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# Energy Risks in North Africa and the Middle East

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# *Introduction*

# Introduction

Any estimate of energy risk is highly uncertain. The reality can vary sharply according to national and global economic conditions, politics, war, natural disasters, discoveries of new reserves, advances in technology, unanticipated new regulations and environmental issues, and a host of other factors.

Moreover, any effort to model all aspects of world energy supply and demand requires a model so complex that many of its interactions have to be nominal efforts to deal with the variables involved. Even if perfect data were available, there could still be no such thing as a perfect model.

That said, the US Department of Energy (DOE) and its Energy Information Agency (EIA) do provide estimates based on one of the most sophisticated data collection and energy modeling efforts in the world. Moreover, this modeling effort dates back decades to the founding of the Department of Energy and has been steadily recalibrated and improved over time – comparing its projections against historical outcomes and other modeling efforts, including those of the International energy Agency and OPEC.

The DOE modeling effort is also relatively conservative in projecting future demand for petroleum and natural gas. It forecasts relatively high levels of supply from alternative sources of energy, advances in new sources of energy and liquid fuels, and advances in exploration and production. It also forecasts advances in conservation and efficiency, and assumes relatively high growth levels in the use of coal and nuclear power in spite of environment and political issues.

This analysis draws on the work of the EIA to illustrate the energy risks in the Middle East and North Africa affecting the production and export of oil and gas. It draws on a wide range of EIA sources, including its International Energy Outlook for 2012, its preliminary Annual Energy Outlook for 2012, and its various country studies. The data used is referenced in each of the “slides” used in this presentation.

The analysis is divided into several main sections:

**Section One focuses on demand issues and their impact on global and regional demand for liquid fuels, impact on supply, price issues, and the special conditions affecting US demand for energy imports.** It indicates that growth in Asian demand for MENA oil and gas exports will be high through 2035 (the cutoff date for projections), creating a “demand vulnerability” in periods of moderate to

high economic growth that will keep prices high and stimulate major increases in production. It also shows that US political posturing about energy independence is just that – dishonest political opportunism that does not reflect the total different results of US government modeling and analysis.

**Section Two deals with the risks that MENA Dependence on Oil exports creates for MENA states.** It highlights the economic problems of over-dependence on petroleum exports, the problems created by energy subsidies and their impact in cutting export capacity, and the growing risk posed by gross inefficiency in energy use and pollution.

**Section Three covers North Africa.** It indicates that the projected growth in Algerian and Libyan supply will be limited by global standards, but be of importance to Europe. It also indicates that Algeria and Libya are moderate risk countries because of the political uncertainties in each state and their uncertain ability to attract sustained energy investment over time.

**Section Four covers Egypt and the Levant.** It indicates that Egypt will increase some aspect of gas production, but that both Egypt and Syria are steadily declining oil producers, and increases in Egyptian gas exports may have a local impact but only a token impact on world markets. Egypt emerges as a moderate risk country and Syria as a high risk country.

**Section Five covers the Gulf and Yemen.** It shows that the Gulf remains the key source of additional oil and gas production in spite of major projected gains in the rest of the world's output. It also shows that these increases are highly dependent on two high risk countries – Iran and Iraq. Yemen is a high risk country, but one with negligible and declining impact on world exports. The Southern Gulf producers –Kuwait, Oman, Qatar, the UAE and Saudi Arabia –face some individual problems but are rated as low risk with the exception of the potential impact of a future conflict in the Gulf.

**Section Six covers the risk of a war involving Iran.** There is no way to predict the form such a conflict might take or to estimate a probability in any meaningful mathematical model. The risk of some clash in the coming three years is, however, at least moderate and the risk of a serious clash over time will rise to high if Iran does not abandon its nuclear program, and improve its relations with its neighbors.

The first five sections attempt to summarize and quantify key trends in energy production and exports and the key factors shaping risks in a given country and area. Section Six focuses on the build-up and capability of Iranian forces “to close the Gulf” and present a range of threats from low-level asymmetric warfare, to a Gulf-wide conflict that could involve the use of long-range missiles.

# *Putting MENA Risks in Context*

## Putting MENA Risks in Context

- There is no simple way to put the issues surrounding future demand for MENA oil and gas into context. The figures in this section focus on a few key trend lines take from the much broader modeling efforts provided in the EIA International Energy Outlook (IEO) and Annual Energy Outlook (AEO) for 2001 and 2012, which explain the forecasts made about economic growth and demand, the interaction between different demand sectors, the resulting growth in all forms of energy supply, and how these affect given regions.
- **Risk Relative to Demand: Asia and Transportation Dominate Demand for Liquids: 2008-2035:** Asian demand from non-OEC countries, and growth in demand in other parts of the world will keep up constant pressure on the global supply of all types of energy liquids through 2035. More than 75 percent of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where strong economic growth and, in the case of the Middle East, access to ample and relatively inexpensive domestic resources drive the increase in demand.
- The primary source of growth will be in the transportation sector where only limited shift to alternative sources of energy – such as electric cars – will affect global transportation through 2035. Consumption of petroleum and other liquid fuels increases from 85.7 million barrels per day in 2008 to 112.2 million barrels per day in 2035. liquids production increases by 26.6 million barrels per day from 2008 to 2035, including the production of both conventional unconventional supplies
- **Asia’s Rising Role in Liquid Fuel Consumption: 1950-2025:** The critical impact of Asia on world energy demand and demand for exports is reflected in the step increase in demand since 1980, which has effectively tripled Asian demand for liquid fuels in three decades. The growth in other developing regions has, however, been nearly as great. Given population pressure and the rate of growth in the developing world, similar trends are likely to keep up demand pressure and prices through 2035, as well as lead to serious price spikes and supply issues if any serious interruption takes place in the flow of global and Middle East energy exports at a time of moderate to high economic growth.
- **Repeating History: Gulf-Driven Oil Shocks Before \$100 Oil:** Price shocks have been a continuing problems since 1973, driven by war, instability in exporting states, and global economic growth. The trends involved have moved steadily upwards, but have been erratic and unpredictable, and have often reflect speculative or panic buying – with prices dropping even if wars and internal crises intensify.
- **DOE/EIA Estimate of Possible Oil Prices Through 2035:** Even though the EIA and International Energy Agency estimate that all forms of energy will steadily increase in supply through 2035, and major increases in energy efficiency will take place, the EIA estimates that global demand for energy exports will be so high that reference case prices will average well over \$100 a barrel after 2020 without any political or military crisis, and could spike to levels approaching \$200 in worst case contingencies.

- **OPEC and MENA Share of World Production Continue to Increase Through 2035:** Additional EIA analysis highlights the impact of growing Asian Non-OECD demand. It also shows that OPEC production of conventional liquids -- which will be increasingly dominated by MENA and Gulf producers -- must continue to increase steadily through 2035, in spite of major increases in non-conventional liquids. Non-OPEC producers will decline in total output.
- **Risk Relative to Global Energy Liquids Production: 2008-2035: Saudi Arabia, Iraq, and other Southern Gulf producers will drive the increase in conventional oil liquids production and exports during the period from 2012 to 2035, increasing the importance and risk of Middle Eastern exports in spite of the increases in non-conventional liquids,** although key nations like Canada and Brazil will become major new producers, limiting the rate of increase dependence on Gulf exports. This will occur in spite of optimistic EIA projections of Russian US, and other non-OPEC production.
- **Risk to MENA Liquids Production by Country Through 2035:** The EIA projects that the Gulf percentage of the total supply of world oil production and exports will increase slowly from 27% 2009 to 31% 2035, even though the production from the smaller Gulf producer (Oman and Yemen) will drop. The output from North Africa and the rest of the Middle East other than the Gulf will also drop, increasing the risk of strategic dependence on the Gulf.
- **US Liquid Fuels Production and Imports: 1950-2025:** The political dishonesty of both US political parties in talking about energy independence from the Nixon Administration to the present is illustrated by the fact that the EIA -- as the one element of the US government capable of making meaningful projections shows -- estimates of direct import dependence still leave the US dependent on imports for 38% of all its liquid fuels through 2025. *This is a major reduction from a peak of 60%, but it does not reduce the strategic dependence of the American economy on the secure flow of global exports or direct imports.*
- **DOE/EIA Estimate of US Strategic Dependence on Oil Imports Through 2035:** A more recent EIA estimate reinforces this point. It projects that US import dependence will remain at 36% through 2035. Moreover, these estimates of US dependence on direct imports *sharply understate US strategic dependence* in three key ways: (1) The US has massive *indirect* imports in the form of manufactured goods from Asia and other areas. (2) The US pays global oil prices even for domestic production and any crisis immediately affects the US economy. And, (3) the US economy, and every job in America, is dependent on a global economy that is steadily becoming even more dependent on the reliable flow of Gulf, MENA and other energy exports than the US.

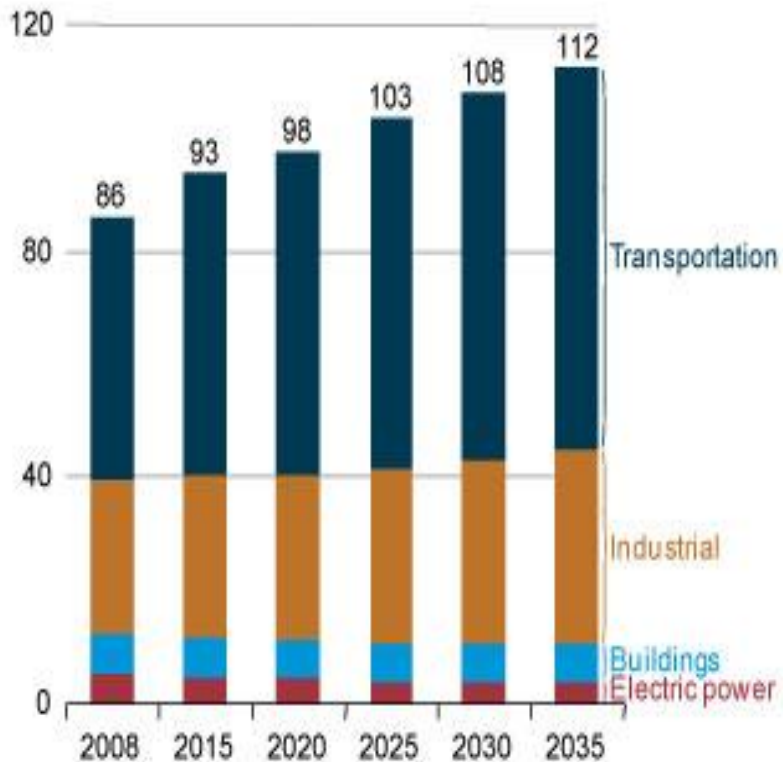
- **But, US Dependence is Highly Price & Scenario Dependent:** Future US import dependence is tied to the price of oil, but even a gradual shift to a high price of \$200 a barrel or more would leave the US dependent on imports for at least 30% of its oil through 2025. This dependence will be much higher in the reference and low price cases.
- **Indirect Energy Imports: Growth in US Commodity Imports: 1996-2012:** The US has become more and more dependent on indirect imports of energy as its manufacturing sector has declined and its commodity imports have increased. Total US imports nearly tripled between 1995 and 2011, and imports from Asia doubled. The vast majority of these imports can from nations that import oil and gas, and imports from Asia involved large indirect imports of oil and gas from the Gulf. Any analysis of the US import dependence that ignores these realities – and growing US dependence on the overall health of international economy – is totally unrealistic.



# Risk Relative to Demand: Asia and Transportation Dominate Demand for Liquids: 2008-2035

**Demand by Sector**

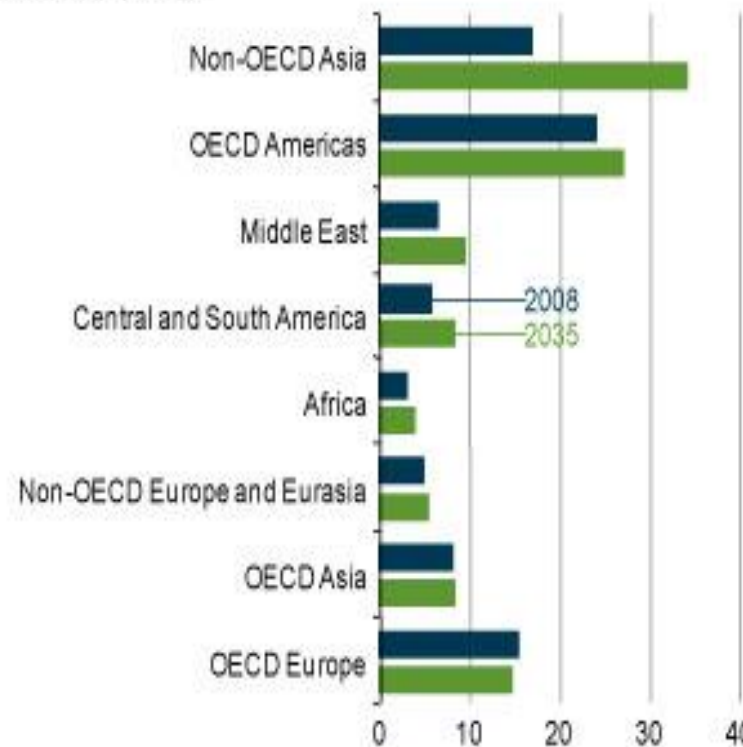
Figure 33. World liquids consumption by sector, 2008-2035 (million barrels per day)



Consumption of petroleum and other liquid fuels increases from 85.7 million barrels per day in 2008 to 112.2 million barrels per day in 2035. liquids production increases by 26.6 million barrels per day from 2008 to 2035, including the production of both conventional unconventional supplies.

