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Global Energy Demand and Capacity Building in Saudi Arabia's Petroleum Sector

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Introduction

Current estimates indicate that the Middle East and North Africa have some 63% of all of the world's proven oil resources, and some 37% of its gas. In 2003, Saudi Arabia alone was estimated to have roughly 26% of the world's proven oil resources and 4% of its gas, Saudi Arabia also provided 12.55% of the entire world's oil production, the Gulf provided 28.72%, and the entire MENA region provide approximately 34%.ⁱ The Energy Information Agency (EIA) of the US Department of Energy and the US Geological Survey (USGS) estimate that Saudi Arabia now has the capacity to produce a maximum of 11.2 million bpd of crude (with a sustained capacity of 10.6-10.8). The EIA estimates that these high oil reserves, and low incremental production costs, will ensure that Saudi Arabia and the Gulf region the will dominate increases in oil production through at least 2015.ⁱⁱ

The EIA estimates that Saudi Arabia alone will account for 4.2 million bpd of the total increase, Iraq for 1.6 million bpd, Kuwait for 1.3 million bpd, and the UAE for 1.2 million bpd by 2015 in its reference case projection. These four countries will account for 8.3 million bpd out of a worldwide total of 17.9 million bpd (46%). To put these figures in perspective, Russia will account for an increase of only 1.3 million bpd.ⁱⁱⁱ

The International Energy Agency (IEA) estimates that total conventional and non-conventional oil production will increase from 77 million bpd in 2002 to 121.3 million bpd in 2030. This is a total increase of 44.3 million bpd worldwide. The Middle East will account for 30.7 million bpd, or 69% of this total. The IEA also estimates that the rate of dependence on the Middle East will increase steadily after 2010 as other fields are depleted in areas where new resources cannot be brought on line. It estimates that 29 million bpd, or 94% of the total 31 million bpd increase in OPEC production between 2010 and 2030 will come from Middle Eastern members of OPEC.^{iv}

In these estimates, and virtually every other major forecast, Saudi Arabia is a key petroleum exporter and central to a steadily more interdependent global economy. Saudi Arabia is also the only oil producer that has consistently sought to maintain surplus oil production capacity, with a nominal goal of 2 million bpd. This situation will not change in the foreseeable future.

There are, however, serious uncertainties in virtually every aspect of such estimates. For the examples, the claims MENA and Gulf countries make regarding their "proven reserves" have become highly political over the last few decades and may well be exaggerated. Nevertheless, the issue is not whether Saudi Arabia and the Gulf will play a critical role in world energy supplies it is rather how much petroleum capacity they can develop and export. The Kingdom has roughly 80 oil and gas fields and more than 1,000 oil wells; however, more than 50% of the Kingdom's reserves are in only eight fields.^v

Most estimates indicate that Saudi Arabia holds roughly one-quarter of the world's proven oil reserves, with a nominal figure of 261.90 billion barrels, according to the EIA, and may contain up to 1 trillion barrels of ultimately recoverable oil.^{vi}

Saudi sources have recently gone much higher. On December 27, 2004, Saudi oil Minister Ali Al-Naimi stated that the country proven reserves can go up to 461 billion

barrels in the next few years.^{vii} He reiterated this point on April 8, 2005. He was quoted as saying "There is a possibility that the Kingdom will increase its reserves by around 200 billion barrels, either through new finds or by increasing what it produces from existing fields...These reserves enable the Kingdom to remain a major oil producer for between 70 and 100 years, even if it raises its production capacity to 15 million bpd, which may well happen during the next 15 years."^{viii} Increasing oil reserves by 200 billion barrels, however, continues to be an unverifiable possibility.

There are no certainties here or any other major aspect of current estimate of Saudi capacity and world demand. Matthew Simmons, an outside analyst, has argued that the Kingdom reserves are overestimated by Saudi Aramco. Saudi Aramco claims that the total depletion rate of its oil fields, so far has been approximately 28%-30%. Mr. Simmons argues that Aramco is underestimating the depletion rates of the oil fields including Ghawar, the largest in the world, and that Saudi oil fields have a higher water cut than is reported by Aramco. The EIA forecasts that Saudi oil production capacity could reach 18.2 million bpd by 2020 and 22.5 million bpd by 2025.^{ix}

In brief, Mr. Simmons bases his conclusions on the following points:

- A large portion of the Kingdom's production is based on a small number of giant and super-giant oil fields. All of the giant and super giant Saudi oil fields, but two, have been discovered along time ago. Ghawar, for example, accounted for 50%-65% of Saudi output in 2003.
- Saudi giant and super-giant oil fields have matured, which means that they peaked and are on the decline. They have high natural depletion rates of the giant and super-giant oil fields are higher than Aramco is reporting.
- Aramco has used intense water management to keep reservoir pressures high and postpone the natural depletion on the 5 large Saudi fields.
- Data from Aramco, OPEC, the EIA, and the IEA contradict each other, and have proved to have many holes in them.
- "Easy oil" era is over. Vertical wells in Saudi Arabia appear to be obsolete. MRC (maximum recovery contact) horizontal wells anchor future production.
- Aramco has explored the Kingdom thoroughly, and it is unlikely that future exploration will discover any new giant or super-giant oil fields to take the place of the aging fields.
- Claims that Aramco and other oil companies "overbooked proven reserves" because, "They all assumed that 3-D seismic and computer modeling could effectively replace the old practice of drilling a multiple number of appraisal wells and coring/flow testing them. This still remains the only way to predict with any accuracy the extent of original hydrocarbon in place and the ultimate recoverable reserves."
- Argues that, "multilateral horizontal wells can create very high flow rates but these are simply turbo-charged super straws and probably create pressure drops far faster than it production is slowed way down." This technology, he argues, cannot increase reserves or recovery.
- Higher depletion rates mean higher chances of the field collapsing. That Ghawar's depletion rate is a lot higher than the 48%, reported by Aramco, and cites Aramco's engineers' warning in 1979 that: North Uthmaniyah in Ghawar will start an irreversible decline in 1989, and Ain Dar/Shedgum will start its irreversible decline between 1992 and 1994.

These points are more a thesis, based on an analytic "chain of negatives" than a definitive proof. They pull together a chain of negative indicators and possibilities that deserve

serious consideration. However, much of their validity depends on the Saudi managers Aramco being wrong or covering up massive risks and development problems, and virtually all of the other analysts examining world oil reserves and production potential being wrong about both the size of the world's oil reserves and the ability of modern technology to provide future significant gains in ultimate recovery. His analysis also does not fully explore the extent to which technology gain can increase production (an area of considerable uncertainty) or the extent sustained high prices would lead to more efficient exploration, production and recovery.

At the same time Simmons does raise a host of legitimate questions and uncertainties in an area where there is little international transparency. Moreover, any other analysis of Saudi Arabia's capacity to sustain and increase production must be based to a high degree on what the country's experts and officials say. There is no way to independently validate such projections and claims.

More generally, many layman don't understand the bases on which forecasting methodology is based. It is all too clear that the modeling the EIA, IEA, and OPEC use in the global petroleum supply and demand forecasting is still driven by estimating global demand at comparatively low oil prices (the reference case is \$25 to \$27 per barrel in constant dollars), and does make a serious effort to explicitly model whether such supply tracks with national plans. The costs of new production in the MENA area are generally assumed to be extraordinarily low, and there is no explicit analysis of the capability of Saudi Arabia or any other major exporter and supplier to actually produce the amount of oil estimated in the model.

Such models and forecasts also include a host of uncertain assumptions about price-driven elasticity in conservation, efficiency, and alternative/substitute fuels that make every aspect of their forecasts progressively less credible. As a result, the forecasts of EIA, IEA, and OPEC must be regarded to be at best illustrative of what might happen in a world where virtually everything goes right from the importer's view where Saudi and other export capacity automatically responds to need and political and military risk have no impact.

Macro Dynamics: Price, Demand, Supply, & Expectations

Price is a key uncertainty affecting both global demand and the willingness of Saudi Arabia and other states to fund new capacity and produce oil. Through 2004, the EIA, IEA, and OPEC still projected reference cases of \$25-\$27 per barrel oil through 2005 with high price cases of no more than \$35-\$37 per barrel.

The world, however, is changing at least in the short term. In early 2005, Saudi oil Minister, Ali Al-Naimi, said that oil prices are expected to stay between \$40 and \$50 a barrel for the rest of 2005, the OPEC Secretary General said that the price of a barrel of oil might reach \$80, and Goldman Sachs said that the price could be between \$50 and \$105 a barrel.

Energy experts question whether the latest oil price hikes are due to conventional supply-demand forces or to a "bubble." Some believe in the "bubble." Lee R. Raymond, the chairman and CEO of Exxon Mobil said "We are in the mode where the fundamental of supply and demand really don't drive the price...Oil is a commodity and history tells us the commodity prices never stay high forever."^x Some experts holding this view see today's prices as a supply-demand phenomenon and that high oil prices are due to the fact that the market forces *believed* that OPEC was not able to clear the market in the 4th quarter of 2004.^{xi}

Other experts take a very different stand. They believe that recent high oil prices are not due to shortages as was the case in the 1970s, but rather due to surging demand and high depletion rate of oil fields. CIBC predicts that oil prices will average \$77 per barrels, and could reach as high as \$100 per barrels during 2005-2010.^{xii}

About all that is certain at this point is that recent oil prices have been both volatile and high, The IEA April 12, 2005 monthly report, summarized developments in the energy market as follows:^{xiii}

- NYMEX light crude hit a new record high of \$58.28 in early April, led higher by US gasoline and natural gas prices, strong Asian demand and pre-emptive stock building. Subsequently, rising US crude and natural gas stocks helped trigger a \$5 correction. Forward price structures implied a tighter Asian crude market than that in the Atlantic Basin.
- Cold weather from mid-February lifted year-on-year OECD demand by 1.28 mb/d in February 2005, partly offset by lower FSU apparent demand. Chinese demand growth slowed to 5.4% in the first two months of 2005, well below the 20.8% growth seen a year ago. World 2005 demand is revised slightly downwards by 50 kb/d.
- March world oil supply rose by 365 kb/d to 84.2 mb/d, from a lower February base. Non-OPEC oil output rose by 60 kb/d to 50.4 mb/d. Non-OPEC plus OPEC other liquids growth remains at 1.4 mb/d for 2005. Early-year disruptions affecting OECD output now skew non-OPEC growth into the second half of the year.
- Increases from Saudi Arabia and the UAE contributed to a 290 kb/d increase in March OPEC output to 29.1 mb/d. Iraqi supply was flat at 1.8 mb/d, leaving OPEC-10 crude up 275 kb/d to 27.3 mb/d. The call on OPEC crude and stock change averages 28.5 mb/d in 2005, rising to 29.3 mb/d in Q4 versus expected OPEC capacity of 32 mb/d.

- OECD industry oil stocks fell 39 mb in February, from a 37 mb upwardly revised January base. Stocks closed 96 mb above a year ago. Distillate draws, driven by heating and transport demand, were more modest than in the past two years. Days of forward demand cover rose in February to 52 days from 51 days in January.

Like all economic forecasts, predicting supply, demand, and prices of crude oil involve significant uncertainty. Predicting the oil market is notoriously unpredictable and needs constant updates and additions to the models at hand. However, the most current EIA, IEA, and OPEC forecasts have not been adjusted to consider oil prices in the \$50 and above range, and their influence on the demand, supply, and the long-term elasticity of demand. Moreover, real world estimate or analysis of the oil market must also consider an “expectation factor” that involves geopolitical and security risks. The following key factors influence the oil market and Saudi capacity, and each involves major uncertainties and unknowns:

- **The geopolitics, security, and stability of oil exporting nations:** As mentioned above, the Gulf contains over 65% of the world proven reserves, and stability in these countries, security of oil fields and routes of transportation in the region are of paramount importance to oil market.
- **The sustainable and spare capacity of oil producing countries:** In recent years, there has been much debate about spare capacity of OPEC nations, and their ability to “balance the market.” In this case, perceptions are as important as realities. The market lack of confidence in the producers to meet the demand adds a risk premium to any estimates and pushes prices up.
- **The long-term elasticity of supply and demand:** The development of alternative sources of energy or conservation could have long-term effect on the market, but the likelihood of this taking place is uncertain at best in the foreseeable future.
- **The refining capacity and inventory build up of the importing nations:** The lack of ability by importing states to refine crude oil and distribute it to the domestic market in a timely manner can create bottlenecks that not only squeeze the average consumer but also negatively impact demand by driving up the price of crude futures because of a product-driven market.
- **The overall health of the global economy:** Oil prices and economic growth in developed countries are negatively correlated. High oil prices have negative effect on economic growth in consuming states, but low economic growth in industrialized nations causes a decrease in demand for oil and eventually lowers oil prices.
- **The rise of China and India:** In recent years, the oil market has experienced an unexpected increase demand of oil from countries in Asia such as China and India. According to the IMF, this surge from emerging countries could account for 40% of the increase in oil demand in 2004.

High Demand?

Short-term forecasts still project a relatively high level of demand. According to DOE, world oil demand will exceed 86 million bpd in the 4th Quarter of 2005, which represents a 1.6-1.9 million bpd increase. Furthermore, demand is projected to increase by 1.8-2.1 million bpd over the entire year.^{xiv} In 2004, the world oil demand increased by 2.7 million bpd, and according to the head of the EIA, a third of the increase is due to increase in Chinese demand for oil.^{xv}

Longer-term projections are still based on the relatively low oil price forecasts of 2004. As shown in Figure 2, the EIA forecasts that world consumption would increase steadily in the next 20 years. Total crude oil demand in 2025 would be 120.9 million bpd compared to approximately 86 million bpd in 2004.^{xvi}

The oil price uncertainties in these long-term global projections are compounded by the uncertainties in national and regional trends. The IMF, for example, forecasts a sharp increase in global demand for crude oil from emerging countries in Asia, mainly from China's high economic growth and an increase in automobile ownership. It projects that world oil demand growth rate will be 2.1 million bpd every year. Due to this surge, the IMF forecasts that the price per barrel of oil will be \$34 in 2010 and \$39-\$56 in 2030. The fund concludes that the world needs to adapt to high oil prices for the next 20 years and that the global economy faces "permanent oil shock."^{xvii}

The International Energy Agency, IEA, has reported that between 1996 and 2004, China's total crude imports have increased by over 440% (from 22.8 million tons in 1996 to 122.7 million tons in 2004). According to China's General Administration of Customs, China's imports of Saudi Oil increase by 41.3% to reach just above 3 million tons during January and February of 2005, while their imports of Iranian and Omani oil have declined.^{xviii}

In 2005, China will consume 6.4 million bpd, second to US' consumption of 21 million bpd. China's consumption in 2020 is projected to double. The growth of Chinese oil demand is higher than their domestic supply. China's domestic production could reach 3.65 million bpd in 2020, but its demand is likely to be twice as high. In addition, oil dependence on Middle East oil has increased from 39.79% of its imports in 1994, to 50.99% in 2002, and to over 50% in 2004.^{xix}

The IEA announced that the growth of Chinese oil demand in January and February 2005 was only 5.4%--much lower than it was in the same period of a year ago. This pushed prices down due the expectation that the surge in oil demand that drove them in the first place is easing up.^{xx}

Japanese imports of Saudi oil have also risen in the first two months of 2003. Saudi Aramco's sales to Showa Shell Sekiyu increased from 150,000 bpd to 240,000 bpd after the direct purchase agreement between the two companies, in which Aramco acquired 10% equity. Sales to Showa are expected to increase to 300,000 bpd.^{xxi}

China is scarcely the only factor driving such estimates. On April 5, 2005, Alan Greenspan, the Federal Reserve Chairman, said "Higher prices in recent months have slowed the growth of oil demand, but only modestly." Greenspan also noted that the high oil prices are due to "geopolitical uncertainties" in the oil producing states. He also argued that, "the status of world refining capacity has become worrisome..." and that these factors are creating a 'price frenzy.'"

Oil consumption of the OECD countries in November 2004 was 50.5 million bpd, 4% higher than it was in November 2003. The increase included the UK (+11%), Germany (+7%), Canada, France, and the US (+5%), Italy (+3%), Japan and South Korea (-4%).^{xxii}

The EU imports 75% of its oil and 50% of its gas demand, and projects that by 2030 these numbers will increase to 90% of it oil and 70% of its gas demand. The EU is looking to expand and strengthen its bilateral relations with the GCC, as the EU energy commissioner, Andris Piebalgs, said because the GCC is "one of the biggest long-term suppliers of hydrocarbons for the European Union." The EU and the GCC held a conference in Kuwait city in early April 2005 to discuss the EuroGulf relations. The

direct negotiations between the EU and the GCC was seen by some as a signal of a crisis because the International Energy Agency (IEA) traditionally represented oil consuming nations in such deliberations with oil producing states.

Oil experts such as John Gault, however, see the EU move as a response to aggressive Chinese efforts in the Gulf. Gault argued that, "competition for access to oil is accelerating and that countries whose governments do not become directly involved risk being left behind." Mr. Piebalgs answered the speculations by saying that "It is a more integrated [European energy] market and that the means we should have a more integrated policy...That is why the Commission is more active on this issue. But it does not mean that we are taking responsibilities from the IEA."^{xxiii}

Limited Supply?

