recent throughput)

- Two 50-50 joint venture export-oriented refineries (one with ExxonMobil, the other with Shell) in Saudi Arabia (705,000 b/d)

- Ownership interests in refineries located in consuming countries (2.145 million b/d). Saudi Aramco always partners with local refiners when it operates abroad.

The refinery expansion program is chiefly aimed at adding new capacity to export-oriented refineries in Saudi Arabia and at building new capacity in partnership with others in consuming countries.

The major elements of this expansion program include a yet-to-be announced capacity expansion program at its joint venture with Shell in Port Arthur, Texas. Some recent press reports have quoted sources at Motiva Enterprises LLC (Saudi Aramco's refining and marketing joint venture with Shell Oil Co.) as saying that Port Arthur's capacity may be expanded from its current 235,000 b/d up to 600,000 b/d, which would make it the largest refinery in the U.S. and the most significant single capacity expansion project in the U.S. in decades.

Motiva now says it may not finalize plans until next year. Any expansion is likely to include sophisticated "high-conversion" capacity which can process most grades of crude into the products most in demand in the U.S. market today—gasoline, diesel, heating oil and jet fuel. The expansion of existing refineries in the U.S. is by far the most efficient way to add needed capacity.

In China, where demand for oil has been an important factor in driving up crude oil prices in 2004-2005, Saudi Aramco, ExxonMobil, and Sinopec signed agreements and

broke ground on a project to triple the capacity of Sinopec's existing Fujian refinery in southern China to 230,000 b/d as well as adding much needed capacity to manufacture petrochemicals. The Fujian project represents an investment of \$3.5 billion by the joint venture partners. Saudi Aramco is also negotiating with Sinopec for a proposed new \$1.2 billion Qingdao refinery in Eastern China. Saudi Aramco executives attended a groundbreaking ceremony for the new 200,000 b/d refinery in early July and the company is said to be negotiating for a 25% stake in the venture. Both the Fujian and the Qingdao refineries are tentatively slated to be completed by 2008. Saudi Arabia is China's largest oil supplier.

In Saudi Arabia, Saudi Aramco is moving ahead with two projects, which will add more than 825,000 b/d of new or newly upgraded export capacity. Saudi Aramco last year agreed with Japan's Sumitomo to a \$6-7 billion project to completely upgrade an existing refinery at Rabigh, which had been built in the 1980s as a 50-50 joint venture with Greek firm Petrola, but which was not designed to produce the kind of products most in demand today. Saudi Aramco bought out Petrola in 1995. When the upgrade is completed, the new plant will produce 425,000 b/d of the kind of products the market now demands, as well as a wide range of petrochemicals. While an upgrade does not add primary distillation capacity, what counts is the ability to convert crudes into the lighter products increasingly in demand.

Saudi Aramco is also in the process of selecting an international joint venture partner to build a new grass-roots refinery, most likely at its Red Sea petroleum hub at Yanbu, which is to have a capacity of 400,000 b/d, with the aim of exporting gasoline to the U.S., diesel fuel to Europe, and naphtha and fuel oil to Asia, as well as another new grass-roots joint-venture refinery at Jubail, also project to have a capacity of 400,000 b/d. The ultimate size, location, and configuration of any joint venture refineries obviously depend on reaching agreements with the joint venture partners. Saudi Aramco's two existing joint venture refineries in the Kingdom do provide attractive examples of how such ventures can be structured.

## **Conclusion**

The preceding demonstrates that Saudi oil policy is based upon a dual strategy of simultaneously increasing its upstream and downstream capacity in order to restore maximum flexibility to the world's oil supply system and overcome the current mismatch between spare crude oil capacity and the ability of refiners to handle heavier crudes.

Not only will the Kingdom be adding 1.5 million b/d in net new increments of light crude, it appears that it will be building at least as much high-conversion refining capacity to handle heavier crudes, depending on the outcome of joint venture agreements yet to be concluded.

Work already underway at Rabigh and Fujian will enhance the conversion capacity of 655,000 b/d of primary distillation capacity, while new-build and capacity-addition projects in proposed or existing joint ventures in the U.S., China, and Saudi Arabia may add up to 1.365 million b/d of additional high conversion capacity. Thus the new refining capacity is also aimed not only at achieving geographic diversity but also greater operational flexibility within diverse product markets.

Ideally, these moves will restore more reliability to the world's petroleum industry across the supply chain in order to ensure reasonably predictable prices in the event of natural or other disruptions. Restoring greater reliability will, however, also depend on price-induced demand restraint, success in using advanced technology and development methods, and the continuing stability of governance in Saudi Arabia.

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<sup>1</sup> “Saudi Arabia Could Double its Oil Output Capacity, Aramco Chief.” Kahlil Hanware. May 18, 2005. [www.arabnews.com](http://www.arabnews.com)

<sup>2</sup> “Saudi Arabia, Resources and Energy.” [www.saudi-usrelations.org](http://www.saudi-usrelations.org)

<sup>3</sup> “Aramco CEO’s Speech at CERA Conference in Houston.” February 15, 2005. [www.saudiembassy.net](http://www.saudiembassy.net)

<sup>4</sup> While Saudi Arabia’s and OPEC’s supply management strategies have sometimes been likened to “price fixing” schemes, this is inaccurate inasmuch as it implies a secret or illegal scheme that targets the interests of consumers, whose interests are no more served by boom-and-bust price cycles than are those of producers. This has been acknowledged in official statements from both Democratic and Republican Administrations since 1998. Not only does OPEC ensure that buffers of spare capacity are created when it temporarily restricts supplies during periods of surplus, it also provides an essential price floor for its non-OPEC competitors, many of whose high-cost projects would be driven into bankruptcy without such floors.

<sup>5</sup> “Aramco says Manifa can Produce 1M Barrels a Day.” Pramit Pal Chaudhuri. August 17, 2005. Hindustan Times.

<sup>6</sup> Some recent analyses have raised doubts about Saudi reserves and their ultimate producibility, based on reviews of available literature. The gravamen of these analyses is that Saudi Aramco officials either are unaware of the technical risks their fields face or choose to be deliberately misleading about these risks. Together with the subject of “peak oil”, the ensuing public discussion of Saudi reserves has tended to raise prices of long-dated crude contracts on the futures market, with the net effect in the long run of encouraging the development of costly alternative sources of supply, such as Canada’s oil sands. This paper is based on the assumption that Saudi Aramco officials are both technically proficient and not misleading, an assumption which in turn is based on their considerable track record and the personal knowledge of the authors.