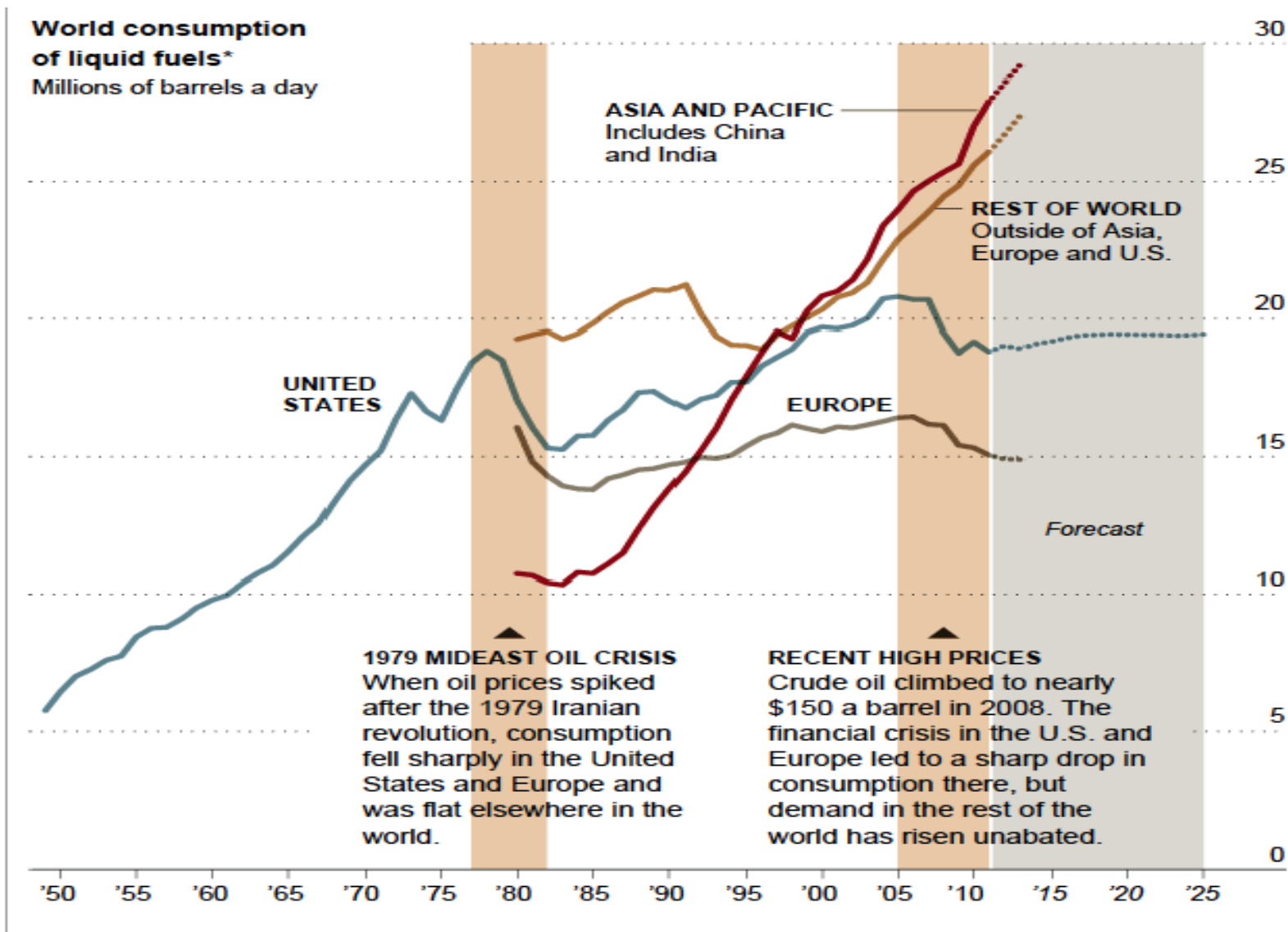
**Demand by Region**

Figure 34. World liquids consumption by region and country group, 2008-2035 (million barrels per day)



More than 75 percent of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where strong economic growth and, in the case of the Middle East, access to ample and relatively inexpensive domestic resources drive the increase in demand

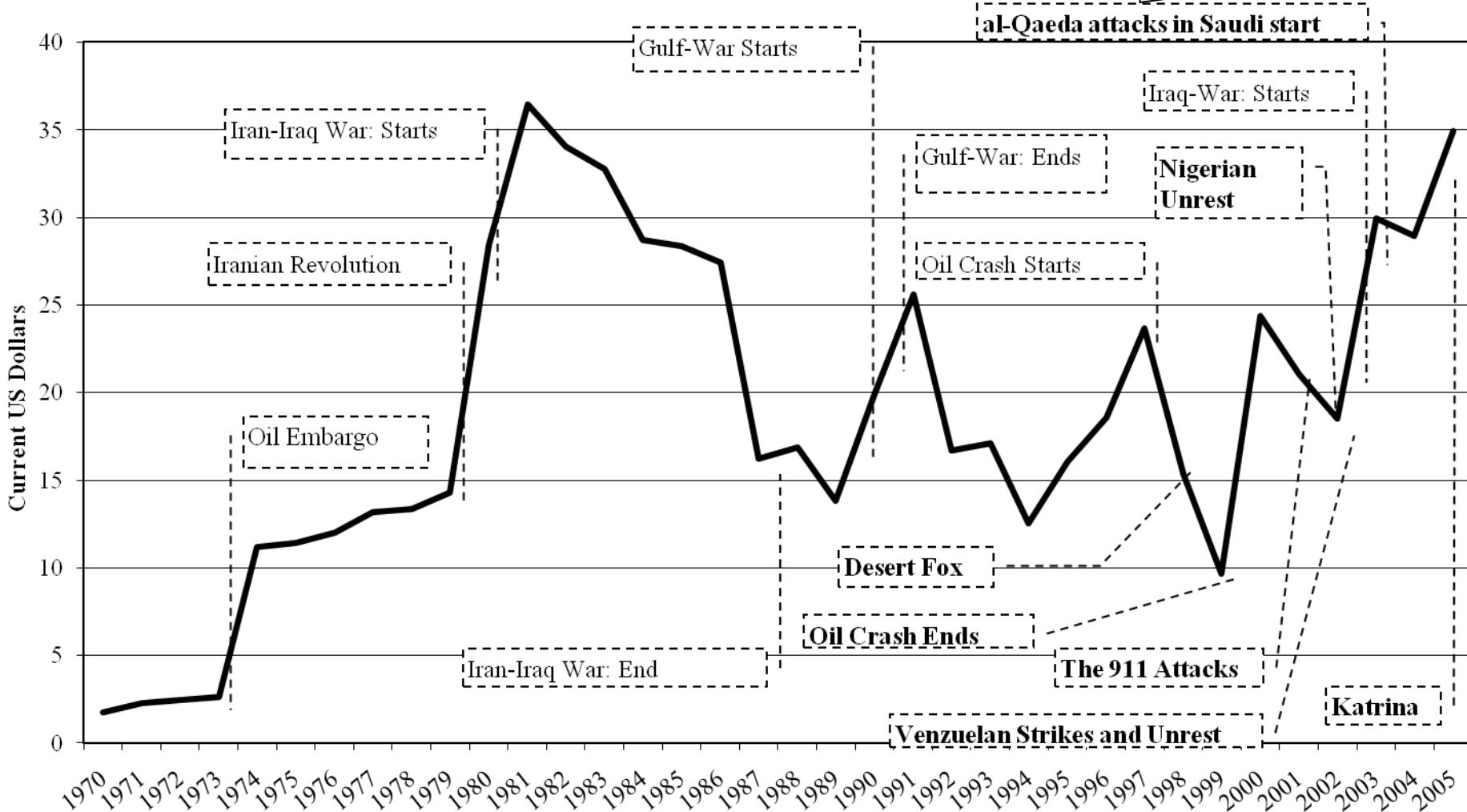
# Asia's Rising Role in Liquid Fuel Consumption: 1950-2025



Source DOE, EIA; Bloomberg; New York Times 23.3.12, <http://www.nytimes.com/interactive/2012/03/22/business/energy-environment/while-the-us-moves-toward-energy-independence.html?ref=energy-environment>

# Repeating History: Gulf-Driven Oil Shocks Before \$100 Oil

Overtimes: more incidents, more frequent volatility, higher risk of asymmetric attacks, and more geopolitical uncertainties.



Source: EIA, "Crude Prices by Selected Type 1970-2005," <http://www.eia.doe.gov/emeu/aer/txt/ptb1107.html>.  
 Note: These prices are averages of several types: Saudi Light, Iranian Light, Libyan Es Sider, Nigerian Bonny Light, Indonesian Minas, Venezuelan Tia Juana light Mexico Maya, and UK Brent blend

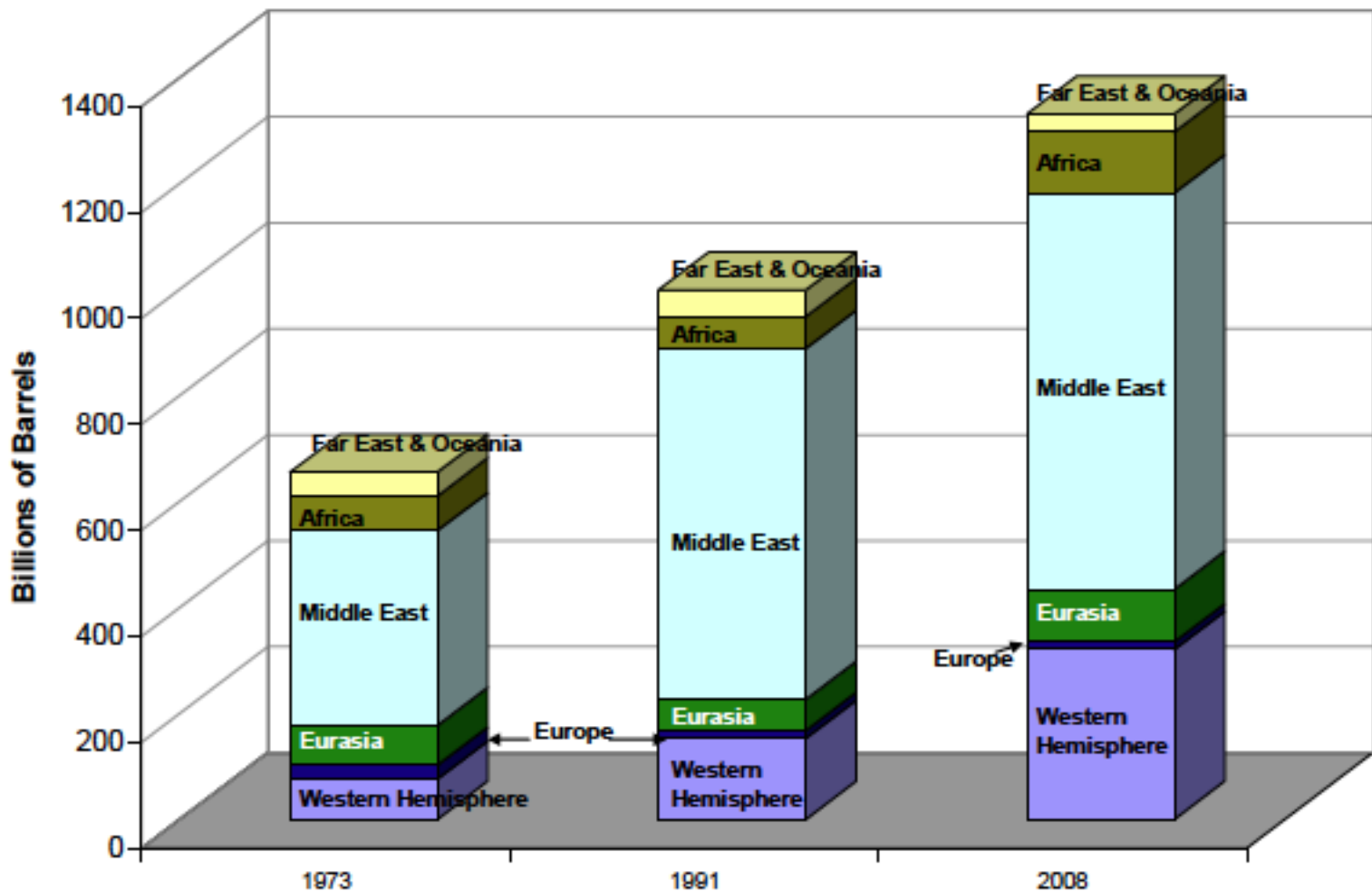
# Modern Oil Price Instability: 2000-2012

Price for West Texas Intermediate Crude Oil (WTI)



Source: CRS and EIA.

# MENA Reserves Keep Increasing as Share of World Total: 1973-2008



**Source:** EIA, *International Energy Annual (IEA) 1990*, Table 32 and *IEA 2007* Table 8.1 Table of World Proved Oil and Natural Gas Reserves, Most Recent Estimates. (data is from *Oil and Gas Journal* and is not certified by EIA, except for the data for the United States in the Western Hemisphere category).