If such demand growth actually occurs it will put a growing strain on both global supply and Saudi export capacity. The EIA reported that in 2004, the average total world production was 73 million bpd—higher than the 2003 average by 3.3 million bpd. OPEC on its own produced 31 million bpd, which is higher than their 2003 production by 200,000 bpd. The increase also came from the UK by 55,000 bpd, the US by 51,000 bpd, and China by 33,000 bpd.^{xxiv}

Non-OPEC supply so far has been slow to respond to the high oil prices. In fact, it increased by only 0.60 million bpd in 2004 (83.3% of which will come from the FSU), and according to DOE the expected increase for 2005 is only 0.92 million bpd.^{xxv}

Estimates of spare capacity are increasing uncertain and inevitably differ. According to the IEA, OPEC has 1.92-2.42 million bpd spare capacity, but according to the EIA, it has 1.1-1.6 million bpd. In both cases, practically all of the spare capacity is from Saudi Arabia. HETCO forecasts that in 2005, OPEC will increase its production by 0.70 million bpd. Again, most of the increase will depend on Saudi Arabia's ability to increase its capacity, and HETCO forecasts an increase from 10.68 to 11.15 million bpd.^{xxvi}

As for longer-term supply, the EIA forecasts that world production will steadily increase in the next two decades and that the total supply will be 126.1 million bpd in the reference case in 2025 and 171.3 million bpd in the high price case. In this projection, forecast increases in oil capacity meet the increase in oil demand.^{xxvii}

There is, however, serious global risk and uncertainty on the supply side in both the short and long term. In the short-term, such uncertainty includes:

- Some oil firms have downgraded their reserve estimates of certain oil fields.
- The surge in oil demand pushed producing many countries to produce at their maximum capacity, which instilled fears of the lack of spare capacity in case of a spike in the market.
- Oman has falling production levels.
- Kuwait and the UAE have been slow to modernize production facilities and techniques.
- The world oil market is losing 1 million bpd from depletion every year.^{xxviii}
- Uncertainty about the flow of Iraqi oil exports in the face of the high level of turmoil within that country.

- Continued political uncertainties in Iran and unrealistic policies towards foreign investment.
- Damage inflicted on U.S. Gulf Coast and offshore oil installations following hurricanes Charley, Frances, and Ivan.
- Capacity constraints (upstream, downstream, and transportation).
- In addition, Venezuelan political instability, Nigerian labor strikes, and internal strife between the Russian government and oil giant Yukos also contributed to push crude oil and other petroleum prices higher in 2004.

In the longer-term, uncertainty includes:

- The actual level of producible reserves in virtually all developing states at given levels of price and technology. Experts like Simmons seriously question whether current estimates seriously exaggerate such capability. The country-by-country analyses of the EIA indicate that major additional proven reserves await discovery in Saudi Arabia and virtually every MENA country.
- The real world cost of incremental production capacity. Current EIA, IEA, and OPEC estimates almost certainly use cost estimates that are too low for Saudi Arabia and other MENA countries, and that understate the full cost of infrastructure and advanced recovery techniques. What is not clear is what the real cost will be.
- Debates over the commercially recoverable oil in existing oil fields and countries, the sustainability of production with current recovery techniques, and future technology gain.
- The rate of maturity and decline in given oil fields with present and future technology.
- The future commercial potential of tar sands and heavy oil: A factor that could sharply change the distribution of the world's commercial reserves if resources like Canadian tar sands become as cost-effective as nations like Canada hope.
- Major uncertainties over the ability to find and produce oil beyond the levels counted in proven reserves. The EIA estimates that global proven reserves are 1,265.5 billion barrels, reserve growth will provide another 334.5 billion barrels (a growth of 26%), and there is another 538.4 billion barrels that is undiscovered (an additional growth of 43%).^{xxix}
- Long term substitution effects that bring alternative fuels on-line at competitive prices at whatever petroleum price levels emerge over time.

Global Demand, Supply, and Saudi Capacity

In summary, it is currently very difficult to put an analysis of Saudi capacity into a realistic context of global forecasting. Key modelers of global energy supply and demand have not yet had time to fully react to the recent rises in oil prices and examine cases that go above \$35 a barrel in detail. International Energy Agency (IEA), Energy Information Agency (EIA), and Organization of Petroleum Exporting Country (OPEC) projections need to be revised or expanded to examine such cases.

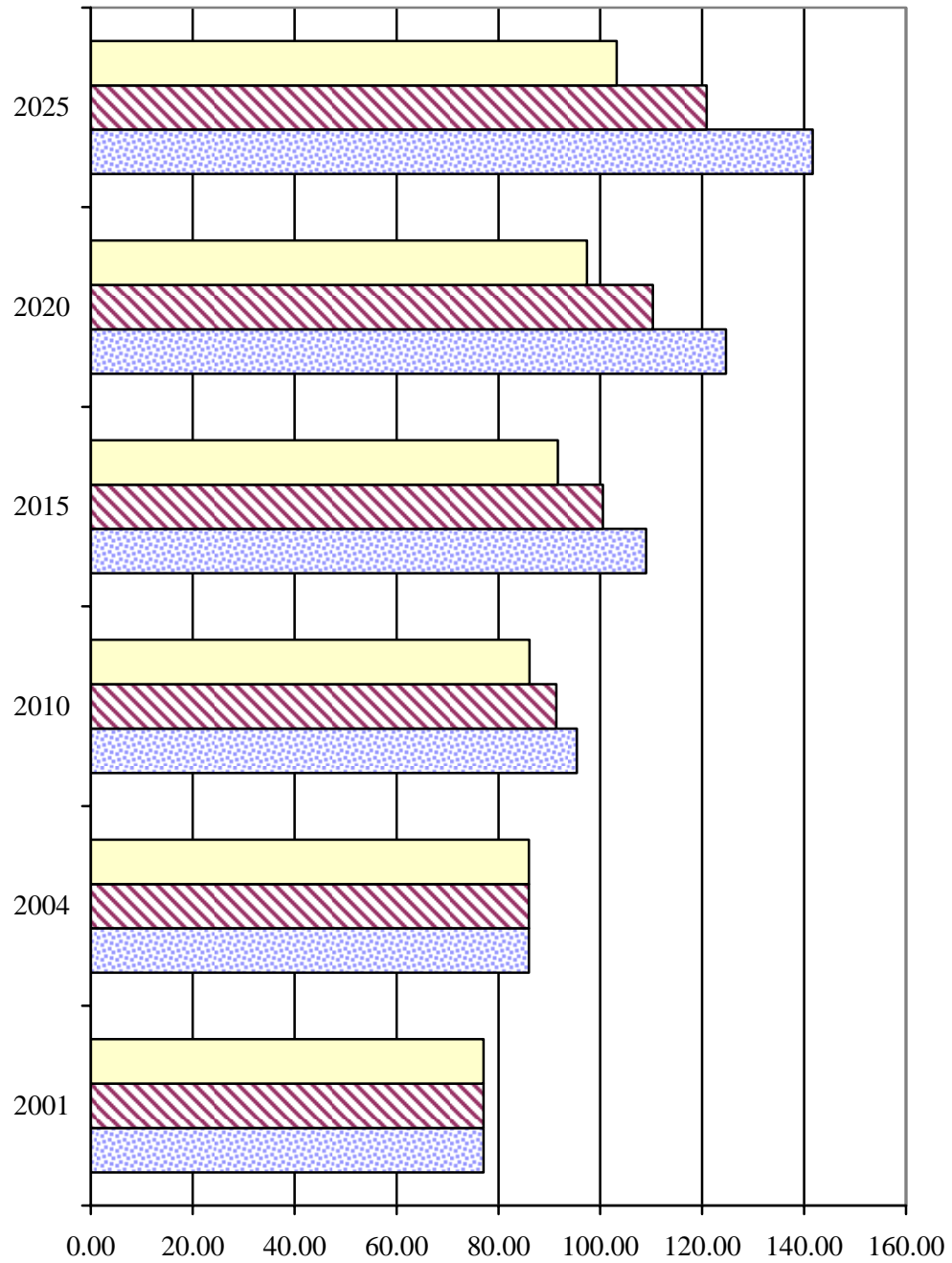
Supply disruptions continue to be real and have contributed to the high oil prices. Capacity constraints and the perception of limited supply have also had as much influence as actual supply disruptions. The world energy market will add only 300,000 barrels of net new on stream supply from 2006 to 2010. This lack of growth is met by a 2.5% increase in demand. Prices would need to rise to clear the market.^{xxx}

At best, demand-driven capacity and export forecasts are unreliable. Forecasts based on low prices have already proved wrong, and this may prove equally true of forecasts that

point to relatively “high” oil prices that range from \$40 to \$105. High prices will eventually dampen demand for crude oil, and the magnitude of the real world drop depends on the elasticity of demand one assumes. Updated forecast models need to be built to adjust for the recent high oil prices and to modify past assumptions about the interdependence between supply forecasts, prices, and current and future demand.

Demand will always be unpredictable. Demand may well go down with a slowdown in Asia growth: “trees do not grow to the sky” even in China and India. If demand does rise steadily, however, Saudi Arabia will face growing challenges in trying to simultaneously increase production to meet demand, replace depleted fields, and recover a reserve of 2.0 million bpd - which would in any case become a steadily smaller percentage of world demand. The marginal cost of surplus capacity in a high demand market could be extremely high, particularly since the real world marginal cost of incremental production is rising all over the world because of increased technical sophistication in production and lower yield oil fields. Saudi policy is still to maintain a surplus, but there are few details on Saudi plans and capacity, and the impact of global economic conditions is highly unpredictable.

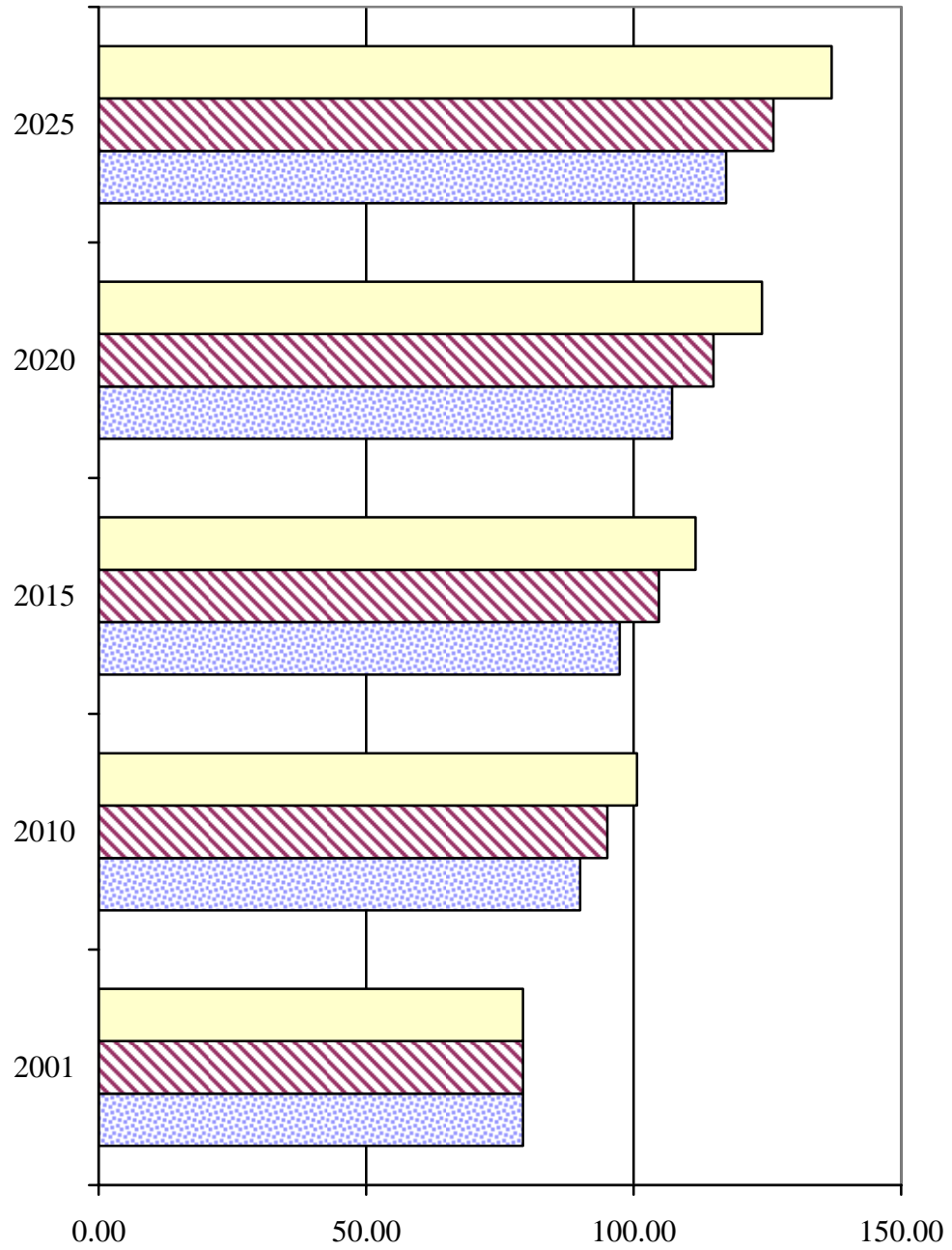
Figure 1: EIA Estimate of Total World Demand based on Economic Growth: 2001-2025
(Consumption in Million bpd)



	2001	2004	2010	2015	2020	2025
Low Growth	77.10	86.00	86.10	91.70	97.40	103.20
Refereneec Case	77.10	86.00	91.40	100.50	110.30	120.90
High Growth	77.10	86.00	95.40	109.00	124.70	141.70

Source: EIA, International Energy Outlook, 2004.

Figure 2: EIA Estimate of Total World Supply Production Capacity: 2001-2025
(Million bpd)

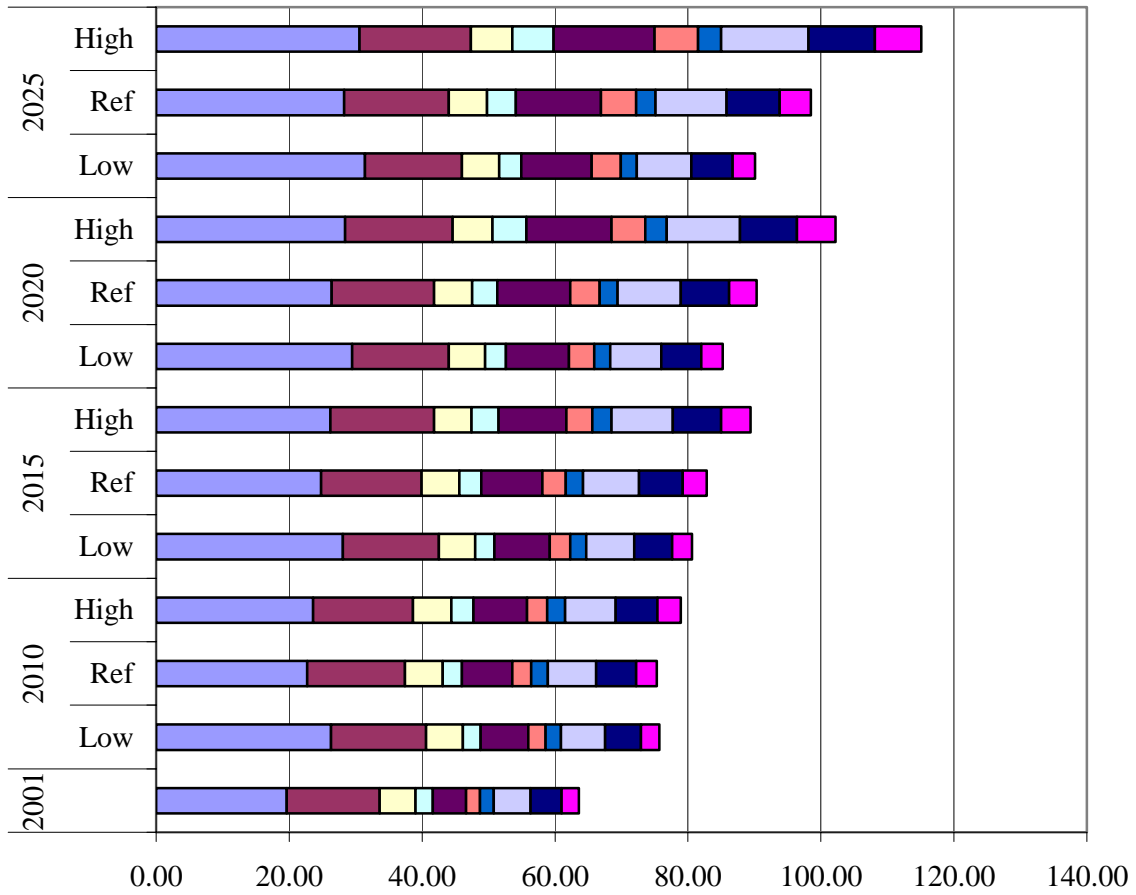


	2001	2010	2015	2020	2025
Low Price	79.30	100.60	111.60	124.00	137.00
Referene Case	79.30	95.10	104.70	114.90	126.10
High Price	79.30	90.00	97.40	107.20	117.30

Source: EIA, International Energy Outlook, 2004.

Note: Price are projected to be Low Price case (\$17); Reference (\$25-\$27); High (\$35-\$37)

Figure 3: EIA Estimates of World Consumption by Region: 2001-2025
(Million bpd)



	2001	2010			2015			2020			2025		
		Low	Ref	High	Low	Ref	High	Low	Ref	High	Low	Ref	High
■ Africa	2.60	2.80	3.10	3.50	3.00	3.60	4.40	3.20	4.10	5.80	3.40	4.70	7.00
■ Other ME	4.70	5.40	6.00	6.30	5.70	6.60	7.30	6.00	7.30	8.60	6.20	8.00	10.00
■ Other Asia	5.50	6.60	7.30	7.60	7.20	8.40	9.20	7.70	9.50	11.00	8.20	10.70	13.10
■ S. Korea	2.10	2.30	2.50	2.70	2.40	2.60	2.90	2.40	2.70	3.20	2.40	2.90	3.50
■ India	2.10	2.60	2.80	3.00	3.10	3.50	3.90	3.80	4.40	5.10	4.40	5.30	6.50
■ China	5.00	7.20	7.60	8.10	8.30	9.20	10.20	9.50	11.00	12.80	10.60	12.80	15.20
■ Russia	2.60	2.70	2.90	3.30	2.90	3.30	4.10	3.10	3.80	5.10	3.30	4.30	6.20
■ Japan	5.40	5.50	5.70	5.80	5.50	5.70	5.60	5.50	5.70	6.00	5.60	5.80	6.30
■ W. Europe	14.00	14.30	14.70	15.00	14.40	15.10	15.60	14.50	15.40	16.20	14.60	15.70	16.70
■ USA	19.60	26.30	22.70	23.60	28.10	24.80	26.20	29.50	26.40	28.40	31.40	28.30	30.60

Source: EIA, International Energy Outlook, 2004.