**Notes:** The categories "Eastern Europe and Former Soviet Union" and "Western Europe," in the data for 1973 and 1991, were changed to "Eurasia" and "Europe" respectively for 2008. Seven countries (Albania, Bulgaria, Czech Republic, Hungary, Poland, Romania, and Slovakia) were moved from the former to the latter.

# OPEC and MENA Share of World Production Continue to Increase Through 2035

Figure 27. World liquid fuels consumption by region, 1990-2035 (million barrels per day)

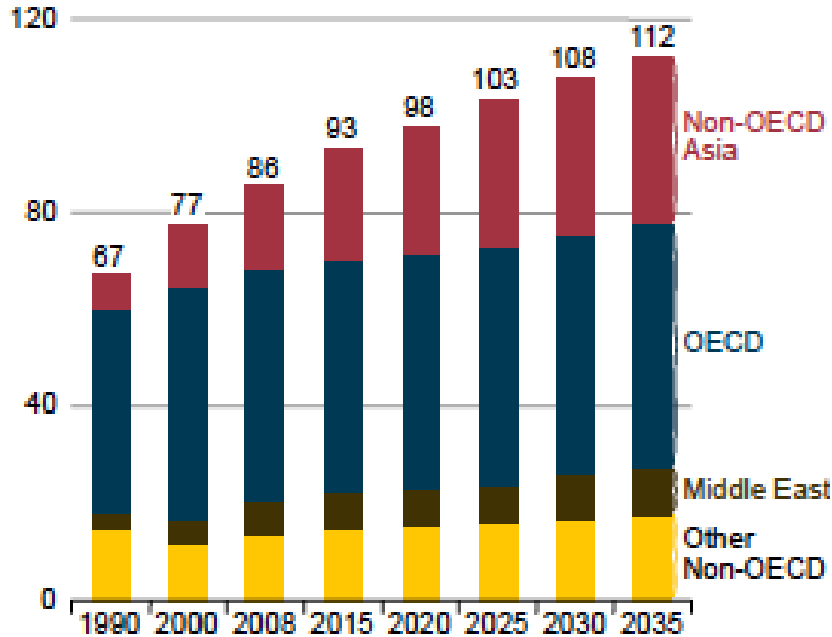
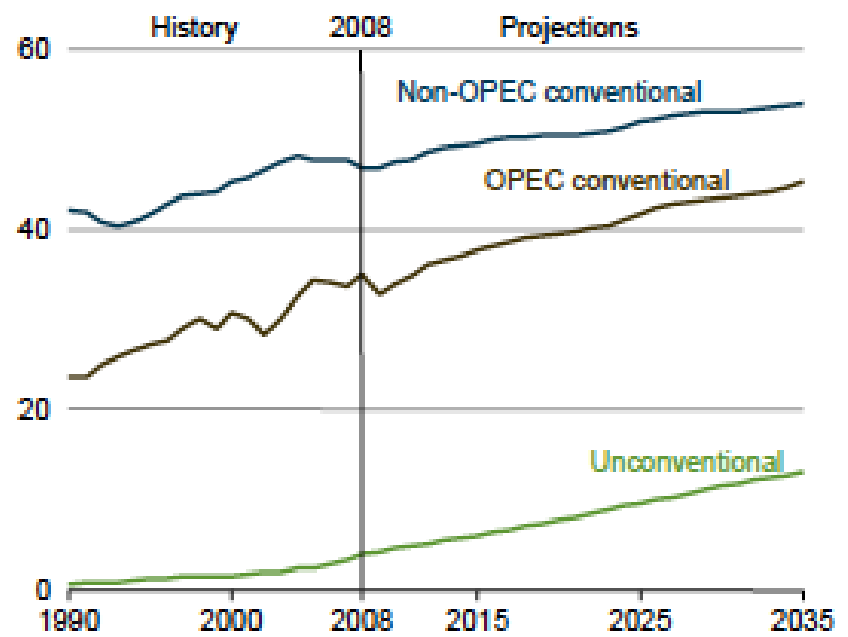


Figure 28. World liquid fuels production, 1990-2035 (quadrillion Btu)

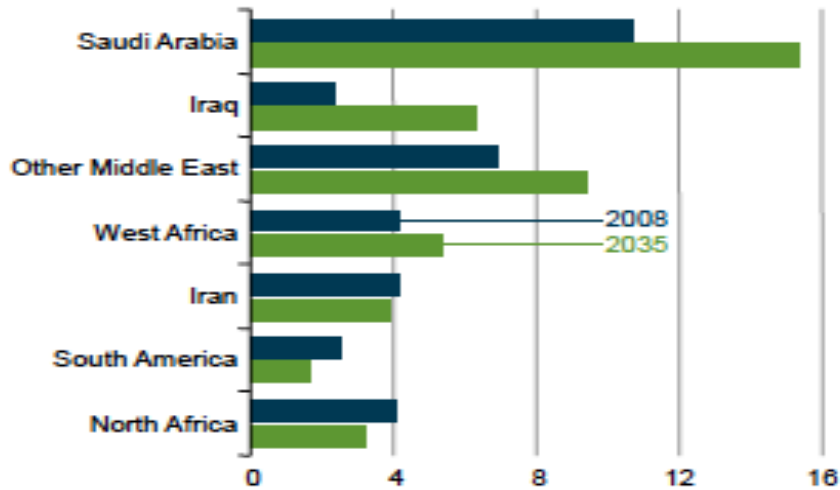


**More than 75 percent of the increase in total liquids consumption is projected for the nations of non-OECD Asia and the Middle East, where strong economic growth and, in the case of the Middle East, access to ample and relatively inexpensive domestic resources drive the increase in demand**

# Risk Relative to Global Energy Liquids Production: 2008-2035

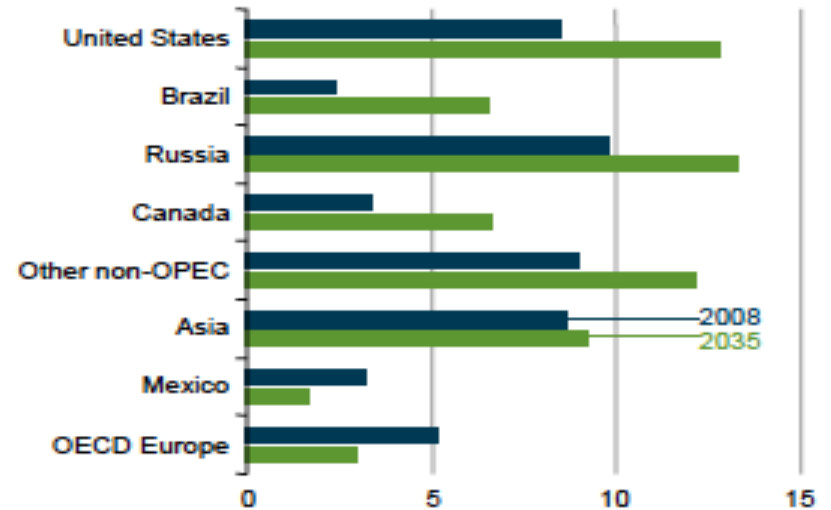
## OPEC - Conventional

(million barrels per day)



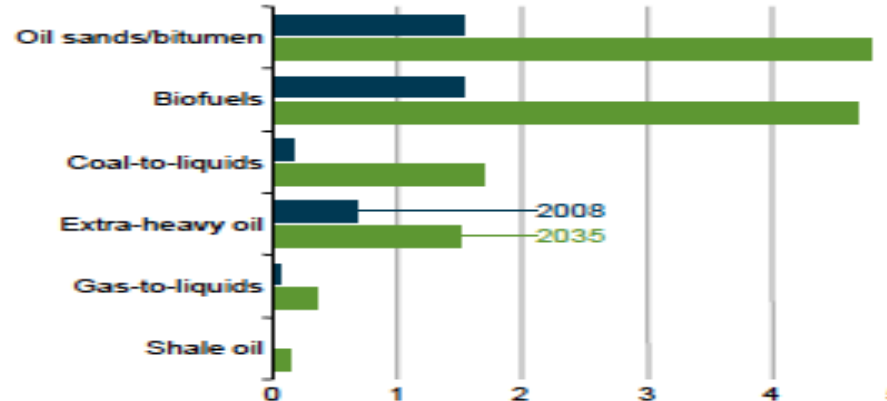
## Non-OPEC – All Liquids

2008 and 2035 (million barrels per day)

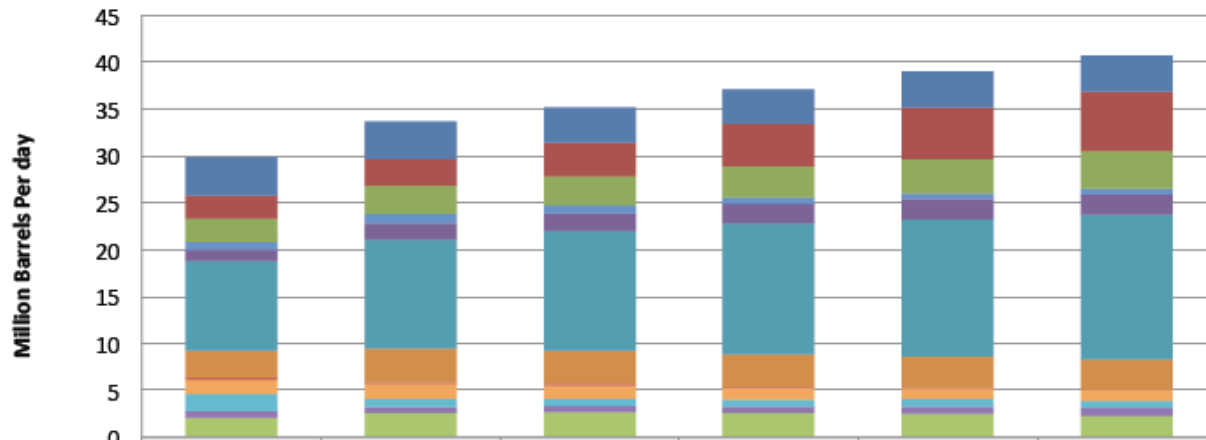


## Global Non-Conventional

by fuel type, 2008 and 2035 (million barrels per day)



# Risk to MENA Liquids Production by Country Through 2035



	2009	2015	2020	2025	2030	2035
Iran	4.1	4	3.8	3.7	3.8	3.9
Iraq	2.4	2.9	3.6	4.5	5.5	6.3
Kuwait	2.5	3	3.1	3.3	3.7	4
Oman	0.8	1	0.8	0.7	0.6	0.6
Qatar	1.2	1.7	1.9	2.1	2.2	2.2
Saudi Arabia	9.6	11.6	12.8	13.9	14.6	15.4
UAE	2.8	3.6	3.5	3.5	3.3	3.2
Yemen	0.3	0.2	0.2	0.1	0.1	0.1
Other Middle East	1.5	1.6	1.4	1.3	1.1	1.1
Libya	1.8	0.9	0.7	0.7	0.8	0.8
Egypt	0.7	0.6	0.7	0.7	0.8	0.8
Algeria	2.1	2.6	2.7	2.6	2.5	2.3
Total World	79.7	87.2	89.2	93.6	96.5	99.1
Total Middle East	29.8	33.7	35.2	37.1	39	40.7
Total Gulf	23.4	27.8	29.5	31.7	33.7	35.6



*Some MENA Energy Risks are  
Self-Inflicted Wounds*

# A Broader View of the MENA “Energy Curse”

- **Classic Problems are:**
  - State drive by export revenues, not broad social and economic needs.
  - Gross distortion of development coupled to finite life of resource
  - Rentier creation of disguised unemployment coupled to major population increases
- **New Arab Development Report adds:**
  - Massive waste through subsidies coupled to steadily growing loss of export capability.
  - Major opportunity cost coupled to loss of incentive for efficiency, global competitiveness.
  - Compounds job creation problems, disguised unemployment.
  - Energy subsidies come as cost of education, health and development.
  - Massive increase in pollution.

# Arab Development Challenges Report: Growth and Structural Transformation

## **Volatile and oil-led growth perpetuate structural retardation**

- ❑ **Average annual real GDP per capita growth rates during 1970-2009 reached 2% per annum for the Arab region, with the overall pattern of growth in the region dependent on oil and its price.**
- ❑ **Structural economic problems in the Arab world include:**
  - ❑ **Stagnating agricultural and manufacturing sectors**
  - ❑ **A rapidly expanding services sector (mainly low value-added activities) at the expense of more productive sectors—Arab states are the least industrialized among developing regions**
  - ❑ **An overwhelming dependence on the oil sector, which exposes Arab economies to volatile oil markets**
- ❑ **Creation of highly productive jobs has also been hindered by the above structural problems:**
  - ❑ **Mining has a high share of output, but a low share of employment**
  - ❑ **Low value added services have become the main employers of labor and contributors to output**

## **Production and exports are concentrated in low value-added goods and services**

- ❑ **The region has failed to develop its trading capabilities within the global market:**
  - ❑ **Exports are still simple, primary products**
  - ❑ **Imports, on the other hand, are very diversified**
- ❑ **The region is the least industrialized among developing regions, due to a weak manufacturing sector that produces low value-added petroleum and food-derived products and a services sector that is similarly engaged in low value output rather than higher value more specialized services such as communications or finance.**

# Arab Development Challenges Report: Employment, Social Protection & Fiscal Policy

- **Employment gains despite demographic pressures**
  - **High average fertility rates** (3.1 children per woman) provide the basis for high population growth expectations
  - **The Arab region is going through a demographic transition, with more participants entering the labor force each year (in 2010, ages 15-64 made up 62.45% of the Arab Population)**
- **Employment in Arab countries** has averaged an impressive 3.3% annual growth rate, amongst the highest in developing regions. However, they also **exhibit one of the lowest labor force participation rates in the world** (due to low female participation rates)
- **The Arab region has one of the highest unemployment rates among developing regions— 9.3% (2001-11), vs. 6.6% for developing regions over the same period.** However, this rate has improved from the 1990s when it averaged 12%.
  - The unemployment rate in the GCC is roughly half that in Mashreq countries.
  - **Youth unemployment in the region, at 24%, is double the world average.**
  - While youth employment has been increasing, growth in the **youth population has been outpacing employment growth such that the employment/population ratio has declined from 27.1% to 24.3% (1997-2009), which is among the lowest rates in the world.**
- **The female unemployment rate is the highest in the world.** This is due to more females progressing through higher education and entering the labor force than before only to be faced with issues such as gender bias in hiring, for example.
- **There is an increase in the Arab region's informal job market** (i.e. jobs outside of social security programs; self employment was used as a proxy for measurement)
- **The education system fails to produce graduates with the requisite skills to find meaningful, productive jobs**

# Demand Side Constraints to Arab Employment

“Arab unemployment is fundamentally a demand-side problem. [...] the growth return of education is low since misguided policies do not enable the country to translate the accumulated knowledge into ideas, innovations, and new productive activities.”

□ Investment has failed to generate sufficient growth in the Arab region (gross fixed capital formation (GFCF), has increased slightly but total employment has remained constant), and this is due to the ineffectiveness of these investments to generate high skilled, meaningful output-contributing jobs. Low wage premiums also cause human capital flight, while remaining workers are often inadequately trained.

- Expected requirements for solving the job creation deficit (excluding GCC) :
  - Scenario 1: keep unemployment in the Arab region constant with no change in labor force participation rate
  - Scenario 2: cut the unemployment rate by half in the Arab region
  - Scenario 3: cut the unemployment rate by half and increase female employment to 35%

	2011-2015		2011-2020		2011-2030	
	Jobs required in millions	GFCF required in \$ millions	Jobs required in millions	GFCF required in \$ millions	Jobs required in millions	GFCF required in \$ millions
Scenario 1	6.1	292,800	15.4	739,200	24.7	1,185,600
Scenario 2	13.6	652,800	24.1	1,156,800	47.1	2,260,800
Scenario 3	28.6	1,372,800	40.8	1,958,400	91.8	4,406,400

*Note: GFCF=gross fixed capital formation measured in 2005 constant prices; excludes costs of upgrading the conditions of the working poor; \$48,000 average cost of creating one job*

## MENA Oil and Gas Production vs. Consumption: 2011

	Country	Oil Production (1000 b/d), 2010	Oil Consumption (1000 b/d), 2010	Net Oil Balance (1000 b/d), 2010	Natural Gas Production (Bcm), 2009	Natural Gas Consumption (Bcm), 2009	Net Natural Gas Balance (Bcm), 2009
Net Energy Importing Countries	Jordan	0.09	98	-97.91	0.25	3.1	-2.85
	Lebanon	0	106	-106.00	0	0.04	-0.04
	Morocco	3.94	209	-205.06	0.06	0.56	-0.50
	Tunisia	83.72	84	-0.28	3.6	4.85	-1.25
	West Bank	0	24	-24.00	0	0	0
Small Energy Exporting Countries*	Bahrain	46.43	47	-0.57	12.58	12.58	0
	Egypt	662.62	740	-77.38	62.69	44.37	18.32
	Oman	867.88	142	725.88	24.77	14.72	10.04
	Syria	401	292	109	6.19	7.1	-0.91
	Yemen	258.75	157	101.75	0.52	0.1	0.42
Large Energy Exporting Countries	Algeria	2077.74	312	1765.74	81.43	28.76	52.67
	Iraq	2408.47	694	1714.47	1.15	1.15	0
	Kuwait	2450.37	354	2096.37	11.19	12.08	-0.89
	Libya	1789.16	289	1500.16	15.9	6.01	9.89
	Qatar	1437.22	166	1271.22	89.29	21.1	68.19
	Saudi Arabia	10521.09	2643	7878.09	78.45	78.45	0
	UAE <sup>26</sup>	2812.84	545	2267.84	59.06	59.06	0

Source: Authors; EIA; Cedigaz

\* Less than 1 million b/d of oil equivalent

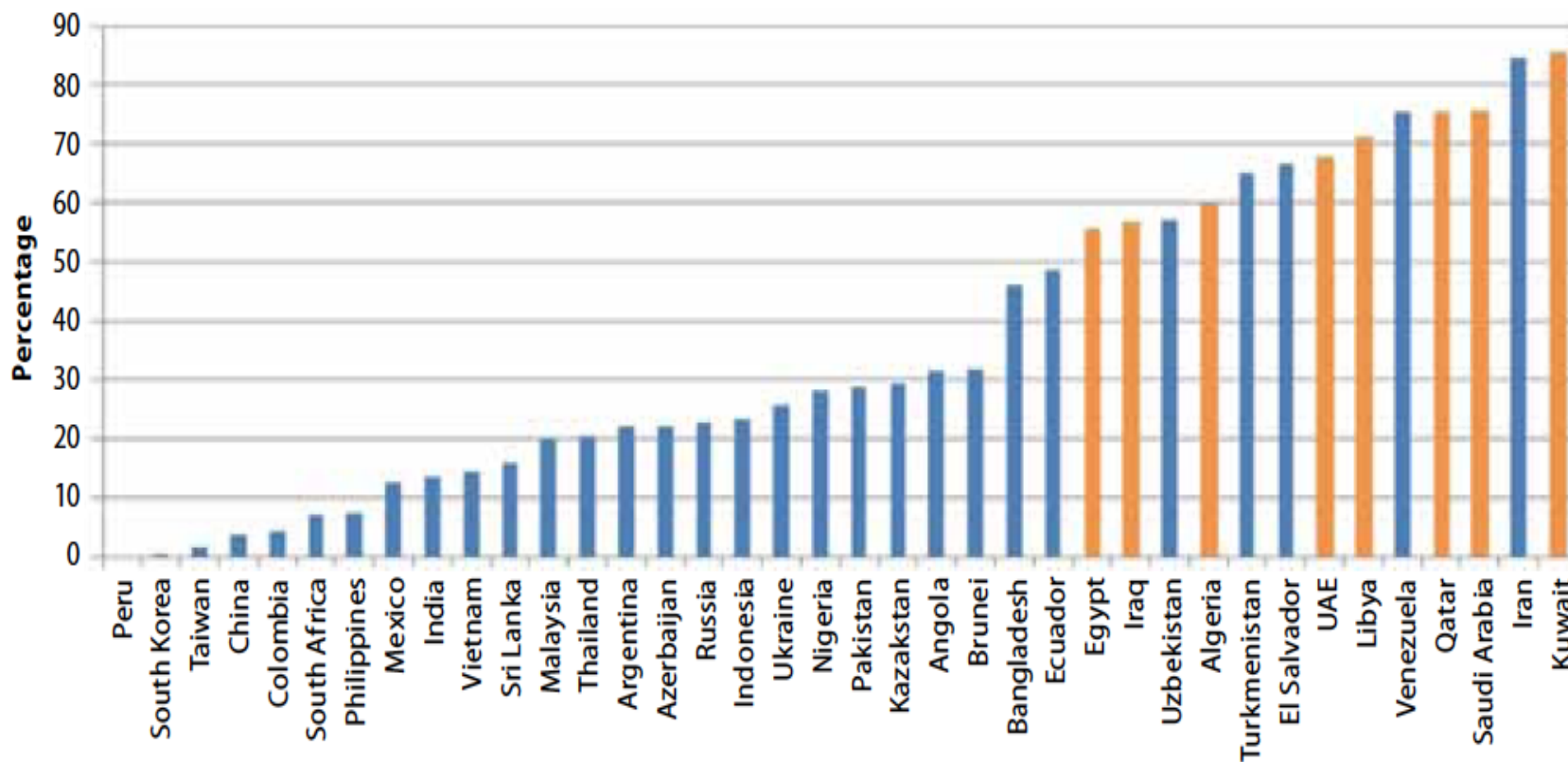
## IEA Estimate of Cost of Energy Subsidies: 2010

	Average Rate of Subsidization (%)	Subsidy (\$ per person)	Total Subsidy (% of GDP)	Subsidy by Fuel			Total Subsidy (US\$ bn)
				Oil	Gas	Electricity	
<b>Algeria</b>	59.80	298.40	6.60	8.46	0.00	2.13	10.59
<b>Libya</b>	71.00	665.00	5.70	3.17	0.26	0.78	4.21
<b>Egypt</b>	55.60	250.10	9.30	14.07	2.40	3.81	20.28
<b>Saudi Arabia</b>	75.80	1,586.60	9.80	30.57	0.00	12.95	43.52
<b>Iraq</b>	56.70	357.30	13.80	8.87	0.28	2.16	11.31
<b>Kuwait</b>	85.50	2,798.60	5.80	2.81	0.90	3.91	7.62
<b>Qatar</b>	75.30	2,446.00	3.20	1.15	1.41	1.59	4.15
<b>UAE</b>	67.80	2,489.60	6.00	2.65	9.99	5.51	18.15

Source: IEA

# MENA Self-Inflicted Energy Wounds: Part One: Comparative Subsidies

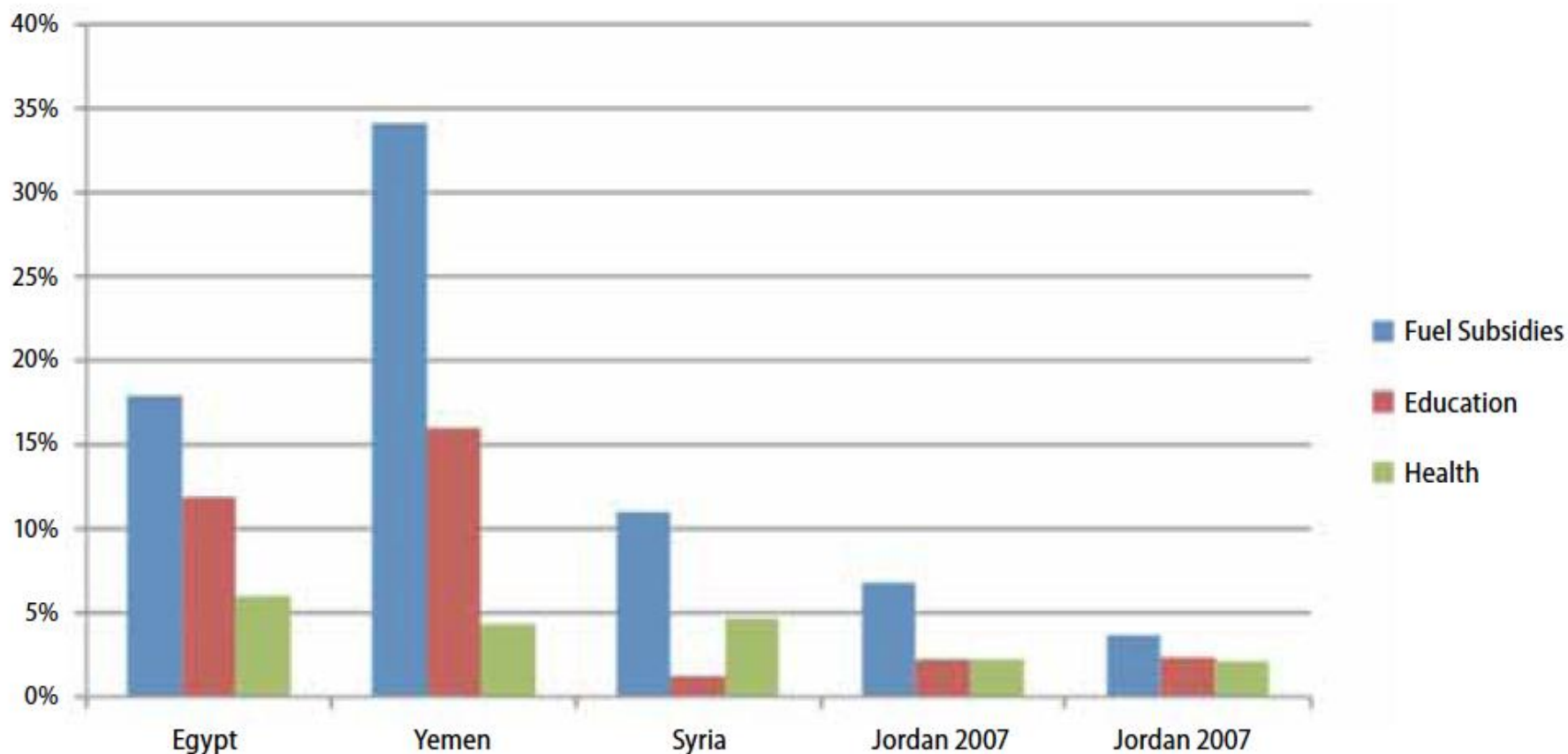
**FIGURE 1: AVERAGE SUBSIDIZATION RATES FOR DOMESTIC FUELS IN SELECTED COUNTRIES (IN %), 2010**