Note: Three cases, High Economic Growth, Low Economic Growth, and Reference Case Economic Growth.

Saudi Arabia Importance to the Energy Market

Regardless of all these uncertainties in global demand and of the uncertainties surrounding Saudi energy capacity the Kingdom will continue to be central to any discussion of the energy market.

- **The largest oil reserves in the world:** Regardless of whether Saudi Arabia has 25% of the world's known reserves (260 billion barrels), Saudi Arabia will still dominate much of the world supply. Most oil producing countries use the same methodology to calculate reserves. In broad terms, the uncertainties affecting Saudi resources affect all other major producers, particularly in the MENA region.
- **The largest oil producer in the world:** Saudi Arabia has produced 12.5% of world total production for the last decade, and has been the only oil producer that has consistently sought to maintain surplus oil production. If it does encounter problems in maintaining and increasing capacity, virtually all exporters will encounter similar or greater problems.
- **An influential member of OPEC:** Saudi Arabia will continue to play a central role in the decisions of OPEC. Due to its immense reserves and influence over the other member states, especially the Gulf countries, the Kingdom has its weight with the organization and the ability to change production hikes or cuts.
- **Largest spare capacity:** The Kingdom still seems to have approximately 1.5-2.0 million bpd of spare capacity. It claims to be "easily capable" of producing 15 million bpd in the next 15 years. Its ability to do, as opposed to its willingness to do so, depends primarily on its ability to manage mega-projects, attract and retain the skill sets needed, as well as its ability to procure the steel, engineering services, drilling rigs, etc. From a geological basis, a resource basis of 100 billion barrels depleted over a 12-year period would be produced by a commercial entity which sought to maximize return to its shareholders at a rate of 22 million bpd. Commercial oil companies have often chosen fairly high and rapid depletion rates. The North Sea Brent oilfield has been depleted at a maximum 9.6% annual depletion rate (as a percentage of initial proved reserves). Sovereign oil producers, however, generally wish their resource base to last for generations
- **Central to Gulf Security:** The Kingdom has the largest and most modern military and internal security apparatuses in the Gulf. Saudi Arabia continues to play an important role in the stability of the other GCC states and in securing oil facilities from asymmetric attacks from extremists or conventional attacks from Iran.

Proven Reserves

There are serious uncertainties in the present estimates of proven reserves in many countries. Some are technical and some are political. The fall of the Shah in 1979, and the Iran-Iraq War, led to a competition in the Gulf to announce new levels of "proven" reserves to demonstrate the strategic importance of given countries, and major increases in the claims made by Iran, Iraq, Saudi Arabia, Kuwait, and other countries. Little hard data seem to be available to validate such claims, and it is not clear that the EIA, IEA, OPEC, or USGS have applied much rigor to a country-by-country reexamination of such estimates. (The USGS does use a different methodology because it looks at the basins on a geological potential basis, but the data available are highly uncertain.)

The country-by-country analyses of the EIA do indicate, however, that all of the Gulf countries - and most MENA exporters - now have significant unexplored areas, and that major increases are likely to occur in their proven reserves. This includes "reserve

growth” of 252.5 billion barrels in addition to the EIA's estimate of 726.8 billion barrels in “proved reserves,” and another 269.2 billion barrels in “undiscovered” reserves.^{xxxix}

In the case of Saudi Arabia, Saudi Aramco has proven to be highly credible over the years with its statements. Estimates of Saudi reserves and production capacity, however, involve many economic assumptions, technological capabilities, and intricate simulations models. There are two very different outstanding views on Saudi reserves:

- Saudi Aramco has argued that the Kingdom's reserves are underestimated not overestimates, and that the reserves could double in the future through new discoveries and upgrading of their existing fields. In particular, Saudi Aramco has pointed out that its estimates of proven reserves do not take into account enhance oil recovery (EOR) methods other than current pressure maintenance programs.
- Matthew Simmons claimed that Saudi Aramco is overestimating its reserves due to higher depletion rates and water cuts of the oil fields. Simmons argued that all the functioning oil fields, with the exception of two, have been discovered along time ago. He concludes that there is no new “easy oil” because Saudi Arabia will need to use horizontal wells, as apposed to vertical ones, to extract oil from aging giant and super giant fields.

The US Geological Survey also supports the high resource figure. According to the USGS 2000, the Kingdom had 283,508 million barrels of discovered oil and 87,093 million barrels of undiscovered.^{xxxix} In 1983, the Kingdom's reserves were 168 billions, and in 2004-2005, according to Saudi Aramco, Saudi reserves are 262 billion barrels.

The Simmons challenge to Saudi Arabia has also provoked a Saudi reaction. On April 6, 2005, the Saudi Oil Minister, was quoted as saying, “There is a possibility that the kingdom will increase its reserves by around 200 billion barrels, either through new finds or by increasing what it produces from existing fields...These huge reserves enable the kingdom to remain a major oil producer for between 70 and 100 years, even if it raises its production capacity to 15 million barrels per day, which may well happen during the next 15 years.”^{xxxix} Increasing oil reserves by 200 billion barrels, however, continues to be an unverifiable possibility.

This Saudi claim may be real, rather than simply political. According to Dr. Sadad Al-Husseini, former Aramco Executive Vice president of Exploration and Production, Saudi Aramco had improved its estimates of oil reserves through the following actions:

- Drilled and logged many key wells in all the active reservoirs.
- Surveyed large oilfields with 3D seismic coverage.
- Ran large simulation models and collected a lot of data on reservoir performance and reserves. Updated the models annually.^{xxxix}

Dr. Al-Husseini argued that simulations seem to confirm Aramco's reserve predictions. As for discoveries of new reserves, he argued that they will be of limited scope:

As to the possibility of future reserves additions, there are extensive reservoir and source rocks in Saudi Arabia spanning the Paleozoic through Cenozoic time scales. These must surely offer additional opportunities for oil and gas discoveries. The size of such fields, however, will be substantially smaller than current proven accumulations... While there may yet be likely undiscovered oil and gas accumulations with millions of barrels of reserves, they are likely to be of limited acreage and vertical closure by Saudi standards...

Whether the exploration for such accumulations will add billions of barrels of future reserves will depend on the prevailing economics and government policies within the Kingdom. The more liberal the policies, the more commercially viable exploration and development will become in future decades.

In terms of immediate additions, the enhancements to conservative oil recoveries in undeveloped reservoirs will be more important than new field discoveries. Furthermore, if the past is any indication of the future, advances in technology are bound to reduce the cost of recovering marginal discovered resources, thus adding to the reserves figures. Given the fact that the discovered but undeveloped Saudi reservoirs make up about 130 billion barrels of the Kingdom's total reserves, the addition of new proven reserves through future reservoir developments is a foregone conclusion.^{xxxv}

Most experts do, however, concede that any new reservoirs will be of lower quality and that the costs and technical challenges in producing from mature reservoirs will increase. The position of the EIA on these two issues is clear:

... whenever the sustainability of the oil resource base comes into question, there are always those eager to warn the world of a looming shortage in oil supplies. Inevitably, the question becomes, "Are we running out of oil?" In April 2000, the U.S. Geological Survey (USGS) released the results of its thorough and methodologically sound assessment of worldwide petroleum resources. The USGS identified at least 3 trillion barrels (mean estimate) of ultimately recoverable conventional oil resources worldwide. The assessment prompted EIA to analyze the long-term world conventional oil supply potential, using alternative assumptions about the levels of ultimately recoverable resources and demand growth. Based on the EIA analysis, all three of the IEO2004 oil price cases would expect conventional oil to peak closer to the middle than to the beginning of the 21st century.

No one doubts that fossil fuels are subject to depletion, and that depletion leads to scarcity, which in turn leads to higher prices. Resources are defined as "nonconventional" when they cannot be produced economically at today's prices and with today's technology. With higher prices, however, the gap between conventional and nonconventional oil resources narrows. Ultimately, a combination of escalating prices and technological enhancements can transform the nonconventional into the conventional. Much of the pessimism about oil resources has been focused entirely on conventional resources. In the IEO2004 forecast, nonconventional liquids include production from oil sands, ultra-heavy oils, gas-to-liquids technologies, coal-to-liquids technologies, biofuel technologies, and shale oil. Total nonconventional liquids production in 2025 is projected at 4.1, 5.2, and 8.0 million barrels per day in the low price, reference, and high price cases, respectively. It is anticipated that nonconventional oil resources will act as a buffer against prolonged periods of high oil prices well into the middle of this century, and perhaps well beyond.^{xxxvi}

The cost of production will be higher to meet the complexity of extracting oil from mature oil fields. This means gradual increase in the production cost in the foreseeable future is virtually inevitable.^{xxxvii}

Figure 4: Selected World Crude Oil Production: 1973-2004
(Million bpd)

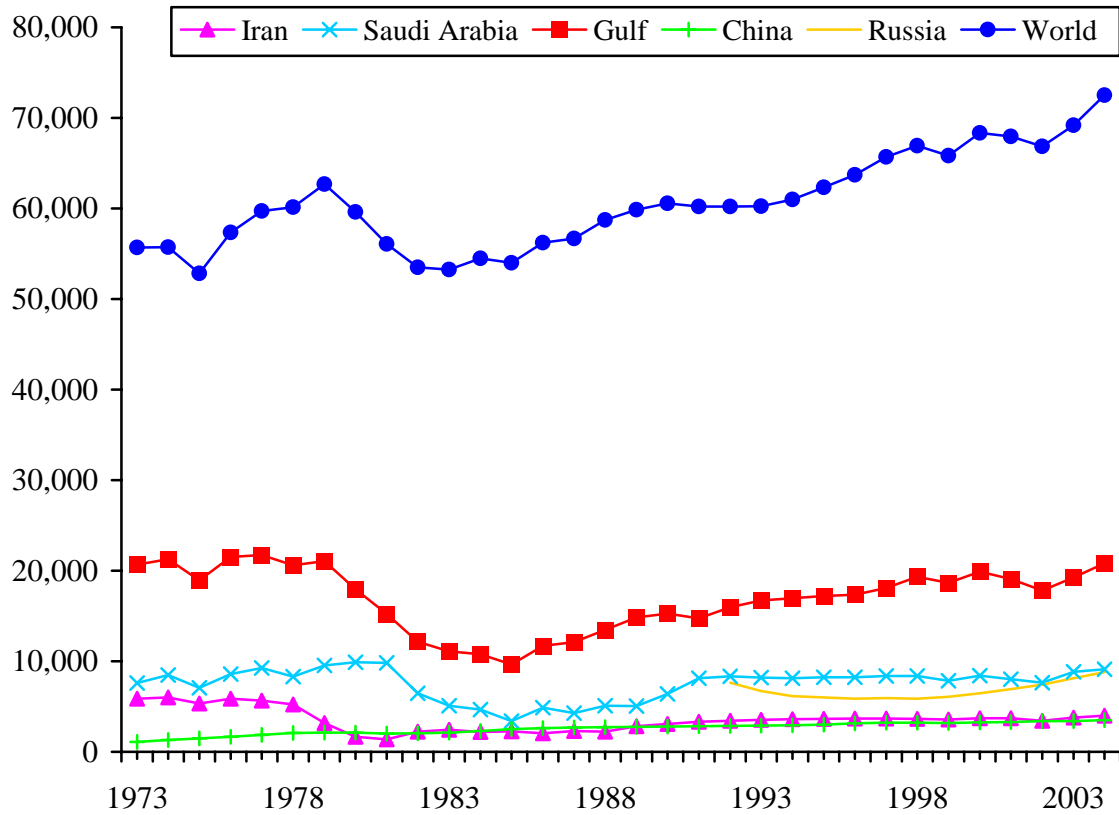
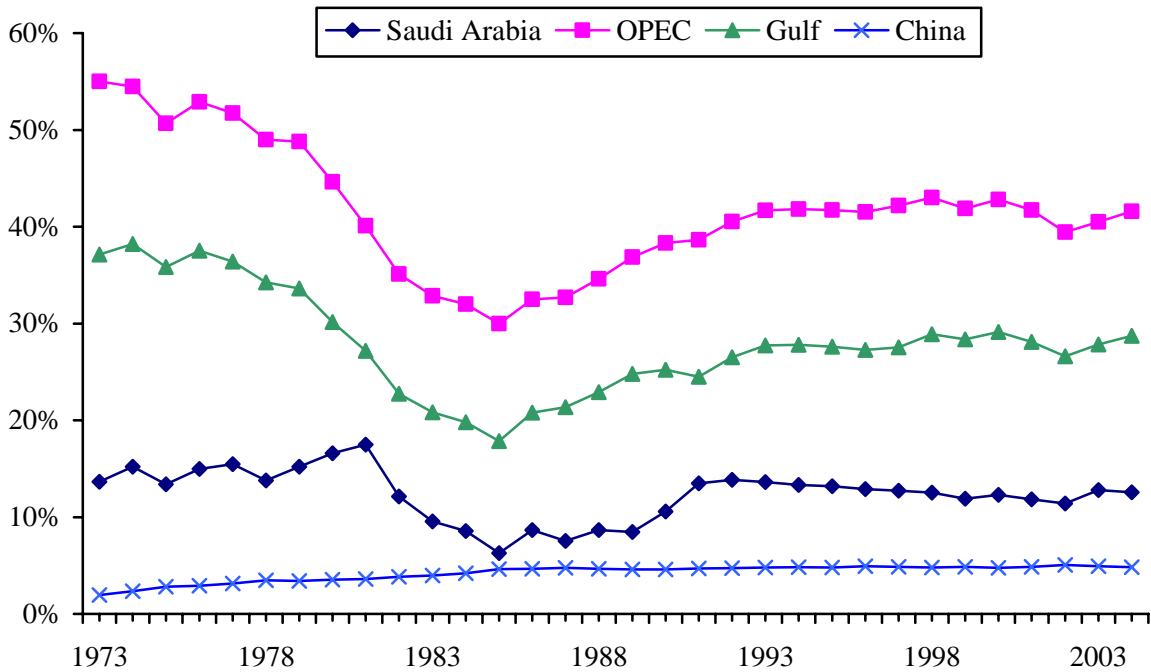
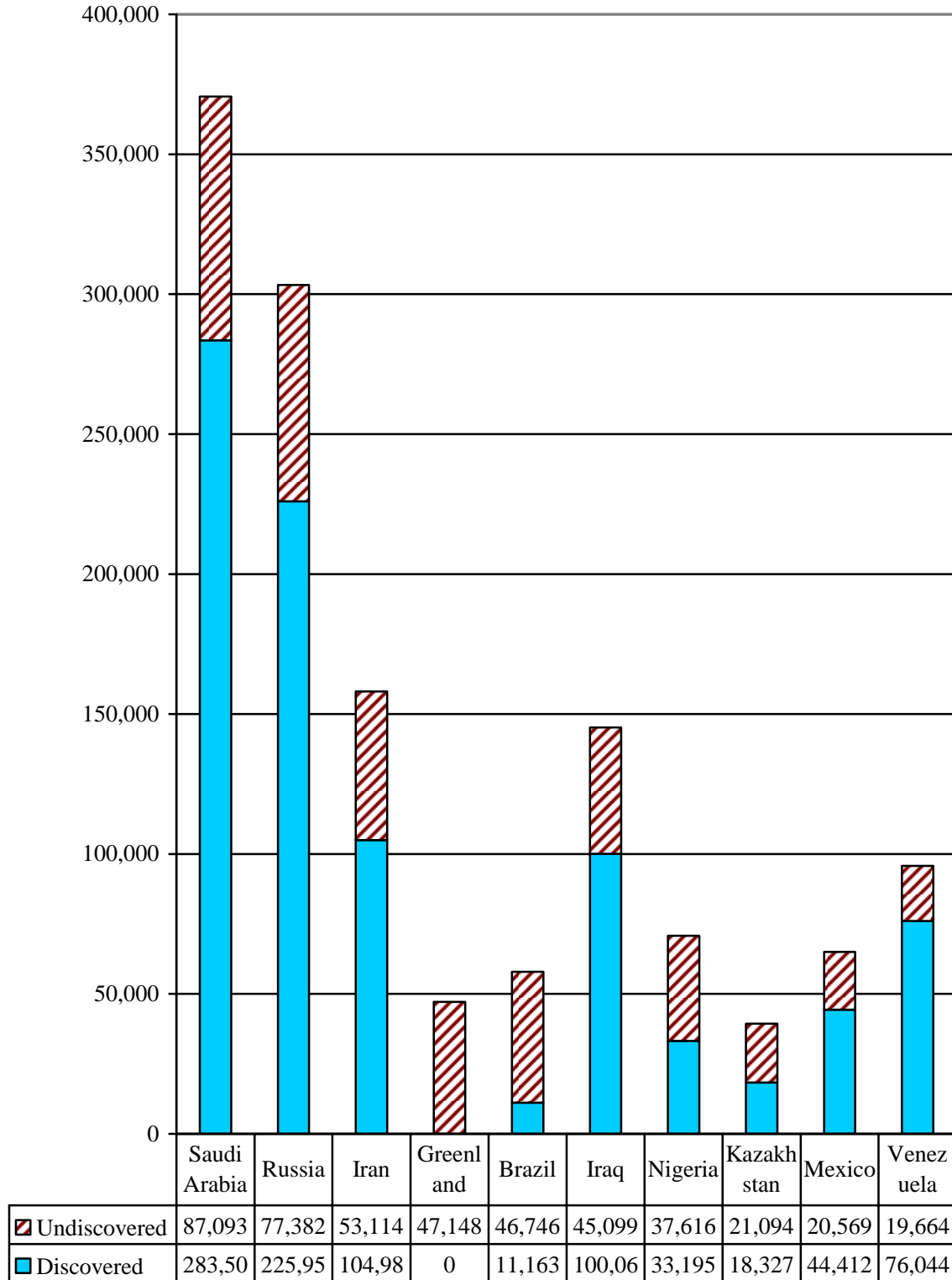