Source: IEA



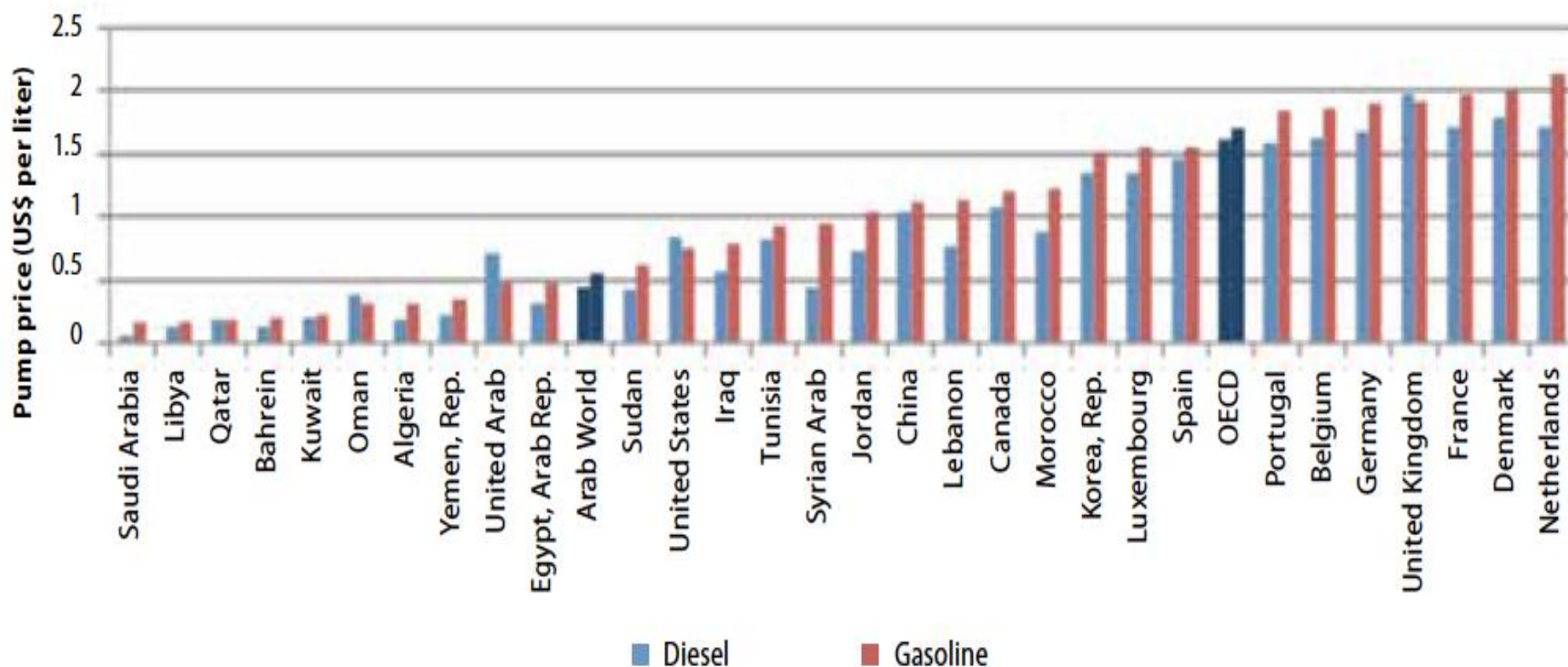
# MENA Self-Inflicted Energy Wounds: Part Two: Energy Subsidies vs. the Public Interest



Source: Egypt: World Bank (2011); Yemen: Breisinger et al (2011), Authors' own calculations; Syria: IMF (2010a), MEES, World Bank (2011); Jordan: IMF (2010b), World Bank (2011).

# MENA Self-Inflicted Energy Wounds: Part Three: Gas and Diesel Prices

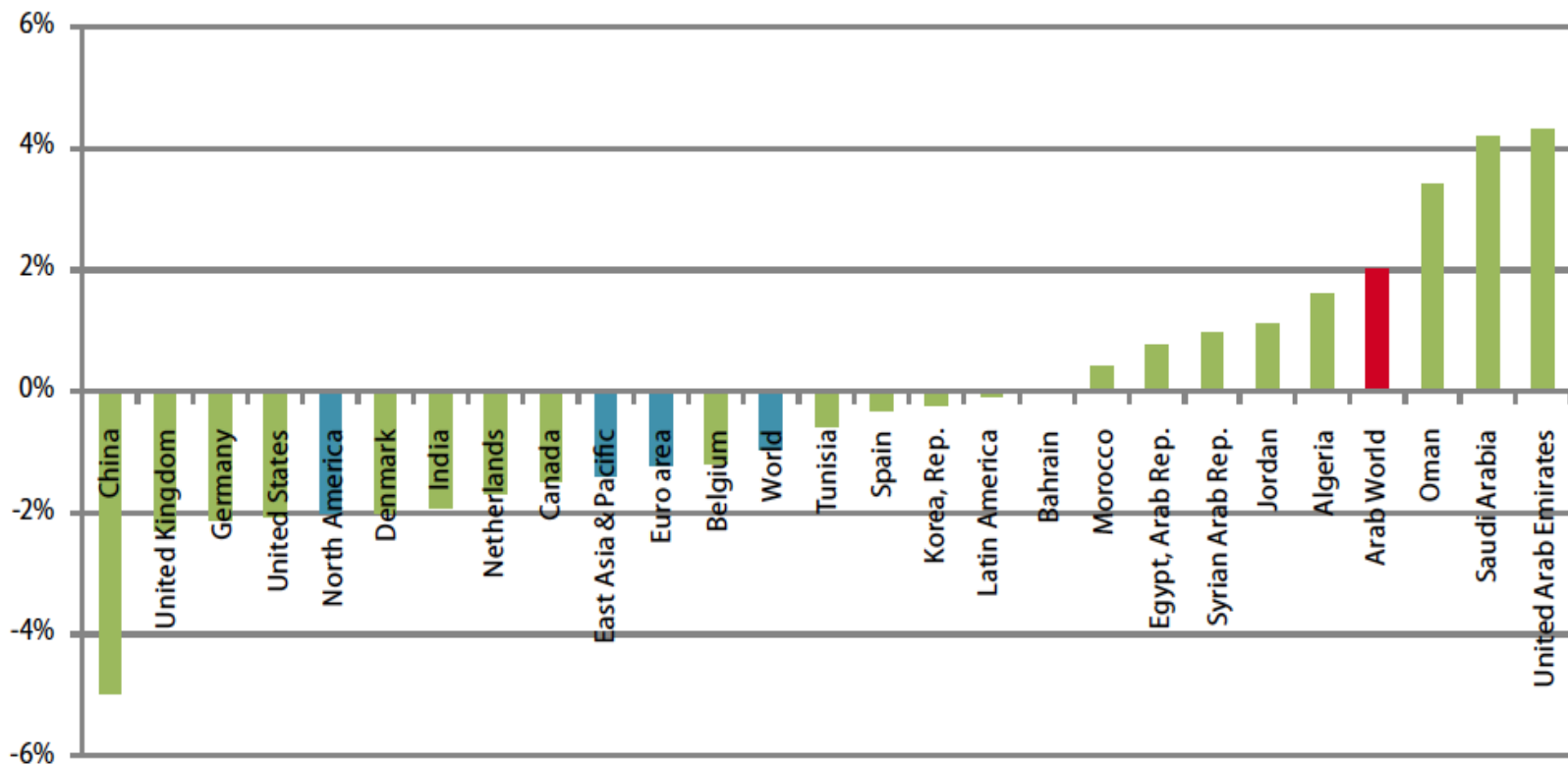
**FIGURE 2: AVERAGE RETAIL PRICES FOR GASOLINE AND DIESEL IN SELECTED ARAB, OECD AND NON-OECD COUNTRIES (IN US\$/LITRE), 2010**



Source: World Bank.

# MENA Self-Inflicted Energy Wounds: Part Four: Growth in Use Per \$1,000 of GDP

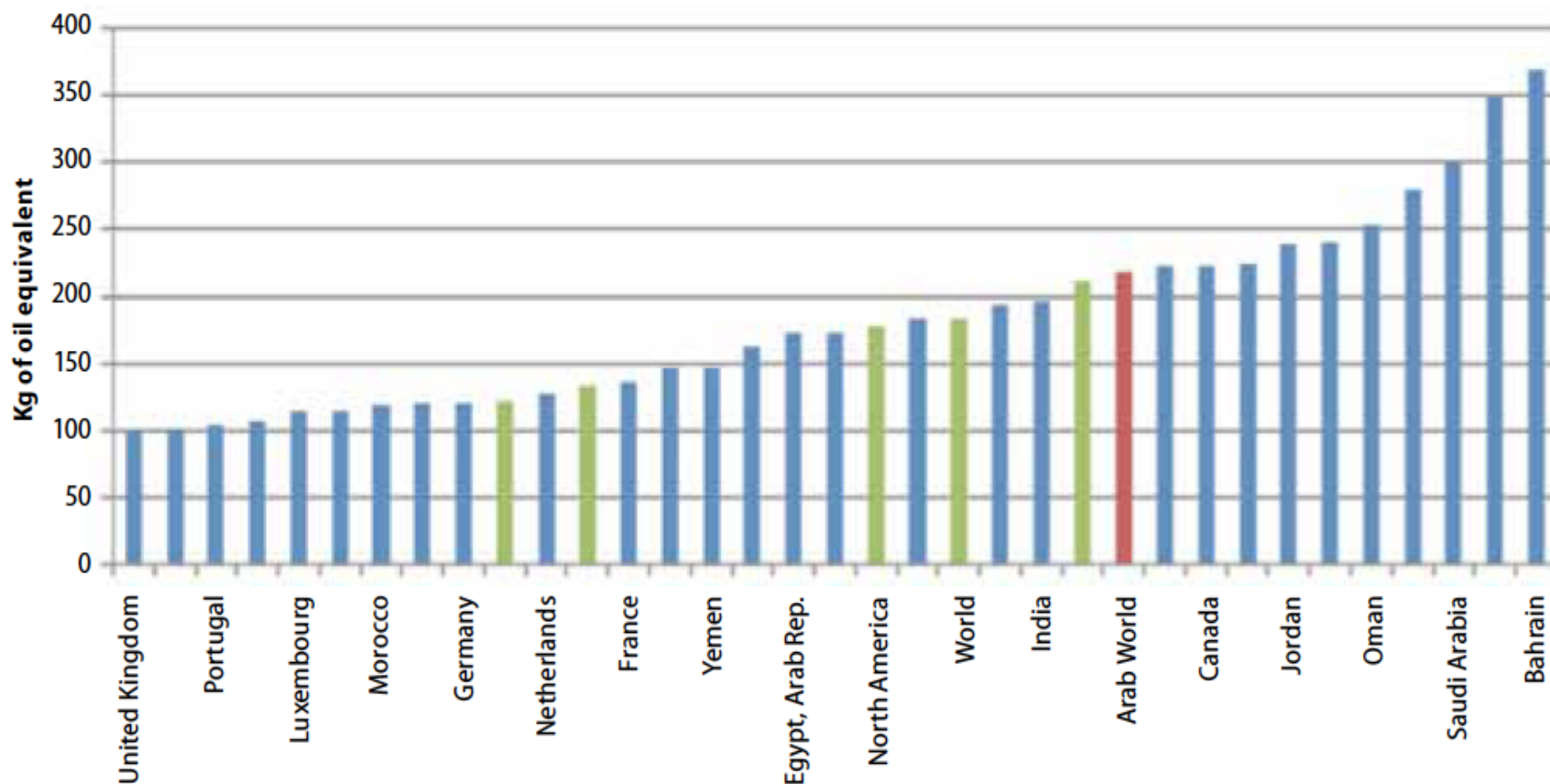
**FIGURE 3: COMPOUND AVERAGE GROWTH RATE OF ENERGY USE (KG OF OIL EQUIVALENT) PER \$1,000 GDP (CONSTANT 2005 PPP) IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES, 1980–2008**