Figure 5: Shares of World Production: 1973-2004



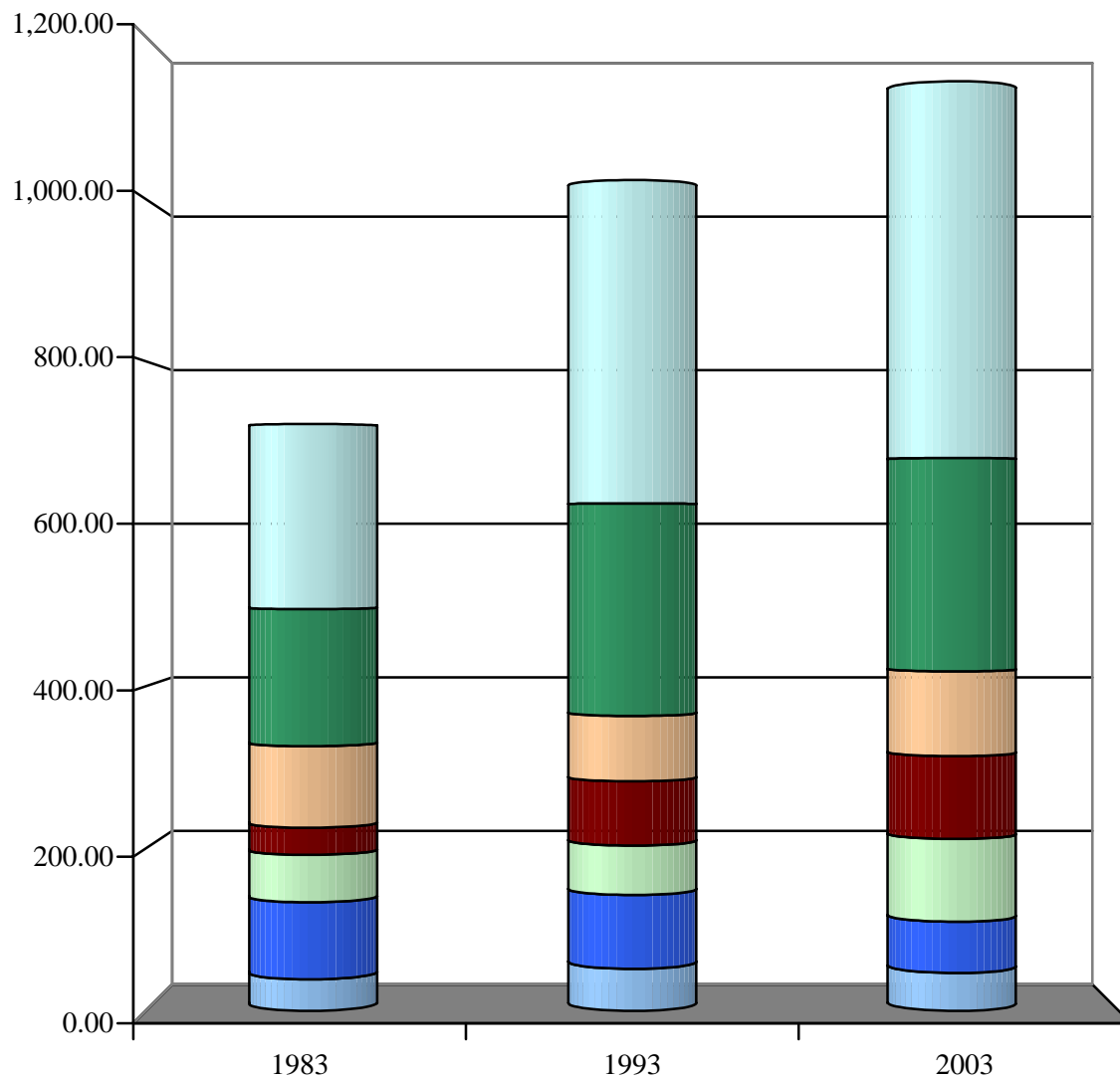
Source: EIA, Monthly Energy Review, March 2005.

Figure 6: USGS Estimate of Recoverable Oil Resources: 2000
(Million Barrels)



Source: United States Geological Survey 2000, Table AR-9.

Figure 7: Trend in Proved World Reserves: 1983-2003
(Billion bpd)



	1983	1993	2003
□ Middle East*	228.10	398.70	463.90
■ Saudi Arabia	168.80	261.40	262.70
■ Europe & Eurasia	100.10	80.40	104.30
■ S&C America	33.70	79.10	102.20
■ Africa	58.20	60.90	101.80
■ N. America	95.00	91.00	63.00
■ Asia Pacific	39.00	52.00	47.00

Source: BP Statistical Review of World Energy, June 2004. P. 4-5.

Note: *The Middle East reserves do not include Saudi Arabia.

Saudi Production Capacity

As has been mentioned previously, the Kingdom produced approximately 12.5% of total world production in early 2005, and continued to play the role of the world's one remaining major swing producer. There has, however, been growing speculation about Saudi ability to both meet the current short-term surge in global demand driven by China, and to increase capacity and to remain a major swing producer if global demand continue to be high and grow steadily in the future.

Saudi Oil Minister, Ali Al-Naimi, said that the Kingdom is able to increase its production by 1 million bpd, but he argued that the problem in the market is not from lack of supply. "It depends on demand, all we need is customers...The perception in the market is that there is not enough supply, which is untrue. There's plenty." ^{xxxviii}

Critical Saudi Energy Facilities

Saudi energy facilities have become far more costly and complex. The days of easy to produce fields are long over, and Saudi Aramco must now rely on the most sophisticated production techniques in the world and fund the most advanced network of production and recovery facilities.

Saudi Arabia has some 80 oil and gas fields, and over 1,000 wells. ^{xxxix} More than half of the Kingdom's oil reserves, however, are contained in eight fields, including the world's largest onshore and offshore fields, Ghawar and Safaniyah, respectively. Ghawar is the world's largest oil field, with estimated remaining reserves of 70 billion barrels. Safaniyah is the world's largest offshore oilfield, with estimated reserves of 35 billion barrels.

According to the EIA, Ghawar's main producing structures are, from north to south: Ain Dar, Shedgum, Uthmaniyah, Farzan, Ghawar, Al Udayliyah, Hawiyah, and Haradh. Ghawar alone accounts for about half of Saudi Arabia's total oil production capacity, and could be a key target if any attack was made on Saudi fields. Safaniyah, however, would be more attractive in terms of asymmetric attacks because offshore fields are easier targets.

Saudi Arabia also produces a wide variety of crude oils, from heavy to super light. As is shown in Figure 9, 65-70% of the country's aggregate oil production capacity is considered light gravity. The remainder is either medium or heavy, although the country is moving towards reducing the relative proportion of these two grades. Ghawar is the major producer of Arabian light crude. Arab Extra Light crude comes from Abqaiq, an enormous field, containing 17 billion barrels of proven reserves. Shaybah – with estimated reserves of 15 billion barrels – produces a mix of Arabian light and Arabian Extra Light.

Short-Term Capacity

Saudi policy is moving to increase short-term capacity. But any discussion of current and future capacity in Saudi Arabia must be viewed in an historical context. How have decisions been made in the past about what capacity Saudi should develop or maintain? Only by looking at this historical context can some of today's misperceptions be clarified.

When Saudi reserves were under the control of Aramco as the holder of the concession in the main producing areas from 1933-1988, the principle decisions about how much capacity the company should have and how much it should produce were made by the shareholders, the predecessor companies to Exxon Mobil and Chevron Texaco. From 1972 on, the Saudi Government also participated in the ownership of the company and clearly had a significant input into these decisions.

Aramco's production did not exceed 1 million bpd until 1958 and didn't exceed 3 million bpd until 1970. Neither the company nor the Saudi Government decided production or capacity levels during this period, which instead were determined by the four American shareholders, who in turn were barred by U.S. anti-trust laws from making collective decisions about production levels. Instead Aramco had an officer based in its New York office whose job it was to collect quarterly "nominations" from the shareholding companies as to how much crude they would buy in the ensuing year. That officer, a member of the Aramco board's Executive Committee, was the sole person allowed to receive the nominations from each company and he in turn would inform Aramco of the collective total of oil that the company would be asked and expected to produce. Aramco was then in charge of developing its capital budget and planning the facilities it would need to build in order to meet this demand.

During 1968-1969 meetings of ExCom, it soon became apparent that the shareholders' nominations were rapidly ballooning. Crude oil production in 1969 was just under 3.0 million bpd, The nominations indicated that Aramco would soon need to produce 10 million bpd on a sustained basis.

The first "energy crisis" of 1973-74, triggered by the 1973 Arab Israeli War, led to a rapid increase in oil prices, which previously had been remarkably stable at \$1.80-2.00 per barrel. However, demand for Saudi crude continued to rise in the aftermath of the crisis and company produced more than 9 million bpd in 1977 and hit a peak of 9.6 million bpd in 1981. At a 1976 Board meeting, a capital budget to increase capacity to 13.4 million bpd was approved, with plans on the drawing board for a capacity expansion to 20 million bpd by 1983.

However, the impact of rapidly rising prices began to reduce global consumption of crude and stimulate non-OPEC production. In an ill-fated move, OPEC first adopted quotas in 1982 in an effort to maintain crude price levels. As a consequence, demand for Saudi oil dipped below 3 million bpd in 1985, before the Kingdom finally launched a price war to regain market share. The Kingdom did slowly claw back market share to the point that it was producing nearly 6 million bpd in 1990, before Saddam Hussein invaded Kuwait and effectively ceded Iraq's market share to Saudi Arabia, the one producer quickly able to fill the supply gap.

Given this history, it is not surprising that critics like Matthew Simmons should have uncovered warnings from Aramco's oil engineers made to Senate investigators in 1979 that Saudi reserves could not sustain planned production levels. At that time, as the concessionaire holding rights to produce unlimited quantities of Saudi crude until the scheduled end of the concession agreement in 1999, the American shareholders were faced with mixed fiduciary obligations—to their shareholders themselves, to the Saudi government, and a broader stewardship duty to the world at large. But there is no

particular evidence that were examining 50-year scenarios for what would be best for the Kingdom or for a global transition to alternate fuels. In fact, there was jockeying among the shareholders for the most advantageous position.

During this period, particularly 1973-1982, the Saudi Government also made sovereign decisions about production levels for political purposes which the American shareholders were not in a position to resist. On an annual basis, production only declined in one year during this period (1975) and that was a result of slowdown in demand. Nevertheless, American presidents and other world leaders looked anxiously to Saudi Arabia to make political decisions on oil production levels. But, with a few exceptions, there is little evidence that Saudi Arabia was engaged in a careful plan for optimizing long-term production goals.

In fact, after the boon from Iraq's removal from the market in 1990, and the UN mandated limits on its exports after 1996, Saudi Arabia struggled to keep its quota at or above 8 million bpd and for a time it appeared to many that the Kingdom's aspirations to produce above that level might never be satisfied. In fact, in the one year that production well exceeded that level, 1997, was followed by the Asian economic collapse and a drastic decline in crude prices.

Thus, it should come as no surprise that the entire question of how much Saudi Arabia can and should produce cannot really be answered by returning to calculations made in different eras. The Saudis have clearly been taking a hard look at where they are now and where they want to be in the future and the decisions they make will not necessarily be based on meeting demand at an arbitrary price level selected as a base case by forecasters. But in addition, it should be noted that best minds in the oil industry in the late 1970s, then planning for Saudi Arabia to boost production to 20 million bpd, have a solid appreciation of what the price levels at that time would do to the world balance and Saudi Arabia's market share.

From 1998-2005, Saudi policy was aimed at preventing any excessive inventory buildup in the OECD, a policy which was rooted in the price collapse of 1998, prior to which OPEC had often turned a blind eye on critical indicators of inventory builds. In practice, that meant keeping OECD inventories from growing much above 52-54 days of forward demand cover.^{x1} In the US commercial crude inventories rising much above 310 million barrels by the end of May was considered an early warning of a possible supply glut by many OPEC ministers. In early 2004, Al-Naimi pronounced that Saudi Arabia watched those inventory numbers "like a hawk."

On March 14, 2005, however, Saudi Arabia and Kuwait announced that they were abandoning this policy.^{xii} The Kingdom's oil policy makers were eager to increase their production in order to "fatten up" inventory levels in consuming countries during the seasonally lower demand second quarter of the year so refiners would have extra supplies from which to draw during the higher demand foreseen in the fourth and first quarter to come.^{xliii}

This move to allow inventory build up was risky for the Kingdom for two reasons. Any curtailment in demand growth could lead to a supply glut, which, as the producers discovered anew in 1998-1999 can require arduous measures to correct. In addition, with Saudi Arabia maintaining relatively high production rates, there would be little spare

capacity to make up for unforeseen supply disruptions, the fear of which tends to support higher prices.

US commercial crude oil stocks did reach 320 million barrels by the first week of April 2005, a level which the Kingdom would have wished to avoid even later in the season in previous years.

Besides encouraging an earlier build up in stocks, the Kingdom also announced on March 14, 2005 that it was ready to meet the projected increase in demand later in 2005. Saudi Oil Minister, Ali Al-Naimi said, "Notwithstanding the uncertainty prevalent in assumptions about future supply and demand levels, projections show an increase in demand in the latter part of the year which would require additional crude oil to satisfy. Accordingly, to adequately fulfill this year's additional demand, Saudi Arabian output shall be increased from current levels at a later time this year."^{xliii}

These decisions also meant, however, that Saudi Arabia could not meet its policy goal of maintaining 2 million bpd of surplus capacity. Twice in the last two years, Saudi Arabia had produced close to its production capacity to meet sudden disruption in supply.

In the first quarter of 2003, the Kingdom increased its production to compensate for strikes in Venezuela, supply interruptions in Nigeria, and the impending loss of Iraq's oil. In the third quarter of 2004; it produced close to capacity to meet unanticipated and nearly unprecedented in growth in world-wide demand coupled with major supply disruptions in the Gulf of Mexico following the hurricanes in the US.^{xliiv}

Since mid 2004, Saudi Arabia has accelerated plans to increase capacity and has also disclosed in greater detail what these plans are as the Kingdom's spare capacity levels have come under greater scrutiny.

As long as the Kingdom had more than 2 million barrels of spare capacity and other producers in OPEC were also constraining their output under OPEC quotas, spare capacity was OPEC's headache and a source of comfort, rather than concern, for consuming governments. The unanticipated growth of demand in 2004, as well as disappointing rates of growth from non-OPEC producers has reversed this equation: spare capacity, or the relative lack thereof, has become the consuming governments' headache.

Greater scrutiny of spare capacity, especially in Saudi Arabia, has required greater precision on the part of Saudi officials in how they speak of spare capacity. For example, in early 2004, Aramco President Abdullah Jumah stated that "our capacity" is 10 million bpd and cannot be increased without additional drilling. However, at the time, Jumah was not including Saudi Arabia's share of the Neutral Zone production in his statement on "our capacity." The Neutral Zone currently produced some 600,000 bpd, so Saudi Arabia's share of that capacity lifted Kingdom-wide capacity to 10.3 million bpd.

In addition, in October 2002, the IEA effectively lowered its estimate of Saudi capacity because it changed the basis by which it measured spare capacity. The IEA issued an explanatory note at the time:

Two changes have been made to the sustainable production capacity...

The first change is in Algerian capacity, which has been increased to 1.10 mb/d. Capacity at foreign joint-venture fields, most notably those involving Anadarko, has been

increasing in recent months. As discussed above, output has risen accordingly, as Algeria pushes for an increase in its production target.

The second change has been to Saudi Arabian capacity. This adjustment involves a definitional change in the timeframe used in the table. There has been no change in the real-world assessment of Saudi Arabian capacity. Previously, the table showed "capacity levels that can be reached within 90 days", and the figure for Saudi Arabia was 10.5 mb/d. The table now shows "capacity levels that can be reached within 30 days", and the figure for Saudi Arabia has been revised downward to 9.5 mb/d. The shorter timeframe is a more helpful indicator of the response potential in case of a supply disruption, and also brings the IEA definition in line with that of other oil market analysts, facilitating comparison.

Part of Saudi Arabia's spare capacity can be brought on stream quickly - within the first month. However, the remainder - the last 1 mb/d - takes more time to start up, requiring a full 90 days. While this is not new information, it had not previously been reflected in the table. Ali Naimi, the Saudi Minister of Petroleum, publicly confirmed this after the recent OPEC meeting. The 90 day capacity of Saudi Arabia will continue to be shown in a footnote to the table. No other country has been affected by the definitional change

When Saudi Arabia embarked on its Crude Expansion program in the late 1980s, it continued its practice of defining its capacity in terms Maximum Sustainable Capacity-90 days, or MSC-90. This by definition was the capacity which Saudi Aramco could reach in 90 days time and sustain for the duration. The 90 day rule was put to the test when Saddam invaded Kuwait in August 1990. MSC-90 at the time was 8.5 million bpd and was easily met by the end of October. MSC-90 was subsequently raised to 10 million bpd, which is where it stood at the beginning of 2004. In order to maintain MSC-90 at 10 million bpd during a period when demand for Saudi crude rarely exceed 8 million bpd, Saudi Aramco added new capacity, including the development of Shaybah, so as to offset natural declines in production. In May 2004, Minister Naimi pointed to 2 million bpd of new capacity added for this purpose; although he did not specify the time it had taken for a decline of that magnitude to appear.