Source: World Bank, World Development Indicators

# MENA Self-Inflicted Energy Wounds: Part Five: Use Per \$1,000 of GDP in 2008

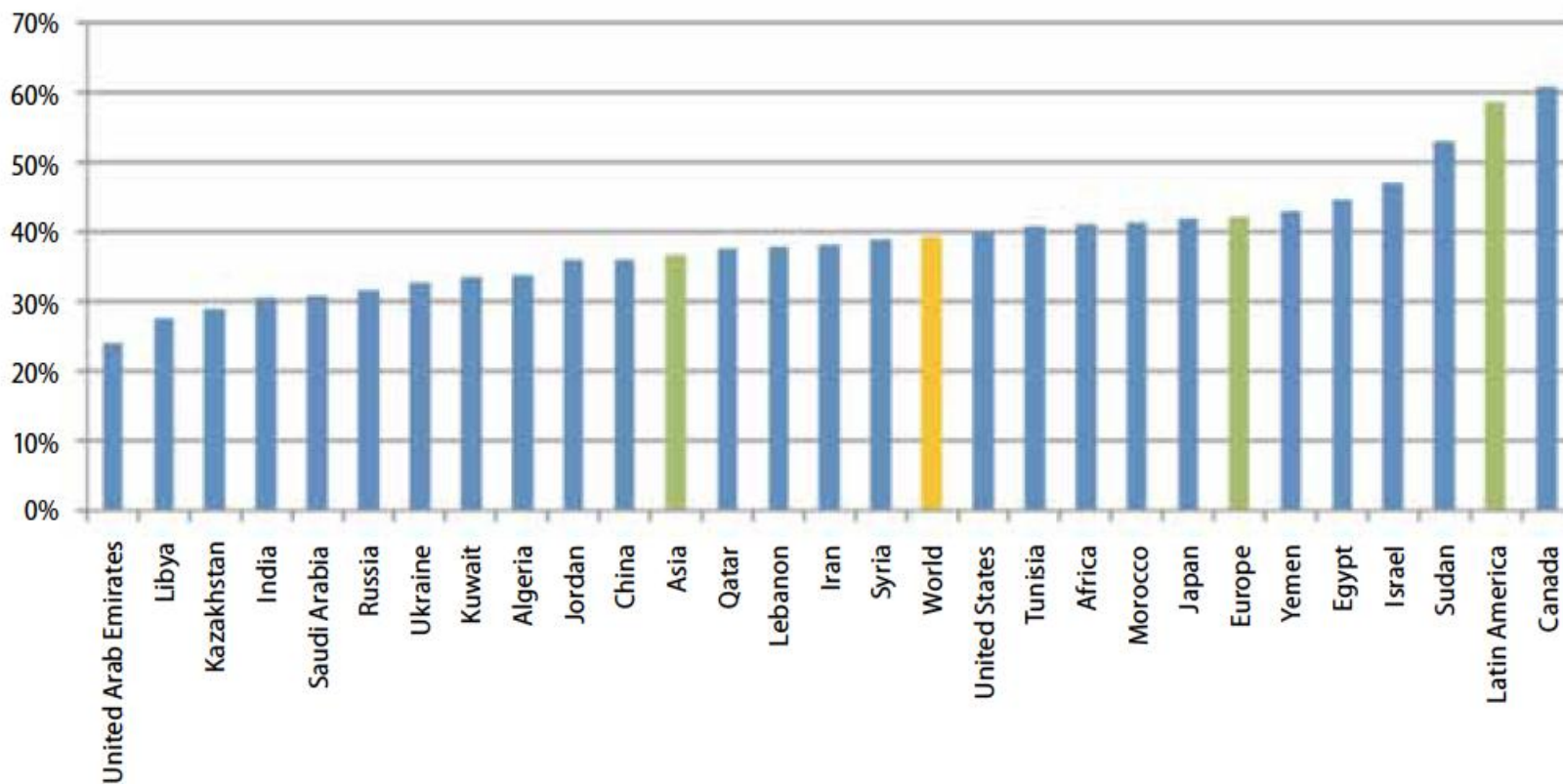
**FIGURE 4: ENERGY USE (KG OF OIL EQUIVALENT) PER \$1,000 GDP (CONSTANT 2005 PPP) IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES, 2008**



Source: World Bank, World Development Indicators

# MENA Self-Inflicted Energy Wounds: Part Six: Efficiency in Power Generation

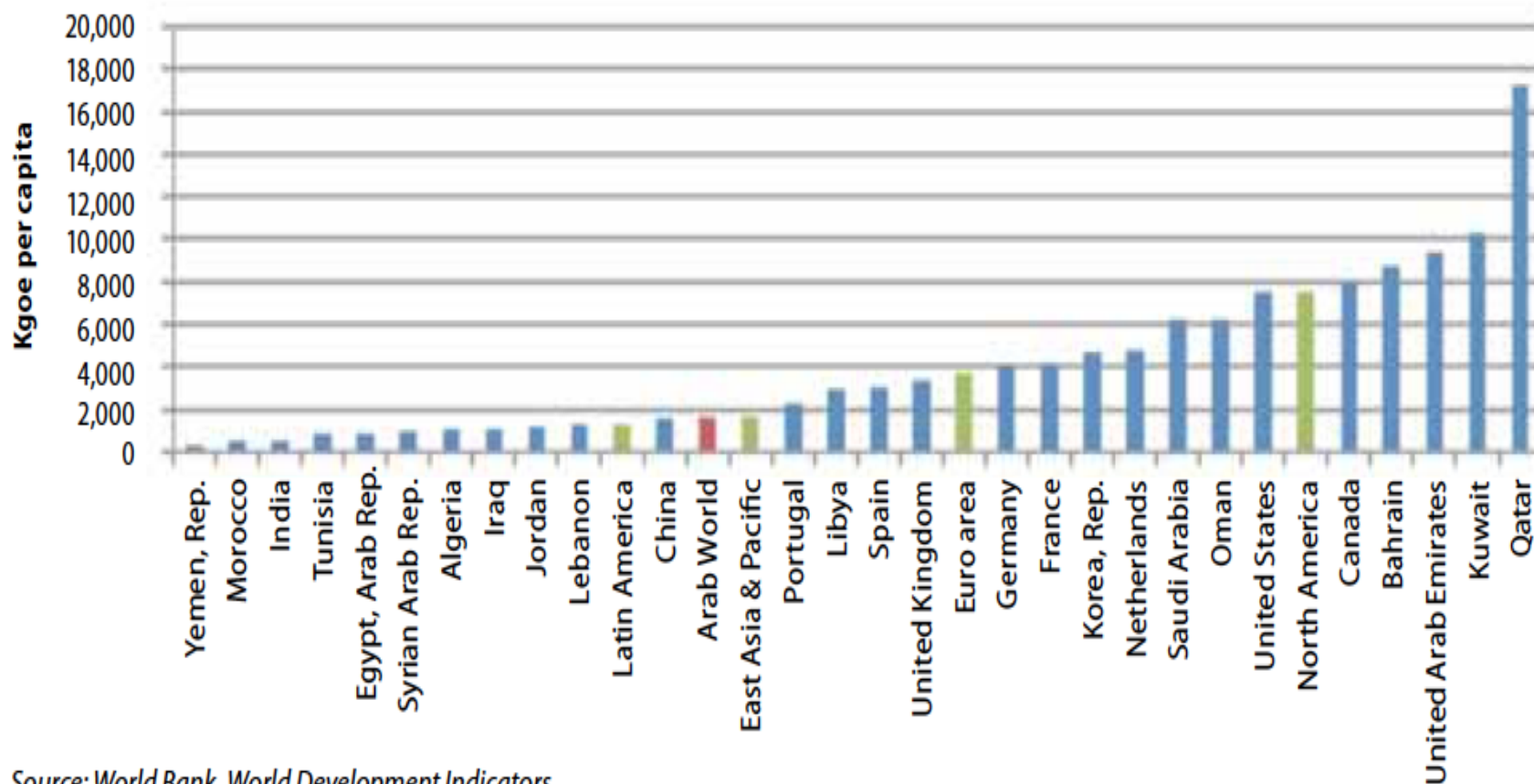
**FIGURE 5: ENERGY EFFICIENCY IN POWER GENERATION IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES (%), 2009**



Source: ABB, Trends in Global Energy Efficiency 2011

# MENA Self-Inflicted Energy Wounds: Part Seven: Oil Use Per Capita

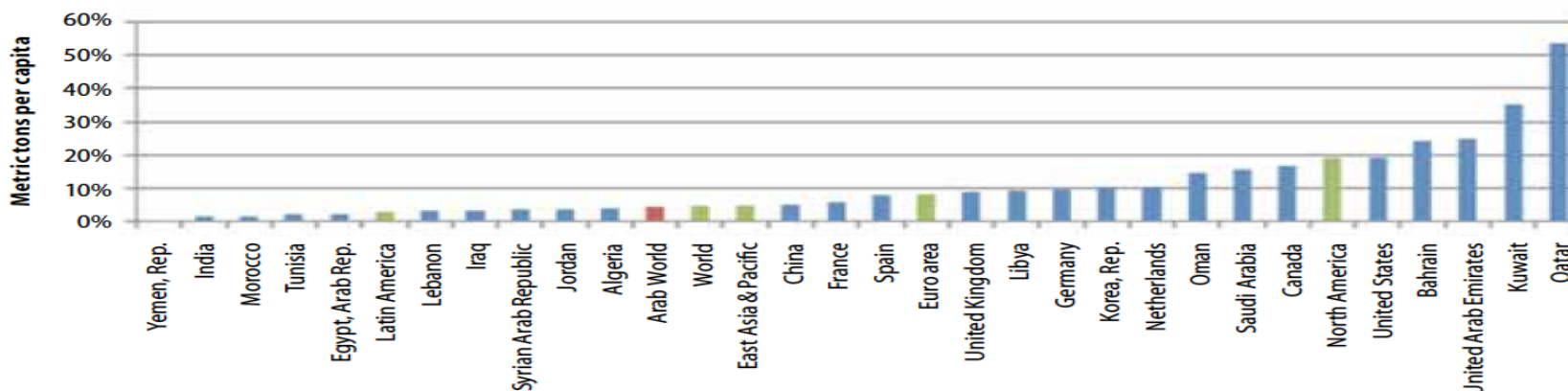
**FIGURE 7: ENERGY USE IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES (KG OF OIL EQUIVALENT PER CAPITA), 2008**



Source: World Bank, World Development Indicators

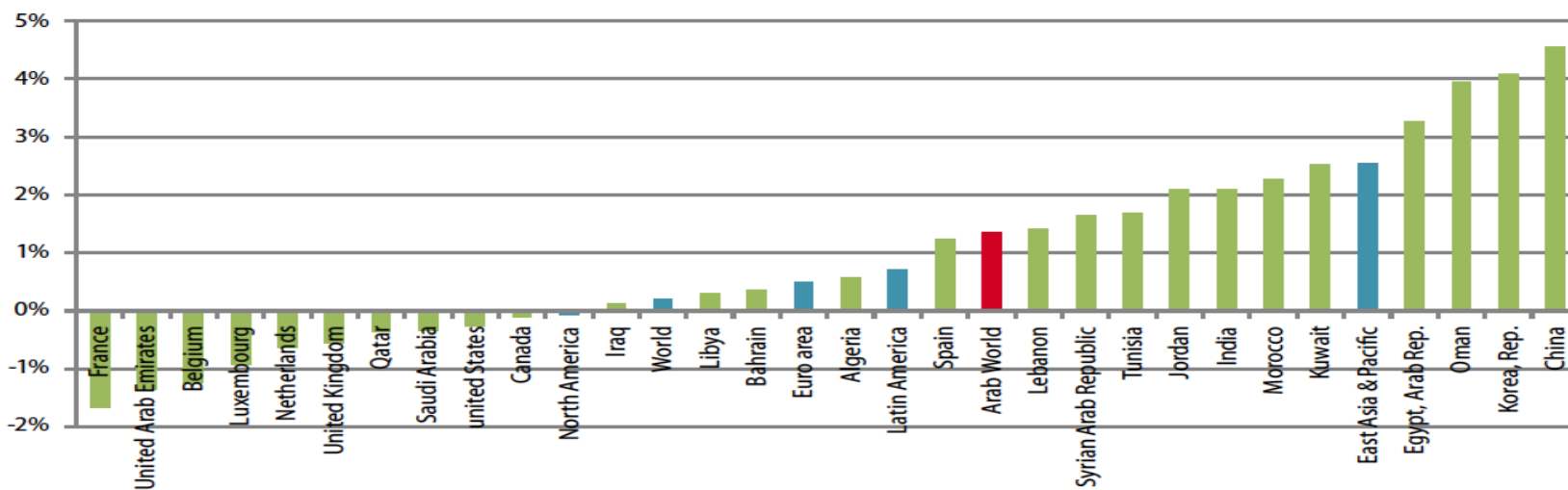
# MENA Self-Inflicted Energy Wounds: CO<sub>2</sub> Pollution

**FIGURE 8: CO<sub>2</sub> EMISSIONS IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES (METRIC TONS PER CAPITA), 2007**



Source: World Bank, World Development Indicators

**FIGURE 9: COMPOUND AVERAGE GROWTH RATE OF PER CAPITA CO<sub>2</sub> EMISSIONS IN SELECTED ARAB, OECD, AND NON-OECD COUNTRIES (METRIC TONS PER CAPITA), 1980–2007**