At the time that the IEA decided to make a downward adjustment in its assessment of Saudi Aramco's immediately available spare capacity, October 2002, it may have been reasonable to assume that Saudi Arabia was at least beginning to make an assessment of the likelihood of a US invasion of Iraq and inevitable loss of Iraqi exports for at least a limited time thereafter. Certainly once a strike shut down nearly all production in Venezuela starting in December 2002, the Saudis had ample time to begin the 90-day process of attaining MSC and one may assume that after the first quarter of 2003, Saudi Aramco did not have to repeat a 90-day preparation period in order to attain a 10 million bpd MSC, but the IEA still maintains the position it adopted in October 2002, and carries Saudi capacity at between 10-10.5 million bpd, although now cavorted as that level which could be produced on 30-days notice.

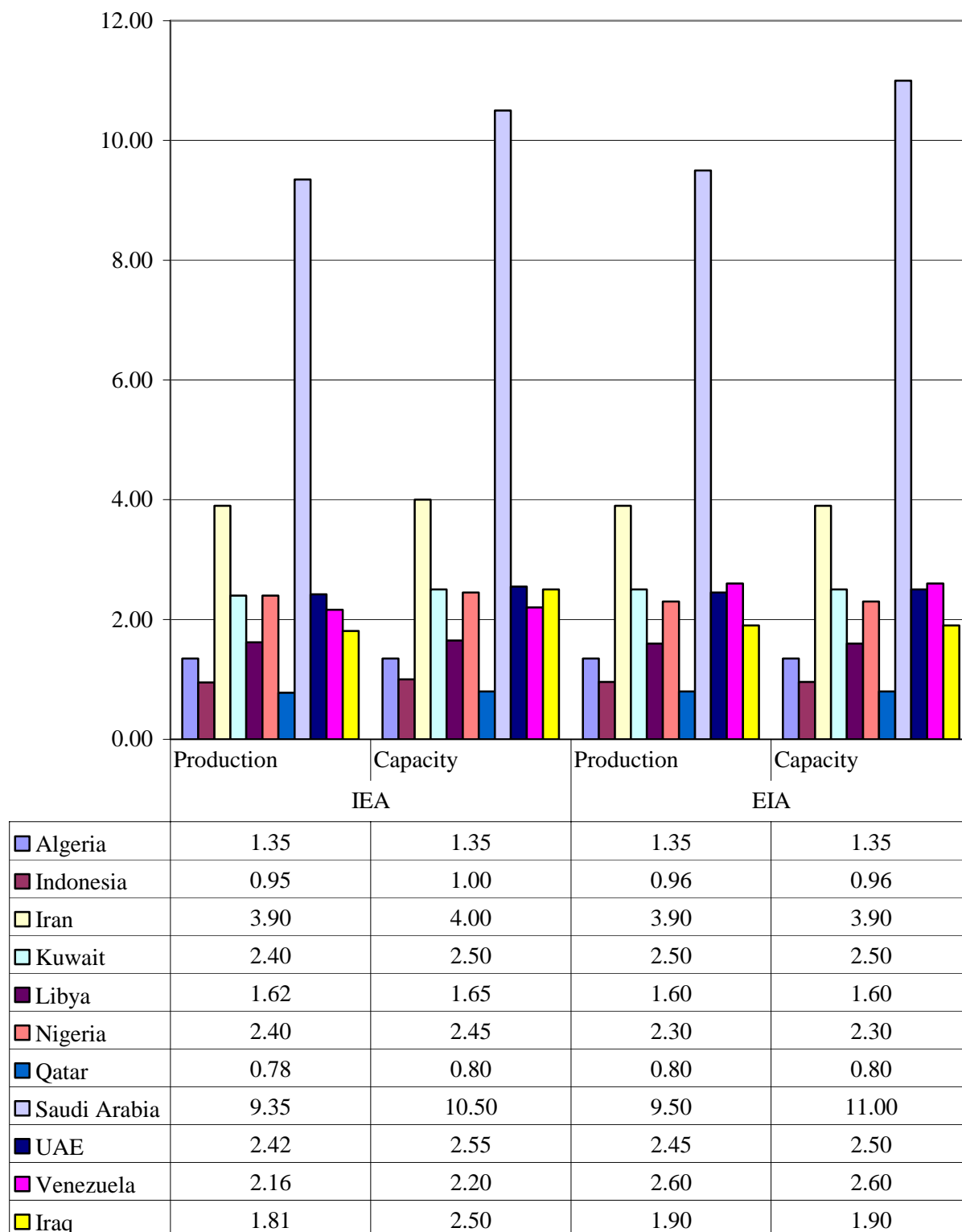
With the greater scrutiny, Saudi officials are now more precise in giving Kingdom-wide capacity figures, including the Neutral Zone, thus in early 2004, MSC stood at 10.3. Until mid-2004, a new capacity addition—the Qatif-Abu Safa increment—was classified by Aramco as capacity which would offset decline, not contributing to a higher MSC. In response to the unanticipated demand growth of 2004, the Qatif-Abu Safa net increment of 650,000 bpd was reclassified as an addition to MSC and Minister Naimi announced that declines would be offset by “intensified drilling in existing producing fields.”

The number of drilling rigs operating in the Kingdom—for years some 30 rigs had sufficed to maintain production and explore for new sources of natural gas and for a modest exploration effort for new reservoirs—has approximately doubled as part of the “intensified drilling” program. Thus the Qatif-Abu Safah net increment raised MSC from 10.3 to 10.95 million bpd. Whether or not the new official MSC of 11 results from rounding, from an extra 50,000 of capacity somewhere in the system, or is just a nice round number in itself is somewhat academic. What should be intuitively obvious is that capacity brought on line during the past decade, representing some 25% of the current MSC, is going to be more robust than the capacity which was replaced.

The “robustness” of capacity has been rarely discussed. Saudi Aramco defines MSC as capacity which can be sustained without interruption—a 24-7-365 capacity. In some other oil provinces, such as the North Sea, capacity is measured in barrels per stream day, which will be some 10% less than calendar day capacity if annual maintenance idles production for a month out of the year. In other oil provinces, the robustness of capacity can be affected not only by maintenance issues but also recurrently bad weather, as has often been the case in the Gulf of Mexico. In still other oil provinces, notably Iraq, robustness is affected not only by weather, but also by chronic equipment breakdowns, power failures, and sabotage. The ability of Saudi Arabia to exceed MSC at any given time—so called surge capacity—would depend on the Kingdom's temporarily postponing planned maintenance or well-workovers, which in turn would result in ultimately less robust capacity.

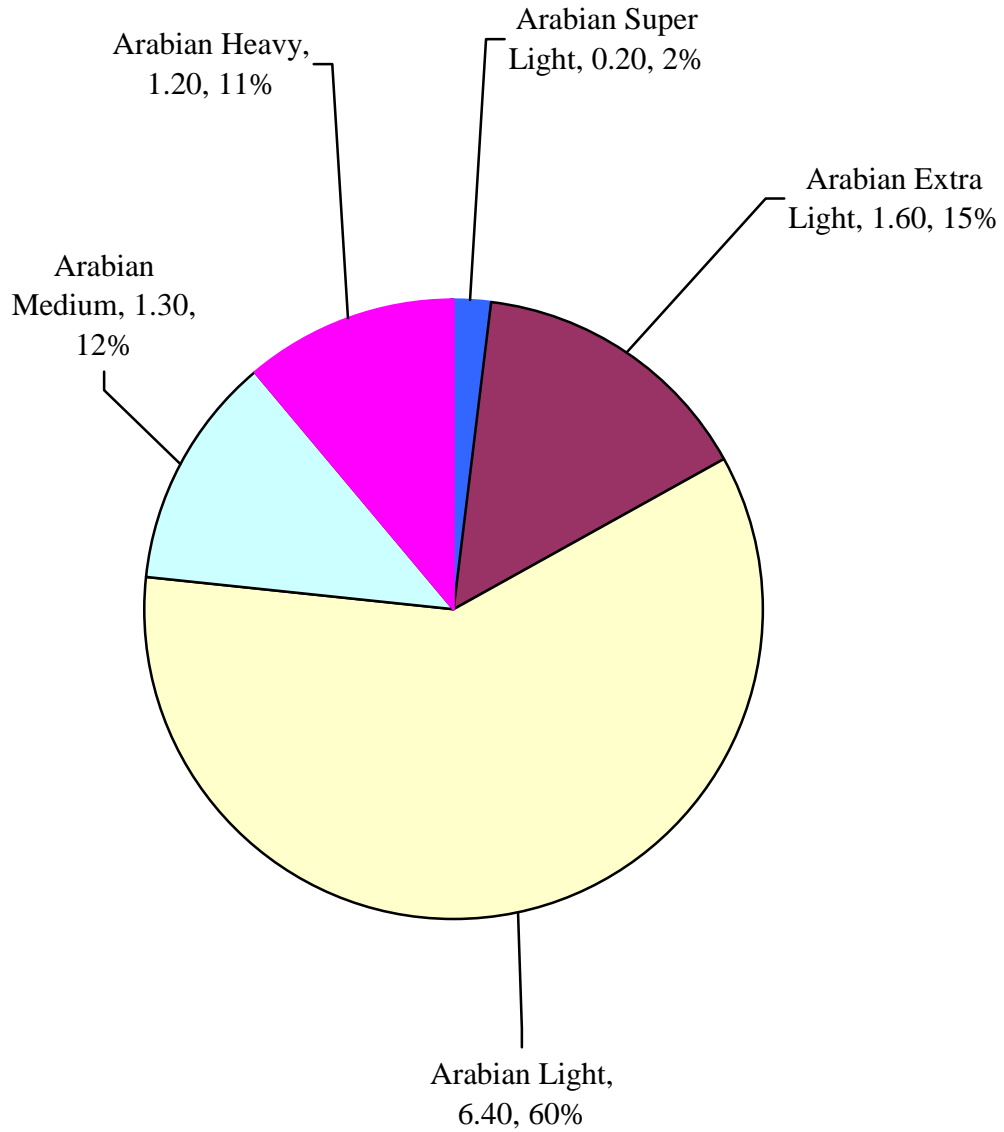
There is independent support for these claims. Deutsche Bank estimated that the Kingdom had 1.23 million bpd spare capacity in the 1st quarter of 2005 and predicted a 9.35 million bpd production for the Kingdom for the second quarter of 2005. To highlight the importance of the Kingdom's spare capacity, the total OPEC spare capacity in early 2005 was 1.71 million bpd, and other MENA states had little surplus production capacity left: Iran 90,000; UAE 140,000; Qatar 20,000; Libya 10,000; Algeria 20,000; Iraq 20,000.^{xlv}

Figure 8: IEA and EIA Estimate of OPEC Capacity by Country: March 2005
(Million bpd)



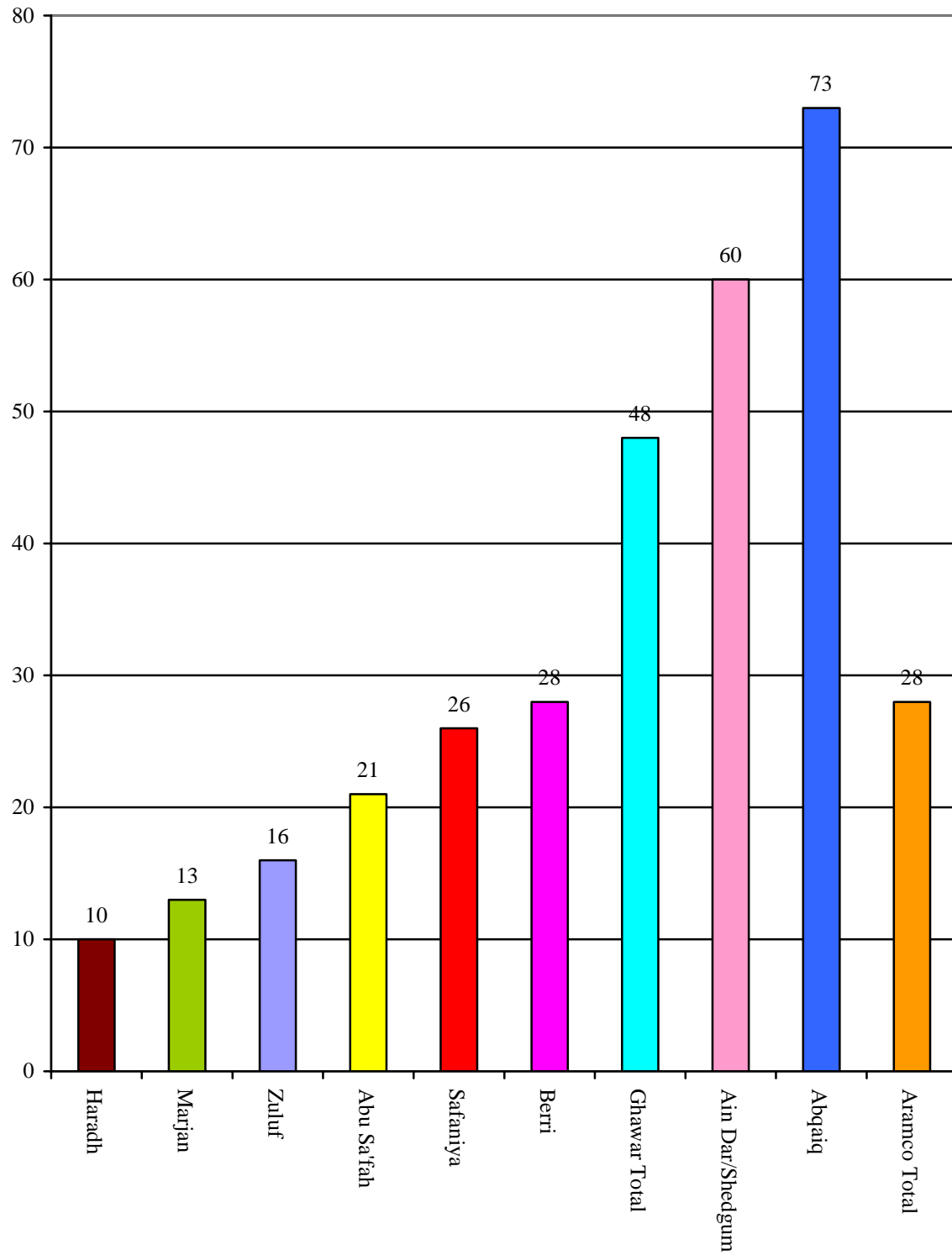
Source: Adapted from IEA *Oil Market Report*, April 12, 2005; and EIA *Short-Term Energy Outlook*, April 2005. Note: Saudi capacity according to the IEA was 10.0-10.5, and the EIA was 10.5-11.0

Figure 9: Saudi Sustainable Capacity by Type of Crude: February 2005
(Percentage & Million bpd)



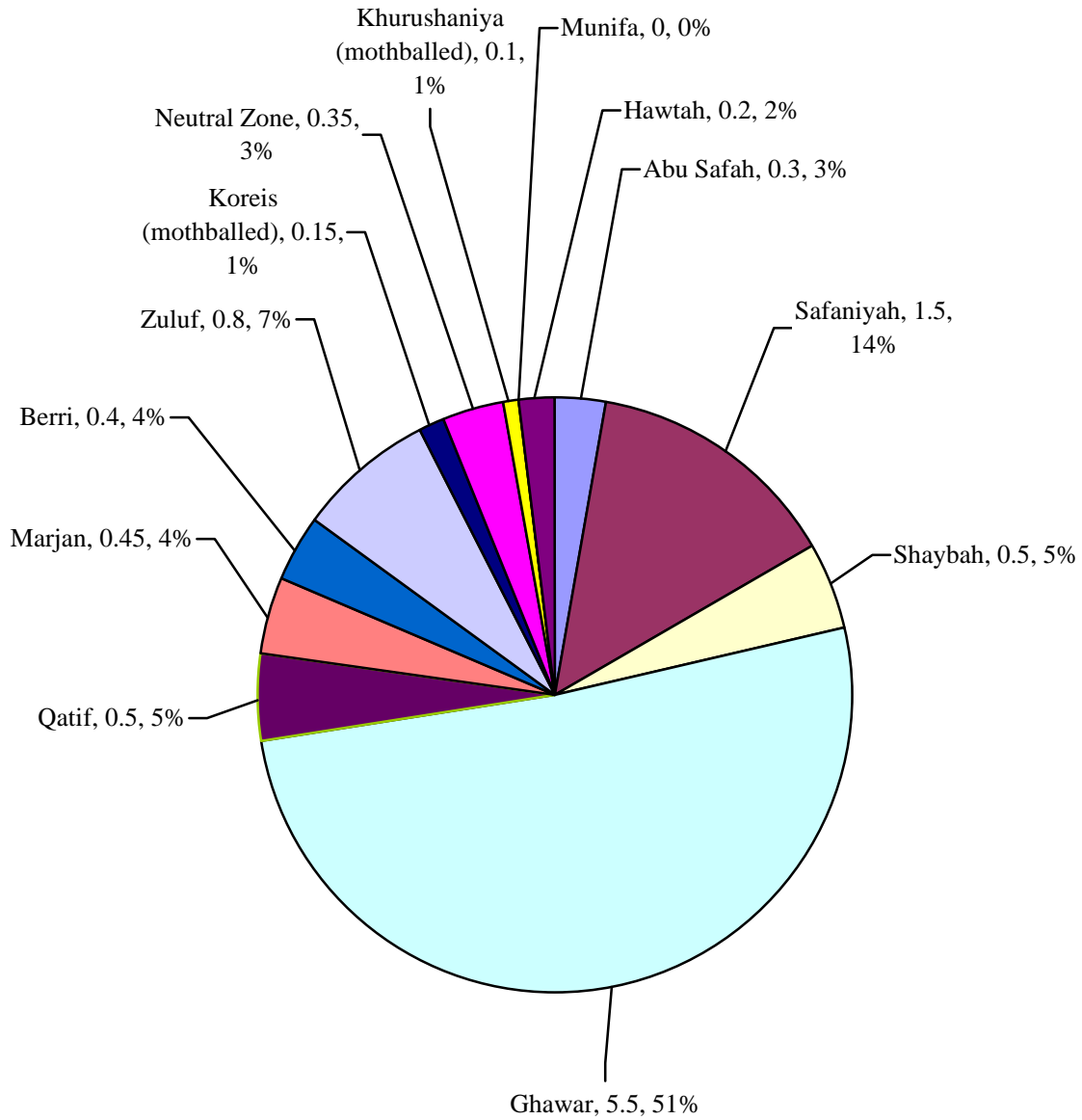
Source: Saudi National Security Assessment Project

Figure 10: Saudi Oil Fields Proved Reserves Depletion: 2004
(Total Depleted Percentage of Total Reserves)



Source: Adapted from Saudi Aramco "Fifty-Year Crude Oil Supply Scenarios: Saudi Aramco's Perspective." February 24, 2004

Figure 11: Percentage of Saudi Production by Oil Field: 2004
(Percentage & Million bpd)



Source: Saudi National Security Assessment Project

Future Production Capacity

Saudi Arabia is very unlikely to provide perfect transparency about its future production plans and capacity. Although the Kingdom has begun to embrace far greater transparency vis-à-vis its oil industry than one might have dreamt a few years ago, and is among the most transparent of all. OPEC countries are issuing annual reports on production and reserves although not on a field-by-field basis as some of critics demand. Oil reserves and production plans have become instruments of political influence in the Gulf (and the world), attract economic leverage and the ability to attract foreign investment, and no country is going to open up its operations to international second guessing without a clear strategic interest in doing so.