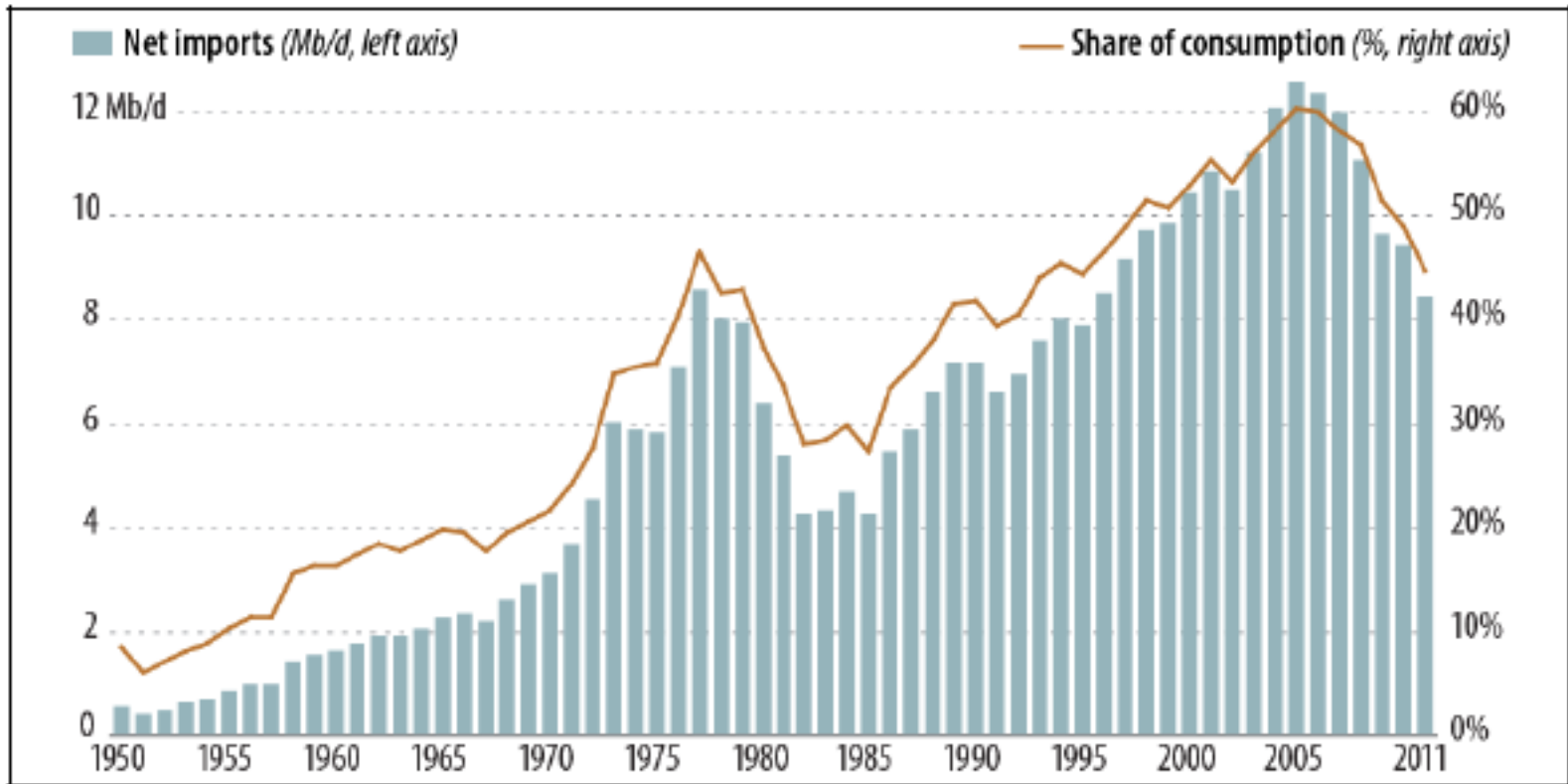


# *Continuing US Import Dependence*



# Overall Trends in US Import Levels: 1950-2011

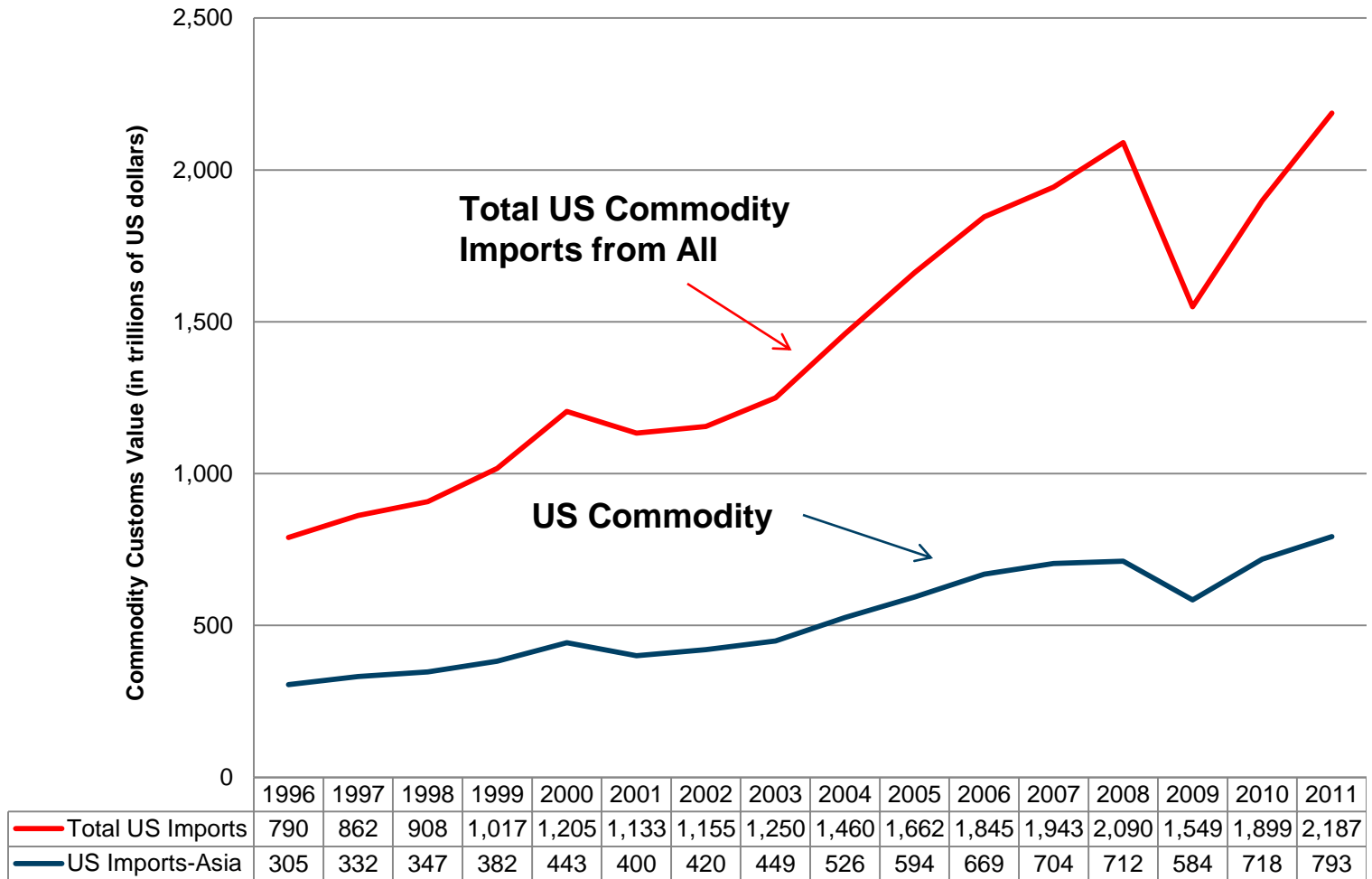
In millions of barrels a day (Mb/d) and as share of U.S. consumption



Data Source: EIA, *Petroleum & Other Liquid Fuels*, February 28, 2012, <http://www.eia.gov/petroleum/data.cfm>.

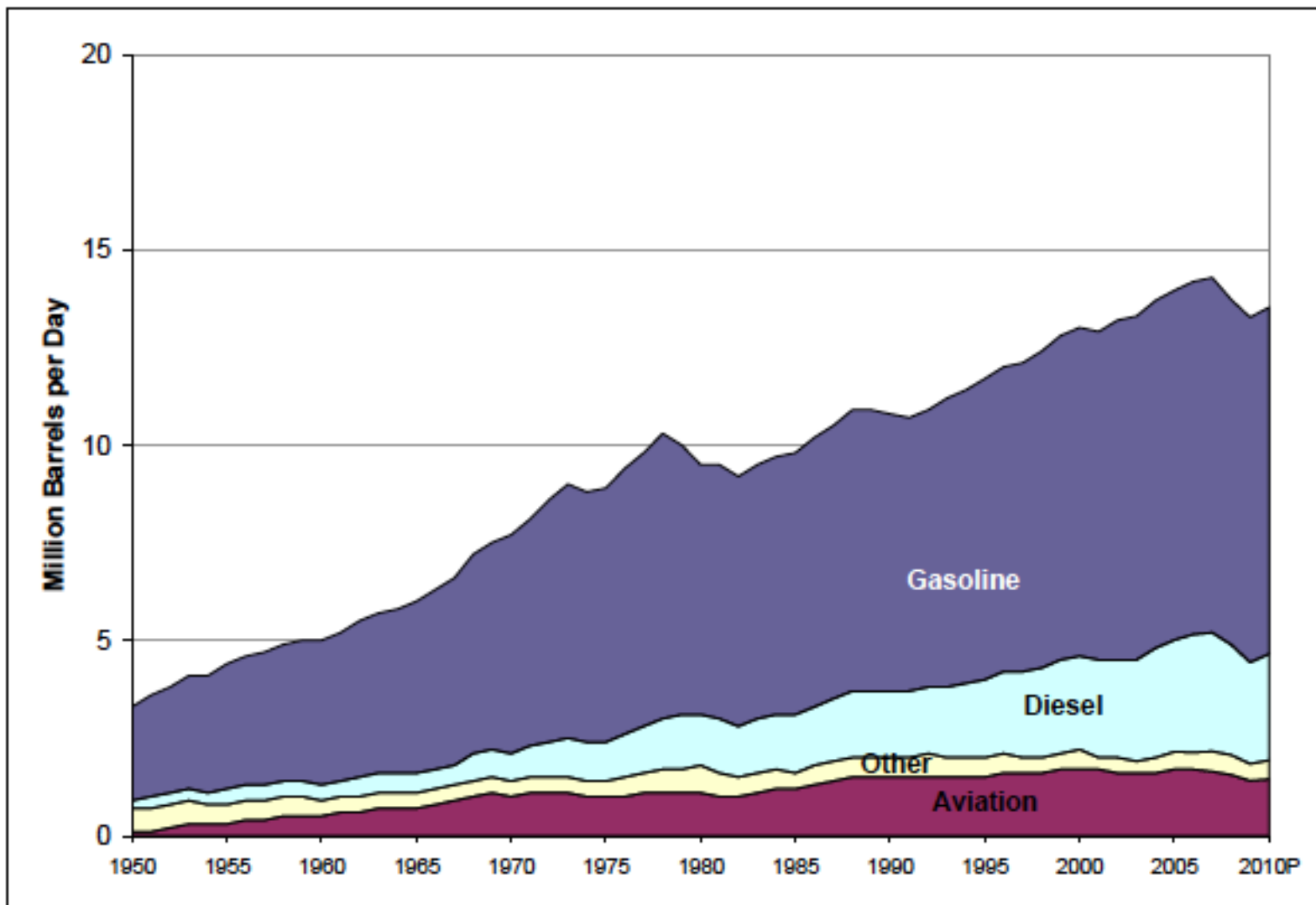
# Indirect Energy Imports: Growth in US Commodity Imports: 1996-2012

(In \$US Billions)



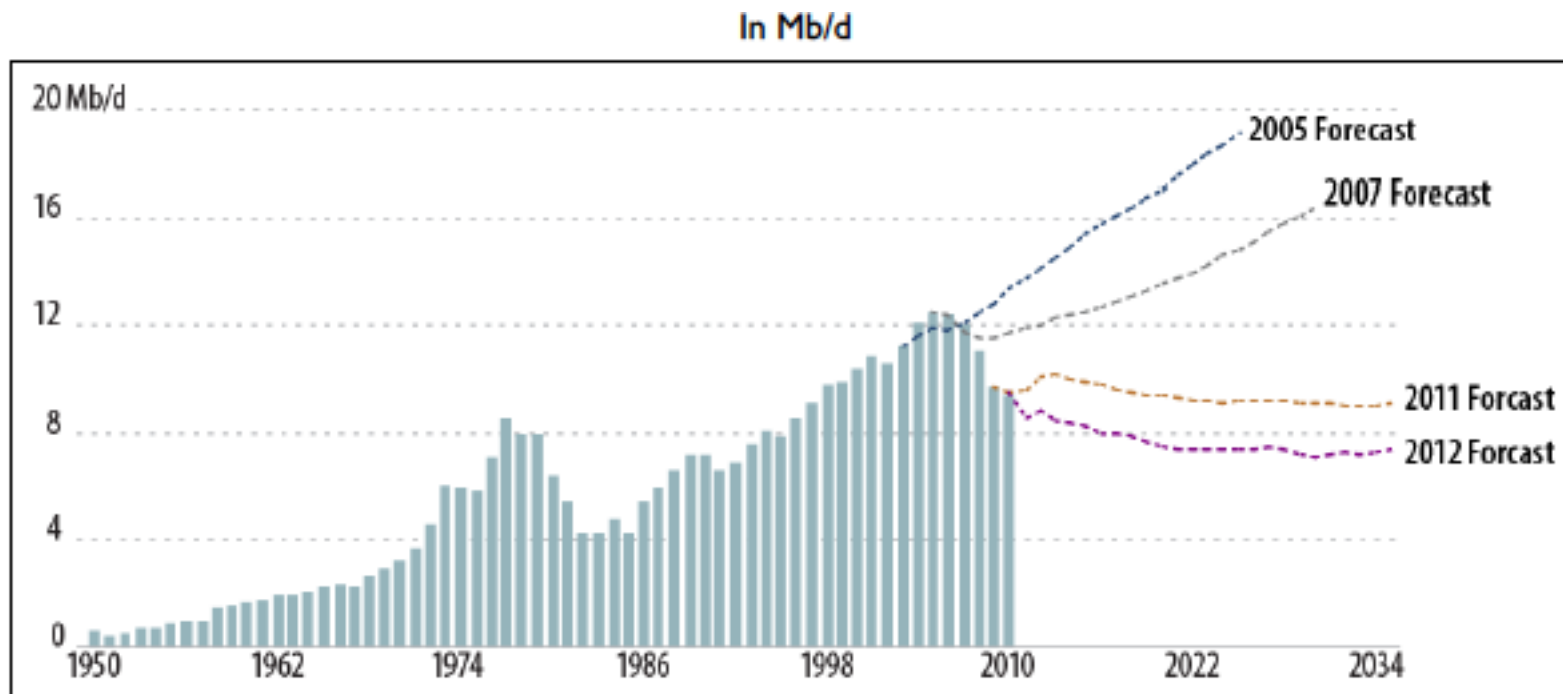
Sources: U.S. Department of Commerce and the U.S. International Trade Commission.