This means, however, that much of the assessment of future Saudi production capacity -- as is the case with the plans in many other nations -- depends largely on Saudi credibility, and particularly the credibility of Saudi Aramco.

That credibility has so far been high. The track record of Saudi Aramco is certainly better than that of some leading Western oil companies, and few doubt Aramco's overall technical capability and management skills. At the same time, the depletion of Saudi Arabia's giant fields has required steadily more complex and advanced production techniques, and uncertainties do exist about both the long term recovery such techniques make possible and the ability to sustain the past growth in production made possible through technology gain. These uncertainties affect virtually every nation in the world, but they are particularly important in the case of the world's largest producer.

Demand is also a critical issue. There also is little reason to judge Saudi performance by the extent to which it meets EIA and IEA forecasts. Saudi plans and capabilities are one thing. Demand-driven global models of requirements are another. The EIA, IEA, and OPEC models of production capacity growth and export growth are not based on assessments of what countries plan to do or will do based on their own self interest. They are based on high, sustained, average rates of global economic growth at prices around \$25-\$27 a barrel.

The underlying assumption of these demand forecasts is that sovereign countries with oil reserves will wish to exploit these reserves at a maximum rate consistent with support for prices at the reference case level. While this might be rational behavior for a commercial entity with responsibility for maximizing the return to its shareholders, it is not necessarily the case with governments, whose time frame must encompass generations and whose duty is towards stewardship of depletable natural resource, not the fastest possible exploitation and depletion of that resource.

This sovereign preference for stewardship—which has now appeared to be a major factor in Russia as well—will inevitably result in price being the arbiter between supply and demand; the role price plays in any market. A producer like Saudi Arabia, however, also has to be cautious and conscious that it does not so stress its stewardship role that it leaves future generations of its citizens with a legacy of billions of barrels of a resource which in the future might be worth less than it is now. Saudi Arabia can sell 3.5 billion barrels a year in today's market for an historically healthy price, but it has to make

necessarily imperfect judgments about the future value of the remaining 257 billion barrels it may sell in the future.

But forecasts which assume that sovereign producers will opt to maximize sales volumes consistent with a \$25 price result in an often absurd and unfair exaggeration of future production rates which no producing nation, or major oil company, has ever committed to or defended as credible. In the EIA reference case projections for 2004, for example, the global increase in oil exports between 2001 and 2025 is one from 56.3 million bpd to 89.4 million bpd, an increase of 59%. The increase from the Gulf alone is one from 16.9 million bpd to 36.4 million bpd, an increase of 115%. This means that 19.5 million bpd of the 33.1 million bpd increase in exports between 2001 and 2025 -- or 60% -- must come from the Gulf, and most must come from Saudi Arabia.^{xlvi}

This also explains why the EIA projects world energy production capacity as rising from 79.3 million bpd in 2001 to 126.1 million bpd in its reference case (\$25-27/barrel), a rise of 59%. Total Gulf production capacity is estimated to rise from 22.4 million bpd in 2001 to 45.0 million bpd in 2025, a rise of 101%. Saudi production capacity is estimated to rise from 10.2 million bpd in 2001 to 22.5 million bpd in 2025, a rise of 121%.^{xlvii}

The impact of higher prices, however, changes this estimate dramatically. The EIA has not yet considered future with average price over \$40 per barrel, but it projected world energy production capacity to rise to only 117.3 million bpd in its "high price" case (\$35-37/barrel), a rise of 48%. Total Gulf production capacity was estimated to rise to 32.9 million bpd in 2025, a rise of 47%. Saudi production capacity was estimated to rise to 16.0 million bpd in 2025, a rise of only 57%.^{xlviii}

All such projections are little more than guesswork, but it should be clear that sustained rates of \$50 oil would drastically further reduce the requirement for increases in Saudi production capacity. Equally important, Saudi Arabia has no obligation to plan to meet idealized demand-driven economic requirements, and would be foolish to do so. It has simply been used as a virtually infinite pool of oil exports by EIA, IEA, and OPEC modelers for their own bureaucratic convenience.

As for Saudi long-term plans, Saudi Oil Minister, Ali Al-Naimi, in an address to the Royal Institute of International Affairs in London in November 2004, talked about the Kingdom's quest of building up its production capacity to deal with recent developments in the international oil market:

We have also recently developed plans to increase gradually Saudi Arabia's sustainable production capacity to 12.5 millions bpd. These plans call for a substantial amount of work in both new and old oil fields over the next few years. Fields and reservoirs for the expansion program have already been identified...

The decision to invest in added production capacity on this scale reflects our belief that demand for Saudi oil will continue to increase through the coming years. For longer term, scenarios to raise the capacity to 15 million bpd have also been studied and can be set in motion if the global demand requires it....

[The Kingdom believes] a reasonable spare capacity of no less than 1.5m bpd. As in the past, the spare capacity helps assure the continuity of stable oil markets by making more oil available in times of supply dislocations or any unusual surge in demand...

[Aramco] was able to advance its production capacity on a sustainable basis from 7.0 million to 10.0 million bpd during the first half of the 1990s, a permanent increase of some 3.0 million bpd, all the while finding new reserves to replace its production.^{xlix}

It is not clear exactly which, how, and how long Saudi Arabia could reach a sustained production levels of 12.5 million bpd or 15.0 million bpd, although this may well be possible.

Saudi mid-term plans are much clearer. Most of Saudi Arabia's present spare capacity comes from Safaniyah. The estimates for the Safaniyah capacity range from 1.2 to 1.5 million bpd, and they come from two onshore wet-crude handling facilities with two trains of 600,000 bpd. The Saudi Aramco's Crude Expansion Program in the 1980s "recompleted" 60 oil wells that were in the shutoff-zones to access lower reservoirs that have been mixed with water. The oil from Safaniyah does not need to be stabilized before shipment because it lacks hydrogen sulfide, but Safaniyah lacks high conversion refining capacity.¹

In 2004, the Kingdom developed two oil fields, Qatif and Abu Safah. The two oil fields have an on stream production of 800,000 barrels per day. These projects increased Saudi Arabia's production capacity from 10.5 to 11.0 million bpd. In 2004, Al-Naimi said that Saudi Aramco "regularly develops and brings on stream major new crude oil increments such as the Arabian Super Light crude from fields south of Riyadh and the massive Shaybah field in the Empty Quarter with its 500,000 bpd production increment..."ⁱⁱ

In March 2005, Aramco awarded 5 projects worth \$8 billion to foreign firms. The projects are expected to be finished in 2007 and are to boost the Kingdom's capacity. The goal is produce 500,000 bpd from Kharsaniya and 310,000 bpd of liquefied gas from Hawiya.ⁱⁱⁱ

Figure 12 summarizes the expected future increases in the Kingdom's production capacity by new projects. The estimates show that between 2004 and 2009, Saudi production capacity is estimated to increase by 2.7-3.05 million bpd. The new oil will be of Light or Extra light grade. Most of the increase will come from Khoreis' approximately 1 million bpd.

Figure 12: Increase in Saudi Production Capacity by Field: 2005-2009

Oil Filed	Grade	Est. Cost (\$Billion)	New Capacity (bpd)	Expected Date
Abu Safah & Qatif	Arab Light & Extra Light	4.0	500,000 to 550,000	2004/2005
Haradh	Arab Light	1.0	300,000	2006
Khursaniyah	Arab Light & Extra Light	3.0	500,000	2007
Shaybah	Arab Extra Light	1.0	400,000 to 500,000	2008
Khoreis	Arab Extra Light	5.0	1 million to 1.2 million	2009
Total		\$12-\$15	2.70 million to 3.05 million	2004-2009

Source: Saudi National Security Assessment Project.

It is notable that the Kingdom announced in 2005 that it had the objective of reaching 12.50 million bpd of sustained capacity. The Kingdom's current capacity is estimated to

be between 10.8 and 11.0 million bpd, which include the increase from Abu Safah and Qatif.

An estimated 2.3-2.4 million bpd of new capacity will come on stream between 2005 and 2009. But an estimated 800,000 of that will go into replenishing the natural decline curve. The end result is a net addition of roughly 1.6 million bpd to the current sustainable capacity of 11.0 million bpd. This addition increases the sustainable capacity to 12.5 million bpd of by 2009. According to Aramco's Senior Vice President for Exploration and Production, Abdullah Al-Saif, the capacity expansion program has been put on a fast track, and the fields may come on stream before 2009.^{liii}

The investment cost for the Saudi capacity expansion plan is estimated to be around \$15 billion. It was also reported that, during the same period, the Kingdom's total investment in the petroleum sector was estimated to total \$50 billion.^{liv} Experts believe that the latter number represent Saudi Arabia's total energy investment, while the \$15 billion represent the cost of the projects outlined earlier.

Whatever the debates over Saudi capacity may be today, these projects and dates now provide clear benchmarks for measuring Saudi capacity and credibility. Success will greatly enhance all aspects of Saudi credibility. Failure will be an important strategic warning.

Outside versus Saudi Capacity Forecasts

At the same time, it should be stressed that Saudi credibility cannot be judged by the kind of production goals projected in EIA and IEA models. The Kingdom has talked about plans to raise sustainable production capacity to 12.5 millions bpd, and longer term scenarios to "raise the capacity to 15 million bpd have also been studied and can be set in motion if the global demand requires it..." It is clear that Saudi Arabia does not currently want to make a commitment to 15 million bpd.

Figure 13, however, presents the EIA forecasts for Saudi Arabia's production capacity between 2001 and 2025. It shows the impact of the two different cases the high price (\$25-\$27) and the reference price (\$35-\$37/barrel).

The EIA estimate for the reference case calls for Saudi production capacity to increase from 10.5 million bpd in 2004 to 13.2 million bpd in 2010, 18.2 million bpd in 2020, and 22.5 million bpd in 2025.

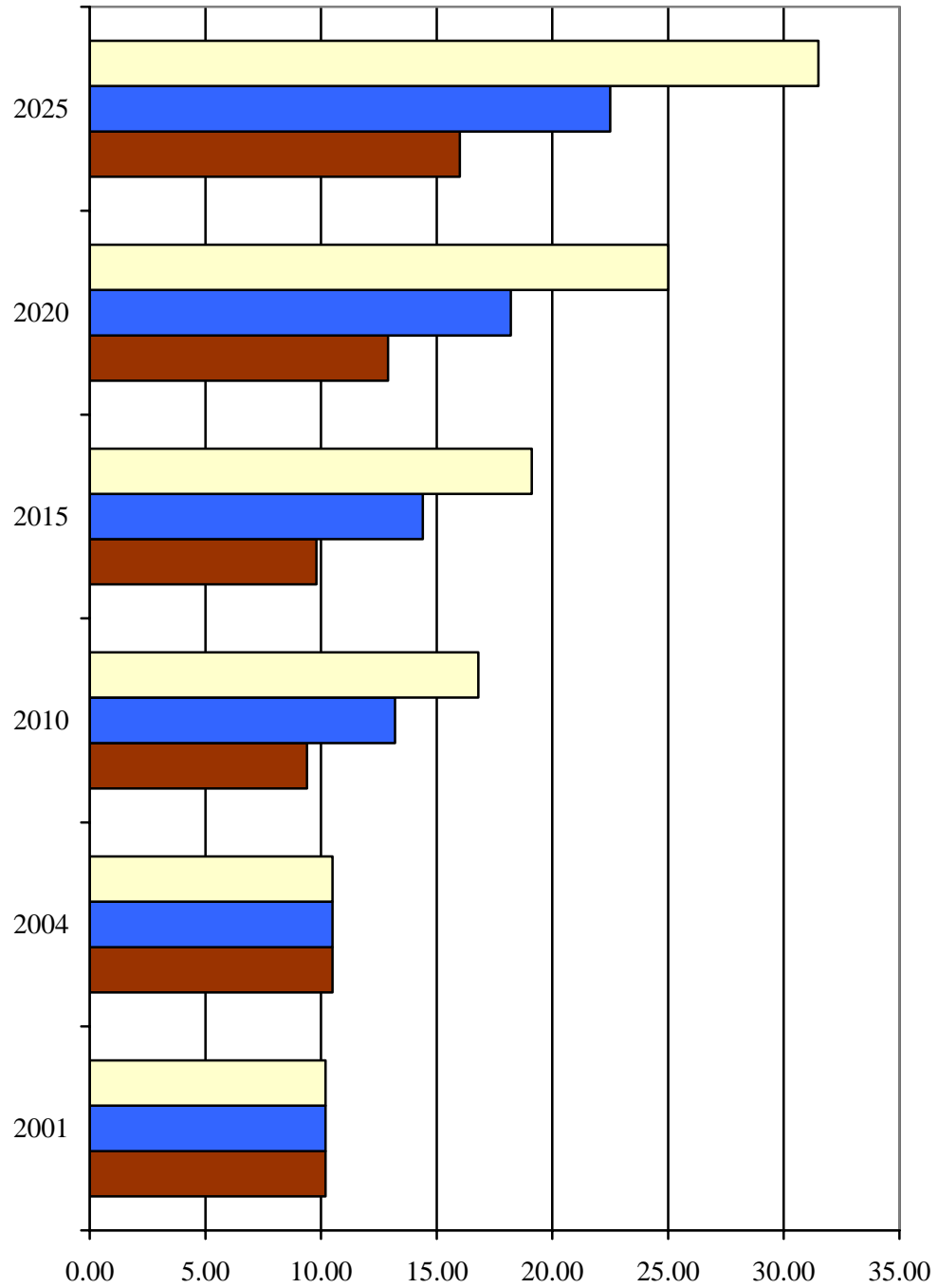
It is hard to argue with the comments of Dr. Sadad Al-Husseini, a former Aramco's Executive Vice President for Exploration and Production. Dr. Al-Husseini said of the EIA forecast "They are perhaps unaware of how unrealistic these numbers are." He argues that the EIA projection assumes very low oil prices. The model, he claims, does not take into account high conservation rates and alternative sources of energy. "The whole industry laughs at [the EIA forecast]."^{lv} Saudi Aramco's forecasts show that in 2025, Saudi Arabia's production capacity will at most be approximately 15 million bpd.
^{lvi}

At the same time, the production capacity called for in the EIA high oil price is closer to Aramco's forecast. This EIA estimate projects that the demand for the Kingdom's crude

and other liquids will change from 10.5 million bpd in 2004 to 9.5 million bpd in 2010, 9.8 million bpd in 2015, 12.9 million bpd in 2020, and 16.0 million bpd in 2025.

There is no way to know how the EIA estimate of the demand for Saudi crude and other liquids would change if prices rose from the high of \$37 per barrel called for in the EIA "high price" case to \$45-\$50 a barrel or more. It seems likely, however, that it would come far closer to 12.5 million bpd than 15 million bpd. It is also quite possible that such a future would do a great deal more to reduce the vulnerability of the world to oil export supply problems, and create a slower and more sustainable conversion to other forms of energy. Saudi capacity of no more than 12.5 million bpd may not only prove to be the real world case, it may well be the better long-term future for both the Kingdom and the global economy.

Figure 13: Saudi Sustainable Production Capacity: 2001-2025
(Million bpd)



	2001	2004	2010	2015	2020	2025
Low Price Case	10.20	10.50	16.80	19.10	25.00	31.50
Reference Case	10.20	10.50	13.20	14.40	18.20	22.50
High Price Case	10.20	10.50	9.40	9.80	12.90	16.00

Source: EIA, International Energy Outlook, 2004.

Investing in Refineries

Saudi's diversification and investment in "downstream" capacity get far less attention overseas than in Saudi Arabia. It is, however, both a measure of how serious Saudi Arabia is about maintaining and increasing capacity, creating new jobs, developing the Saudi economy, and creating the conditions for internal stability.

The Kingdom now has eight refineries, with a combined crude throughput capacity of roughly 1.75 million bpd, in addition to about 1.6 million bpd of overseas refining capacity. A 200,000 bpd fractionation component was completed at the Ras Tanura refinery in August 2003. There are plans to increase the Rabigh refinery's capacity to as much as 400,000 bpd and upgrade its product slate from "low-value" heavy products to gasoline and kerosene. Another innovation will be the addition of an ethane cracker fed by natural gas from the Eastern Province through a converted oil line.

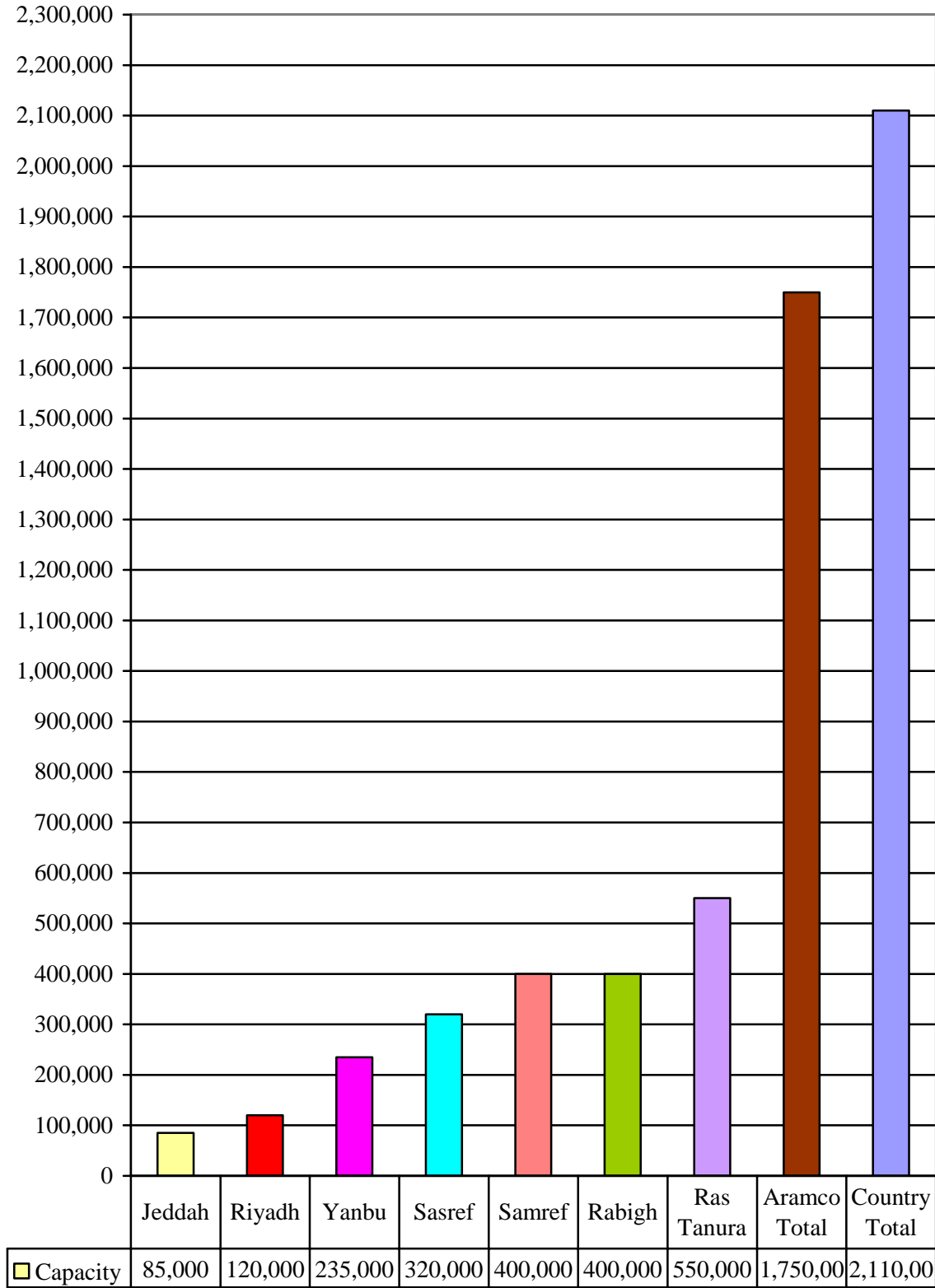
The Kingdom expects that domestic demand for refined products will reach 4 million bpd by 2010, a 10% per year increase.^{lvii} Saudi Aramco has 2 joint ventures in the Kingdom's refineries: Sasref (320,000 bpd) refinery at Jubail with Royal Dutch Shell, and Samref (400,000 bpd) in Yanbu with Exxon Mobil Corp. The Kingdom plans to upgrade and expand its current plants, which could produce 2.1 million bpd with an estimated cost of \$1.5-\$2.0 billion. Aramco was also considering investing \$4-\$5 billion in revamping its Ras Tanura refinery and has signed a \$6-\$7 billion investment agreement with Japan's Sumitomo Chemical Co. to upgrade its refinery in Rabigh.^{lviii}

Saudi Aramco has also said that it has been in talks with possible joint venture partners for an investment of \$4.0-\$5.0 billion to build a new refinery in Yanbu. The refinery will have a capacity of 400,000 bpd and would produce US and European specification products. The Yanbu refinery is expected to run Arab Heavy Crude. It was reported that Hindustan Petroleum Corp Ltd held "preliminary talks," with Aramco on building the refinery.^{lix} Other Indian companies have expressed interests in expanding the refinery, according to Aramco's Vice President for Refining, Khalid Al-Buainain. In 2004, the same plant was reported to be "under discussion" with Japanese companies to be developed as a refinery with a capacity of 800,000 bpd.^{lx}

It is clear from such plans that Saudi Arabia does count on high level of sustained capacity. There is no direct correlation between downstream investment and total upstream capacity, but Saudi Aramco has a clear interest in investing in refining facilities both in and out of the Kingdom which are designed to process its heavy crude efficiently. Ethane-based petrochemical plants located in the Kingdom rank among the most profitable in the world.

On March 7, 2004, Saudi Aramco signed a natural gas exploration agreement with Sinopec, a Chinese firm, in the Saudi Empty Quarter. Sinopec has 4/5 share of the project.^{lxi}

Figure 14: Saudi Major Refineries: 2004
(Capacity Million bpd)



Source: Saudi Aramco

The Saudi Pipeline and Export System

The Saudi pipeline and export system is both another key measure of capacity and a key potential vulnerability although most pipeline facilities can be repaired relatively easily and quickly with the exception of some pumping and control facilities. According to the EIA, the Saudi oil system is divided into a northern producing area and a southern producing area. Northern oil, except for crude from Safaniya and Zuluf, is stabilized at Juaymah and Ras Tanura stabilizers in order to remove toxic hydrogen sulfide and then sent to refineries or the export terminals at Ras Tanura and Ras al-Juaymah.^{lxii}

All the petroleum from the southern areas is pumped to Abqaiq for stabilization and from there to Ras Tanura and Ras al-Juaymah. The 5 million bpd East-West Crude Oil Pipeline (Petroline), operated by Saudi Aramco since 1984 (when it took over from Mobil), is used mainly to transport Arabian Light and Super Light to refineries in the Western Province and to Red Sea terminals for export to European markets.

The Saudi government expanded the Petroline in part to maintain Yanbu as a strategic option to Gulf port facilities in the event that exports were blocked at that end. Furthermore, it is clear that Petroline's capacity could be expanded significantly, and that this would enhance the line's strategic value. Yanbu, however, remains a far less economic option for Saudi oil exports than Ras Tanura. Among other factors, shipments from Yanbu add about five days roundtrip travel time for tankers through the Bab al-Mandab strait to major customers in Asia compared to Ras Tanura (via the Strait of Hormuz).

According to Oil Minister Ali al-Naimi, the Petroline is only utilized at half capacity. Given this fact, as well as the desire to boost natural gas usage, Saudi Aramco has begun converting the line to natural gas pumping capability. The natural gas will supply Yanbu's petrochemical and power facilities.

The 290,000 bpd Abqaiq-Yanbu natural gas liquids pipeline runs parallel to the Petroline is, which serves Yanbu's petrochemical plants. The Trans-Arabian Pipeline (Tapline) to Lebanon is mothballed, and the 1.65 million bpd, 48-inch Iraqi Pipeline across Saudi Arabia (IPSA), which runs parallel to the Petroline from pump station #3 (there are 11 pumping stations along the Petroline, all utilizing on-site gas turbine electric generators) to the port of Mu'ajiz, just south of Yanbu, was closed indefinitely following the August 1990 Iraqi invasion of Kuwait. It was seized by the Saudi government in 2002, after Iraq failed to pay required upkeep fees for 12 years. Saudi Aramco has begun converting the ill-fated pipeline, which was built by the Iraqis during the Iran-Iraq war to bypass its damaged Gulf export facilities but which operated for only six months, to natural gas pumping capability. The natural gas will supply Yanbu's petrochemical and power facilities.

Most of Saudi Arabia's crude oil is exported from the Gulf via the huge Abqaiq processing facility, which handles around two-thirds of the country's oil output. This makes it another key potential target, but there is no evidence of any bottleneck in increasing Saudi export capacity. Saudi Arabia's primary oil export terminals are located at Ras Tanura (5.5-6.0 million bpd capacity; the world's largest offshore oil loading facility) and Ras al-Juaymah (3.0-3.5 million bpd) on the Gulf, plus Yanbu (4.5-5.0

million bpd) on the Red Sea. Combined, these terminals can now handle from between 13.0-14.0 million bpd and demonstrate Saudi Arabia's ability to handle increased production capacity. Each of these terminals is, however, a major potential target for terrorist or asymmetric attacks.

Petroleum Infrastructure Security

While the previous analysis has focused on Saudi production capacity, this is scarcely the only issue affecting the Kingdom's level of exports. At least in the short run, terrorism may be much more of a threat to Saudi exports than any short-fall in production capacity. There have been many studies over energy security over the years, including studies by the CIA, EIA, and IRA. All have found that Saudi Arabia is a key petroleum exporter and central to a steadily more interdependent global economy. Saudi Arabia is also the only oil producer that has consistently sought to maintain surplus oil production capacity, with a nominal goal of 2 million bpd. This situation will not change in the foreseeable future.

While details of the Saudi security budget are classified, it is estimated to total more than \$8.0 billion in 2004. Between 2002 and 2004, the Saudi government allocated approximately \$1.2 billion to increase security at all of its energy facilities. At any one time, it is estimated that there are between 25,000 and 30,000 troops protecting the Kingdom's oil infrastructure. "For years, Saudi Arabia has recognized the importance of protecting its vital facilities, long before the recent terrorist actions. So we've always maintained a high level of security," says Abdullatif Othman, Executive Director of Saudi Aramco affairs.

Oil fields are large area targets, with many redundant facilities. While fires can be set in many areas of a working field, including at oil wells, fires do not produce critical or lasting damage. Unless wells are attacked with explosives deep enough in the wellhead to result in permanent damage to the well, most facilities can be rapidly repaired.

There also, however, are larger items of equipment and central facilities whose damage would do far more to interrupt production and many of which require months of manufacturing time to replace. Such facilities include central pumping facilities, gas-oil separators (GOSPs), and related power plants, water injection facilities, and desalination plants. Vulnerability also increases sharply if key targets in a field are attacked as a system, rather than as individual elements, and if expert assistance is available to saboteurs or attackers.

Recent Patterns of Vulnerability

Such concerns are not theoretical. On May 1, 2004, four attackers broke into the offices of ABB Lummus in Yanbu, a Saudi petrochemical compound, and killed six senior multi-national workers and one Saudi. Al-Qaeda claimed responsibility. The Yanbu attack was followed by a similar incident at the end of May at a residential complex in Khobar that killed 22 people, mainly foreigners. In the first few weeks of June 2004, several more foreign workers were killed, including one who was kidnapped and beheaded. Other terrorist plots have been foiled. In 2002, counter-intelligence investigations uncovered a sabotage plot against the Ras Tanura terminal. Importantly, after interrogations of suspects, Saudi authorities determined that none of the company's employees were involved.

Al-Qaeda sympathizers are not the only threat to the Saudi oil supply. There is also concern over the large Shiite Muslim population in the Eastern Province (Al Ahsa, where much of the petroleum infrastructure is located). In late 1979 and early 1980, riots among this group were alleged to have been inspired by taped messages of the late Ayatollah Khomeini. In 1996, Saudi Shiite terrorists, trained and financed by Iran's Revolutionary Guard, planted a truck bomb that killed 19 American Air Force personnel at the Khobar Towers near Dhahran, headquarters of Saudi Aramco. Shiites -- which make up just under 50 percent of the labor force of Saudi Aramco and around 7.5 percent of Saudi Arabia's population -- have suffered from economic, political, and religious discrimination. The Saudi government has recognized that this represents a potential security threat and has taken steps to address Shiite grievances.

The attacks in Yanbu and Khobar in the spring and summer of 2004 fanned fears about the vulnerability of Saudi Arabia's oil infrastructure, especially in the West, where the media was filled with almost daily reports about instability in the Kingdom and its repercussions on world energy markets. Following the attacks, a senior U.S. State Department official warned that Saudi economic facilities and infrastructure are likely targets of terrorists. And with oil prices at an all time high, such fears gained new urgency in mid 2004. In fact, a "security premium" of at least several dollars was likely factored into the price of oil during that time.

It is important to note, however, that Saudi security agents were able to quickly cordon the industrial portions of the facility during the attack on Yanbu, and force the terrorists away from the compounds and into the city proper, where they were quickly killed; the industrial complex was never in danger. Still, analysts point to several scenarios, which at the very least could destabilize Saudi oil production.

Saudi Arabia's Improving Security Capabilities

Securing the Kingdom's energy infrastructure, which covers hundreds of square miles, is a complex and daunting task. The Kingdom's five enormous oil fields are connected by thousands of miles of pipeline. Ghawar, the world's largest field, is 150 miles long and 25 miles wide. The Kingdom has fortified its oil infrastructure security through the use of high tech surveillance systems and the creation of special security units, as well as deployment of members of various military and security forces.

Under the auspices of the Ministry of Interior, a special unit has been created to oversee security at the major oil facilities. This unit is made up of representatives from the Special Security Forces, Special Emergency Forces, the General Security Service (the domestic intelligence service), regular forces of the Public Security Administration (including police officers), the Petroleum Installation Security Force (PISF), specialized brigades of the National Guard, the Navy, and the Coast Guard.

In most cases, the Petroleum Installation Security Force (supplemented by specialized brigades of the National Guard) guards the wells and other important installations within a given facility. Members of the Special Emergency Forces and elements of the National Guard and regular police forces generally protect the perimeters of these installations. The Navy and Coast guard work to protect terminal docks and offshore fields, and the Air Force provides surveillance and protection from the air. Finally, threat assessment and

intelligence gathering is conducted by the General Security Service and members of the Special Security Forces act as an elite anti-terrorism squad.

An example of the intensive security at these facilities can be found at Abqaiq, the Kingdom's largest oil processing facility, and the largest crude stabilization plant in the world. Recently Abdallah Jumah, the CEO of Saudi Aramco, revealed that Abqaiq and other major installations are protected by approximately 5,000 security guards in the employ of Saudi Aramco. These guards work at key checkpoints and act as a police force within the compounds; the outer perimeter is defended by a specialized brigade of the National Guard and the Special Emergency Forces. At the heart of Abqaiq are ten cylindrical towers within which hydro-desulphurization occurs (the process of making crude oil "sweeter"). Specialized units that work in cooperation with the perimeter forces cordon each tower.

Security is massive at Ghawar, the world's largest oil field. The Petroleum Installation Security Force protects all major wells in the enormous complex. Outside each of the facilities stand National Guard personnel, as well as elements of the Special Emergency Forces. There is continuous air surveillance from helicopters and round the clock F15 patrols. On the perimeter, heavily equipped National Guard battalions stand guard.

Saudi Arabia's terminals are similarly well defended. On an average day, anywhere between 2.5-3.0 million barrels of oil flow through the Ras al-Juaymah terminal. From the main platform, the oil flows to five mooring buoys located offshore, each capable of transferring an estimated 1.5-2.0 million bpd to awaiting tankers. At Ras Tanura, the average capacity is 4.5-5 million bpd, with one platform alone handling 47% of the terminal's exports. Clearly, a successful attack on one of these terminals or on the off-loading platforms could be devastating. For this reason, security at these complexes is colossal and comprehensive. Each terminal and platform has its own specialized security units, comprised of Saudi Aramco security forces and specialized units of the National Guard and the Ministry of Interior. The Coast Guard and components of the Navy protect the installations from the sea. The thousands of tankers entering and leaving these areas each year are escorted by naval ships and covered from the air. While security at the terminals and at sea may seem like a formidable task, six tankers per day are all that is required to export 9.0 million barrels. Pilots at the Dhahran airbase (only 10-15 minutes flying time from Ras Tanura) are trained to defend against any hijacked aircraft.

Perhaps the weakest link in the system is the estimated 17,850 kilometers of pipeline in the Kingdom. While it is impossible to protect the entire length from sabotage, Saudi security forces have ensured that any damage can be quickly contained and repaired. The pipeline is monitored and controlled from a central command center at Saudi Aramco, so that any suspicious activity can be immediately investigated. In addition, the pipelines have always been fitted with emergency shut-down valves at approximately every kilometer, which greatly isolates the potential effect of any accidental or sabotage induced leak. Strategically located along the length of the line are specialized backup teams, which can be quickly dispatched by helicopter to repair any damage. Internal estimates reveal that in a worst-case scenario – where an entire section of pipeline is destroyed – repair teams could bring the pipeline back to normal operation within 36 hours (Saudi Arabia maintains the world's largest stockpile of repair pipeline, stored throughout the length of the pipeline).

Overall Vulnerability

It is impossible to completely eliminate the threat of terrorism against the Kingdom's energy infrastructure, and Saudi Arabia faces the threat of conventional military attack, asymmetric warfare, and proliferation as well. Given the recent security efforts by the Saudi government (much of which remains classified), the overlapping and redundant layers of defense around key installations, and the extensive disaster planning and drills that has taken place has significantly lessens the probability of any major attacks being carried out successfully.

Short of a spectacular strike on the scale of 9/11, or some form of systematic sabotage from inside Saudi Aramco or other key energy industries, most foreseeable assaults are likely to be quickly confined and any resulting damage is likely to be repaired relatively quickly. Energy security will, however, be a continuing problem for Saudi Arabia and the world. Moreover, global energy use expected to rise by more than 50% by 2025, and the security of Saudi energy exports will play a steadily more vital role in the world's economy.

Impact of Oil Revenues on Saudi Reform Efforts & Stability

In the mid and longer term, Saudi oil production and export capability will depend on other factors. Broader economic, social, and political reforms are vital to the stability of the Kingdom, whether or not Saudi Arabia continues to have years of high oil revenues. Progress remains slow and uncertain in many of these areas, but the Kingdom has continued its reform efforts, and has taken advantage of high oil revenues over the last few years and high internal economic growth rates due to the rise in oil prices. It has embarked on strengthening economic ties with the EU and the US, and continued its ambition to join the WTO.

According to the EIA, oil revenues made up 90-95% of total Saudi export earnings, 70%-80% of state revenues, and approximately 40% of the Kingdom's GDP. Figure 15, shows the growth of oil exports in OPEC. Due to high oil prices in 2003 and 2004, and high Saudi oil output, the Kingdom's oil export revenues were more than \$100 billion in 2004, compared to \$77 billion in 2003 (a 35% increase). The EIA forecasts Saudi oil revenues in 2005 and 2006 to be \$111.70 and \$107.00, respectively.^{lxiii}

These revenues cannot compensate for the current slow rate of Saudization, productive economic diversification, educational reform and other areas where the Kingdom can and must do more. They, however, help give it the resources it needs to act.

In practice, the Kingdom has used its oil revenues to make consistent efforts to deal with its rising unemployment rate and the rapid increases in its population – two areas with serious national security implications. Saudi Arabia has sought to diversify its economy away from the petroleum sector, encourage foreign investment, strength Saudization, and revise the tax code. There already has been considerable diversification in the Saudi economy. The oil sector provided 35% of GDP in 2004 compared to 65% of GDP in 1974, although these figures are misleading because petrochemicals and other petroleum-related products are not included in petroleum sector and the growth of the service and manufacturing sectors is heavily linked to petroleum products and revenues.

Figure 15: OPEC Net Oil Export Revenues

	Nominal \$Billions				Constant 2004 \$Billions				
	Change 2004/2003	2004E	2005F	2006F	1972E	1980E	1998E	2005F	2006F
Algeria	32%	\$22.60	\$25.30	\$25.10	\$4.80	\$25.60	\$6.30	\$24.80	\$24.20
Indonesia	-111%	-\$0.20	-\$1.30	-\$1.60	\$3.20	\$29.60	\$3.50	-\$1.30	-\$1.50
Iran	36%	\$32.50	\$32.30	\$32.00	\$14.90	\$26.10	\$11.70	\$31.70	\$30.80
Iraq	105%	\$20.00	\$21.30	\$24.80	\$5.20	\$53.80	\$7.50	\$20.90	\$23.90
Kuwait	40%	\$27.40	\$28.00	\$30.00	\$10.00	\$37.30	\$8.90	\$27.50	\$28.90
Libya	38%	\$18.10	\$19.40	\$19.60	\$10.60	\$44.30	\$6.60	\$19.00	\$18.90
Nigeria	46%	\$29.80	\$30.60	\$32.10	\$7.50	\$47.50	\$9.80	\$30.10	\$30.90
Qatar	43%	\$13.50	\$13.80	\$13.60	\$1.60	\$10.70	\$3.80	\$13.50	\$13.10
Saudi Arabia	35%	\$115.10	\$113.80	\$111.00	\$16.80	\$207.80	\$39.00	\$111.70	\$107.00
UAE	32%	\$30.30	\$31.30	\$32.40	\$3.80	\$37.50	\$10.70	\$30.70	\$31.20
Venezuela	47%	\$29.10	\$30.30	\$29.80	\$11.00	\$36.20	\$13.20	\$29.70	\$28.70
TOTAL	39%	\$338.40	\$344.70	\$348.90	\$89.50	\$556.20	\$120.90	\$338.40	\$336.30

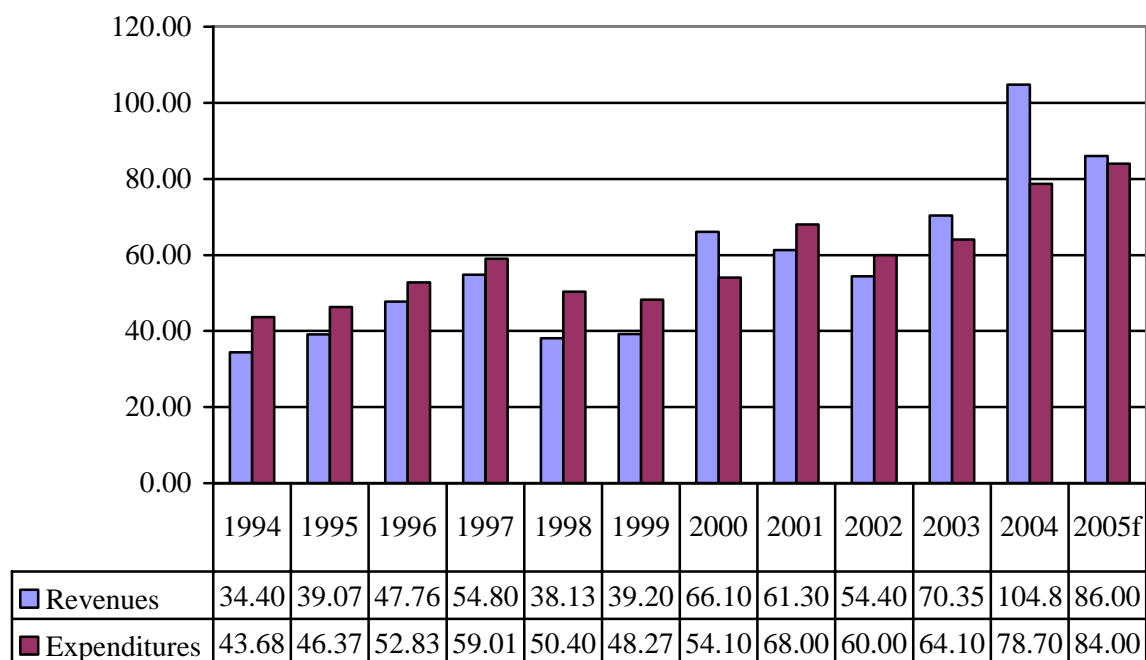
Source: Adapted EIA, "OPEC Revenue Fact Sheet," January 2005.

Fiscal Situation

The Kingdom still need to make major additional progress in structural economic reform, but it has improved its fiscal situation to the point where it can pay for oil development, diversification, and reform with far less strain. This means Saudi Arabia will still need foreign investment and much more productive private domestic investment. Since 1982, the Kingdom has been running high budget deficits due to low oil prices, mismanagement, and high defense spending. Figure 16 shows that the year 2000 was the first year Saudi Arabia enjoyed a surplus, and since that year, with the exception of 2001, the Saudi budget has been either in balance or in surplus.

Figure 16: Saudi Arabian Budget Balance: 1994-2005

(\$Billion)



Source: Brad Bourland, Saudi Arabia's Budget Performance, SAMBA various editions. Forecast of 2005 is based on a \$35/barrel oil price.

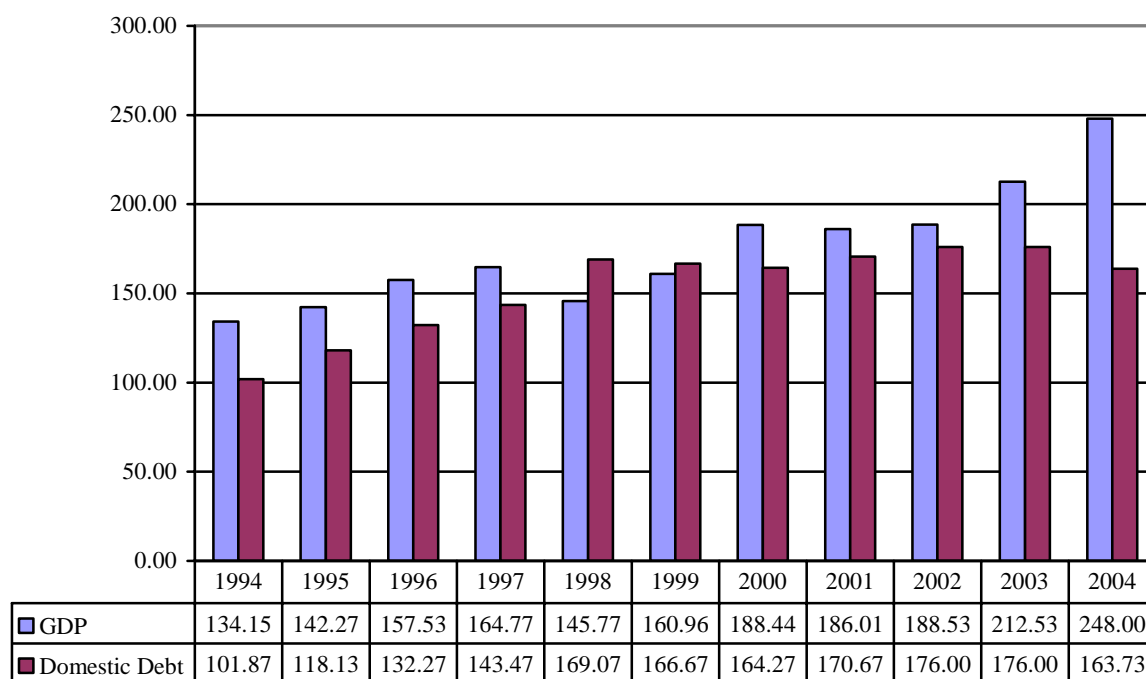
In 2004, government revenues totaled \$104.8 billion, while government spending was \$78.7. The government announced that the \$26.1 billion surplus would be spent on two broad areas. First, \$15.2 billion would be used to pay down the Kingdom's public debt. This payment would decrease the government domestic liability from \$178.6 billion to \$163.7 billion, 66% of GDP down from 119% of GDP in 1999. Saudi economists claim that paying down the Kingdom's debt would increase outside investors' confidence in the soundness of the economic structure of the economy.^{lxiv}

In addition to paying down the debt, \$10.9 billion will be spent on new development projects. Some of the surplus will go to the Saudi Real Estate fund and Saudi Credit Bank aimed at financing new business ventures. The Kingdom hopes to rebuild its infrastructure that has not been renewed since the 1980s. This new spending, if managed well, will boost the construction sector and reenergize the real estate market.^{lxv}

While the fiscal year of 2004 was a year of budget surplus and a 19% nominal GDP growth, the real GDP growth was only 4.7%. In addition, the fiscal health of the Kingdom will face many fiscal challenges in the future. Large entitlement programs, subsidies and debt to domestic farmers, and large spending on domestic security still put a lot of strain the government budget.

As Figure 17 shows, the Kingdom still suffers from a \$163.7 domestic debt. While, the economic growth in 2004 was due to factors other than the hike in oil prices, the Kingdom's economy still highly dependent on oil. Saudi Arabia has to diversify its economy away from oil and the uncertainty of the volatile energy global market. It is still unclear how future surpluses will be used or how these budgetary reforms will translate into real long-term commitment to financial transparency and reforming the relevant governmental agencies.

Figure 17: Saudi Arabia's Domestic Debt: 1994-2004
(\$Billion)



Source: Brad Bourland, Saudi Arabia's Budget Performance and Economy Watch, SMBA, various editions

The combination of paying down the public debt and building up the Kingdom's foreign assets has given Saudi Arabia its best fiscal and debt position since the early 1980s. This growth was due or coincided with three major shifts.

- First, Saudi Arabia enjoyed low interest rates, which increased lending by 26%--increasing liquidity and investment in the Kingdom. The non-oil private sector grew by 5.7% in 2004.
- Second, major ventures were started in the water, gas, power, and petrochemical sectors. This increased capital inflow, created jobs, and increased liquidity. Projects in the energy sector increased the Kingdom's production, refining, and export capacity.
- Third, Saudi Arabia witnessed three major IPOs: Saudi Telecoms (STC), Sahara Petrochemicals, and Ettisalat. These IPOs increased the investment inflow to the Saudi capital markets and spurred real economic growth.

Saudi Economy in 2005

These positive trends seem likely to continue in the short-term. The Saudi American Bank (SAMBA) forecasts that in 2005, real GDP growth rate will be 4.25%. This forecast was based on the assumption that oil price will be at \$35 per barrel price. Oil will revenues will growth by 2% and non-oil private sector will grow by 2.2%. This growth is forecasted to produce a budget surplus of \$2.0 billion, and decrease government debt to \$161.06 billion from \$163.73 billion.^{lxvi}

High liquidity and a lack of investment opportunities may even saturate the market with investment money. Most of this money is expected to go into the Saudi stock market and real estate. Tadawul All-Shares Index started 2004 at 4,500. It almost doubled its value by the end of the year 8,026 points and reached 10,000 point in early 2005. Experts believe that this trend will continue.^{lxvii}

In short, the Kingdom is using its new surge of oil wealth wisely both in funding oil production capacity and basic fiscal policy. It also seems to have all of the funding it needs to reach its plans to increase oil capacity to 12.5 million bpd if its oil reserve development plans proceed on schedule.

Saudi Arabia's current economic windfall, however, is no guarantee for the future. Despite the many good things the Kingdom has done in the last three years, there is a lot to be done. Even if one ignores the need for political, social, and education reforms, the privatization campaign has been slow and the momentum does not yet exist to create a private sector robust enough to meet the employment needs of the country and diversify the Saudi economy away from oil. A sustained and more concerted effort at reform is still needed to deal with issues like demographics and unemployment, to limit the pool of recruitment by extremists, and ensure that Saudi Arabia can both reach the necessary level of oil capacity and safely produce it.

In the mid to long-term, it is also not clear whether the Kingdom will have all of the revenue it needs to meet its needs for domestic development and infrastructure, handle other major energy projects like its Master Gas System, and fund the kind of sustained oil production capacity the market may actually require. Any need for foreign investment, or the domestic privatization of upstream operations, is now theoretical. Like most issues relating to Saudi oil production and export capacity, however, it is one that will have to be steadily revisited over time.

ⁱ Estimates differ according to source, the last comprehensive USGS analysis was performed in 2000, and was seriously limited by the fact many countries were affected by war or internal turmoil and declared reserves without explaining them or provided data by field. Standard estimates of reserves by non-USG sources like those in the *Oil and Gas Journal* and *World Oil* do not adjust reported data according to a standardized methodology or adjust for the large number of countries that never alter their estimates of reserves for actual production.

For example, six of the ten nations with the largest proven reserves are in the MENA region. An IEA analysis shows a range of 259-263 billion barrels for Saudi Arabia, 105-133 billion for Iran, 66-98 billion for the UAE, and 31-29 billion for Libya.. The figure of 115 billion for Iraq is consistent only because it is a figure announced in the past by the Iraqi government and there are no accurate, verified estimates. To put these figures in perspective, the range for Russia is 60-69 billion, 25-35 billion for Nigeria, 23-21 billion for the US, and 52-78 billion for Venezuela. (International Energy Agency, "Oil Market Outlook," World Energy Outlook, 2004, OECD/IEA, Paris, October 2004, Table 3.2.)

Estimates alter radically if an unconventional oil reserve like Canadian tar sands are included. The Middle East has only about 1% of the world's known reserves of oil shales, extra heavy oil, tar sands, and bitumen. Canada has 36%, the US has 32%, and Venezuela has 19%. The rest of the world has only 12%. The cost-effectiveness of producing most of these reserves, and the environmental impact, is highly uncertain, however, even at high oil prices. (International Energy Agency, "Oil Market Outlook," World Energy Outlook, 2004, OECD/IEA, Paris, October 2004, Figure 3.13.)

Reserve estimates also change radically if ultimately recoverable reserves are included, and not simply proven reserves. Some estimates put the total for such reserves at around 2.5 times the figure for proven reserves. For example, the IEA estimate for the Middle East drops from around 60% to 23%. Such estimates are speculative however, in terms of both their existence and recovery price, and do not have significant impact on estimates of production capacity through 2025-2030. They also ignore gas and gas liquids. The Middle Eastern share of undiscovered oil and gas resources rises to 27% based on existing data.

Such estimates are also heavily biased by the fact that so little experimental drilling searching for new fields occurred in the Middle East between 1992 and 2002. The IEA estimates that only 3% of some 28,000 wildcat explorations for new fields worldwide took place in the Middle East. Recent exploration in key countries like Iran, Iraq, and Libya has been minimal. Some 50 Saudi fields, with 70% of the reserves that are proven, still await development. (International Energy Agency, "Oil Market Outlook," World Energy Outlook, 2004, OECD/IEA, Paris, October 2004, Figure 3.15.)

ⁱⁱ Guy Caruso, "US Oil Markets and the Middle East, DOE/EIA," October 20, 2004.

ⁱⁱⁱ Guy Caruso, "US Oil Markets and the Middle East, DOE/EIA," October 20, 2004.

^{iv} IEA estimate in the World Energy Outlook for 2004, Table 3.5, and analyzed in Chapter 3.

^v EIA/DOE, Saudi Arabia, Country Study, January 2005, <http://www.eia.doe.gov/emeu/cabs/saudi.html>

^{vi} EIA/DOE, Saudi Arabia, Country Study, January 2005, <http://www.eia.doe.gov/emeu/cabs/saudi.html>

^{vii} EIA/DOE, Saudi Arabia, Country Study, January 2005, <http://www.eia.doe.gov/emeu/cabs/saudi.html>

^{viii} Nasser Al-Salti, "Kingdom Oil Reserves May Go Up by 200 Billion Barrels, Naimi Says," Arab News, April 7, 2005.

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^{xxvi} Edward Morse and Thomas Stenvoll, "The New Supplier(s) of Last Resort," Weekly Market Review, Hess Energy Trading Company, LLC, April 1, 2005.

^{xxvii} EIA, International Energy Outlook, 2004.

^{xxviii} CICB World Markets, "Monthly Indicators," April 5, 2005.

^{xxix} EIA, International Energy Outlook, 2004. Page 36.

^{xxx} CICB World Markets, "Monthly Indicators," April 5, 2005.

^{xxxi} EIA, International Energy Outlook, 2004. Page 36.

^{xxxii} United States Geological Survey 2000, Table AR-9.

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