# Transportation Sector Drives US Demand



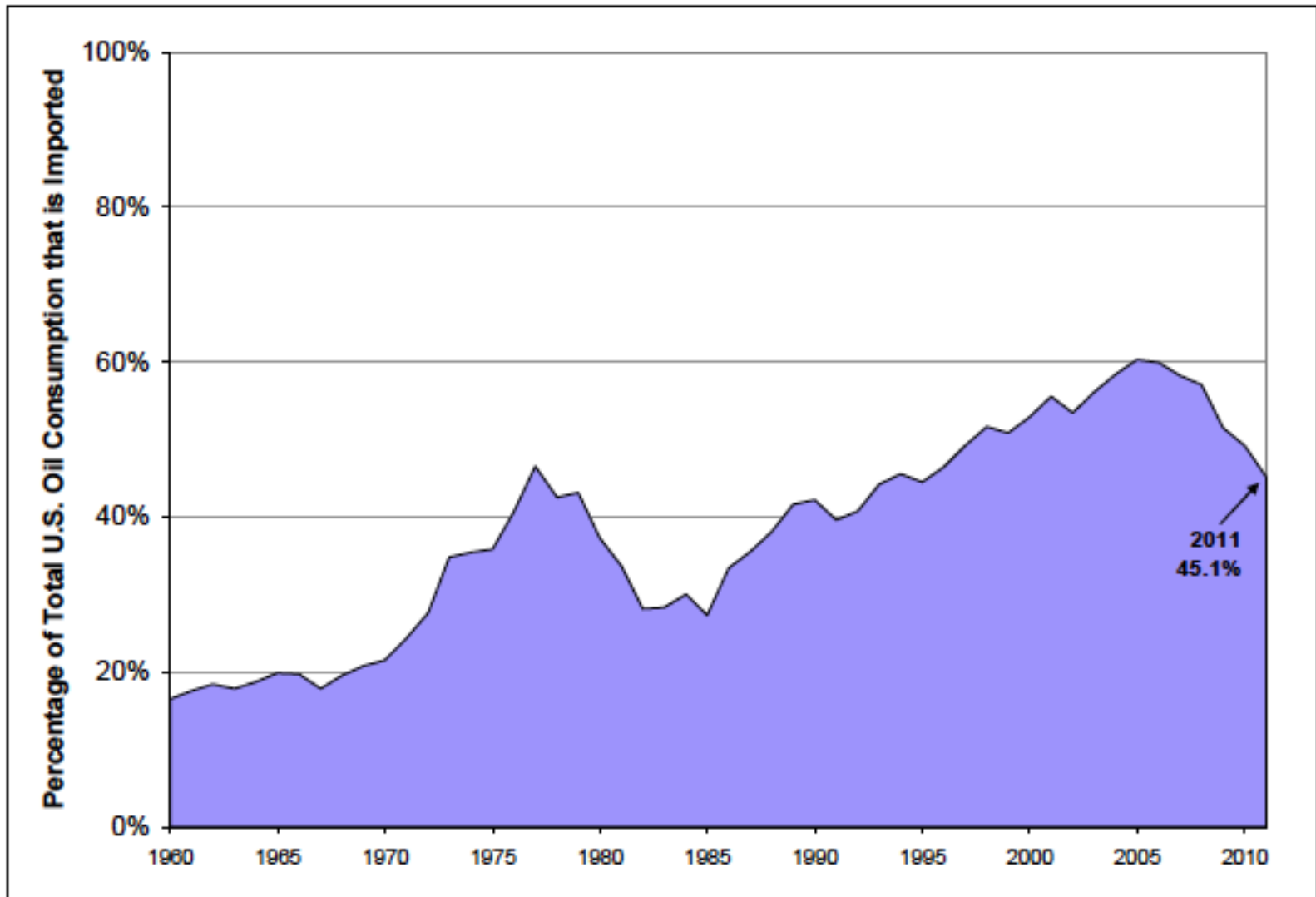
Source Carl E. Behrens, Carol Glover, *U.S. Energy: Overview and Key Statistics*, Congressional Research Service. April 11, 2012, p. 11

# Declining Estimates of Future US Import Levels: 1950-2011



**Data Source:** EIA, Annual Energy Outlook (AEO) from 2005, 2007, 2011, and the preliminary 2012 AEO. For each year, forecasts are EIA's "Reference Case" projection. <http://www.eia.doe.gov/forecasts/aeo/index.cfm>. Also, EIA Annual Energy Review, <http://www.eia.gov/totalenergy/data/annual/>.

# US Import Levels Do Respond to Price

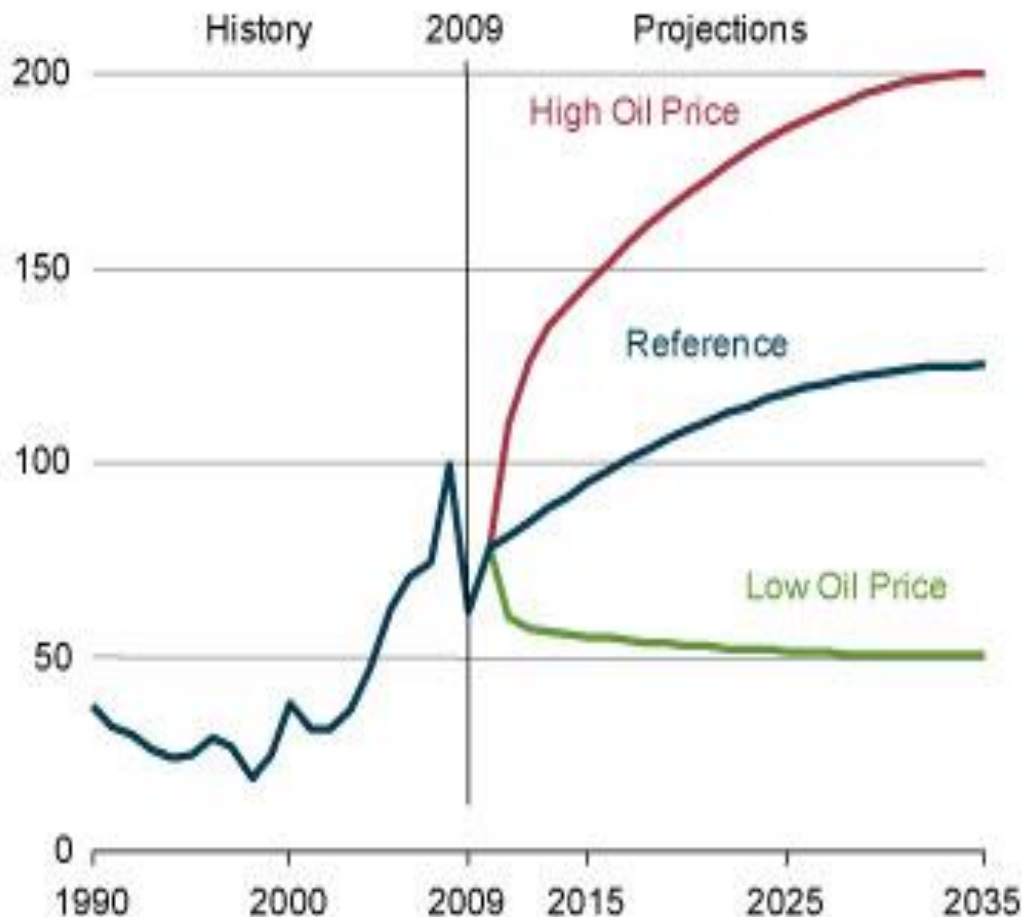


Source Carl E. Behrens, Carol Glover, *U.S. Energy: Overview and Key Statistics*, Congressional Research Service. April 11, 2012, p. 10

# DOE/EIA Estimate of Possible Oil Prices Through 2035

Figure 31. World oil prices in three cases, 1990-2035

(2009 dollars per barrel)



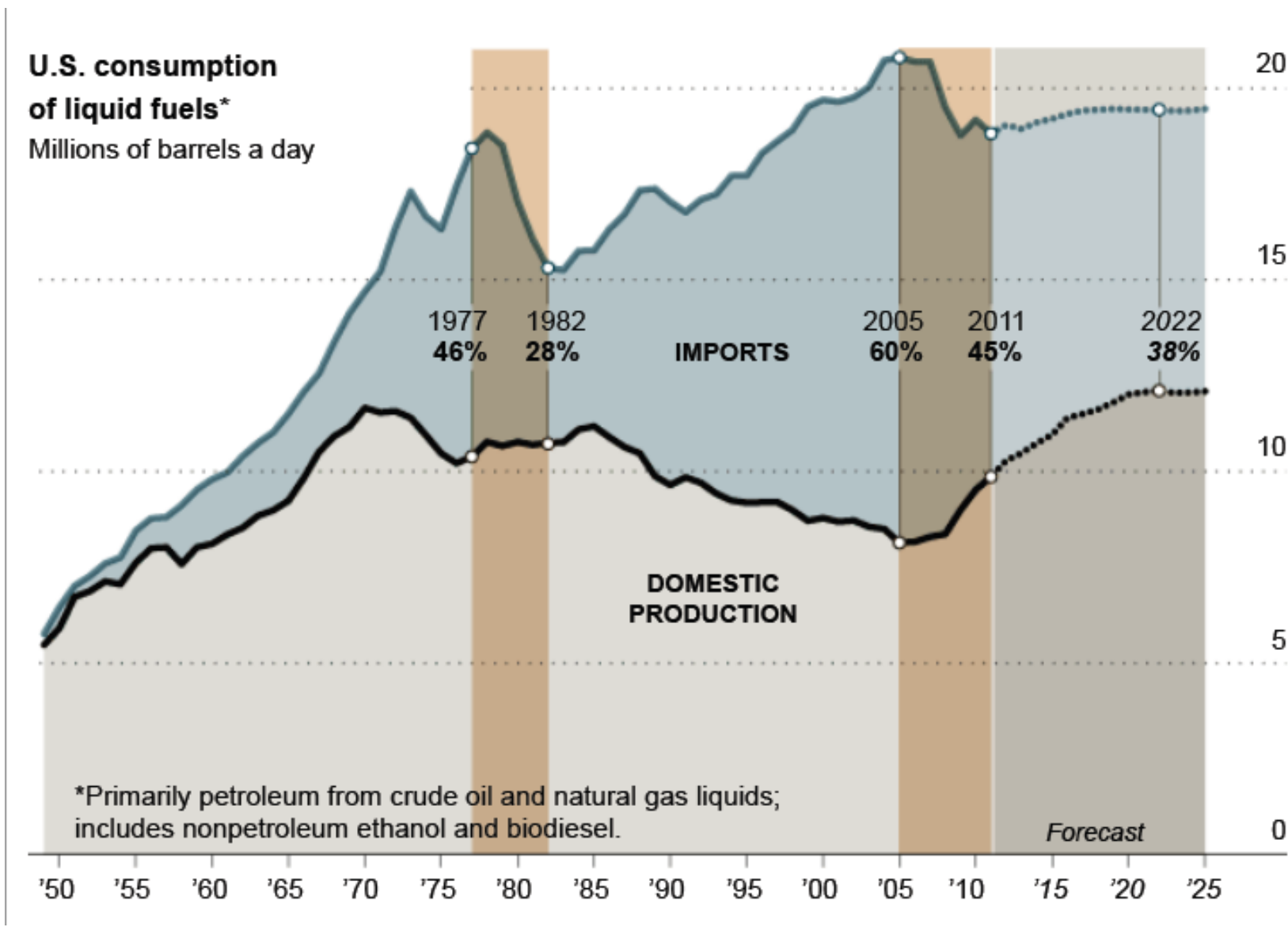
Prices have been exceptionally volatile over the past several years, reaching a high of \$145 in July 2008 (daily spot price in nominal dollars) and a low of \$30 in December 2008, as the global recession substantially dampened demand and thus prices.

Prices rose from an average \$62 per barrel in 2009 to \$79 per barrel in 2010, and they are expected to average about \$100 per barrel in 2011 [42]. In the *IEO2011* Reference case, world oil prices continue increasing, to \$108 per barrel in 2020 and \$125 per barrel in 2035. Prices for crude oil in 2011 remained generally in a range between \$85 and \$110 per barrel. In 2011.

Real imported sweet crude oil prices (2010 dollars) in the *AEO2012* Reference case rise to \$120 per barrel in 2016 as, the world economy recovers, and global demand grows more rapidly than the available supplies of liquids from producers outside the Organization of the Petroleum Exporting Countries (OPEC).

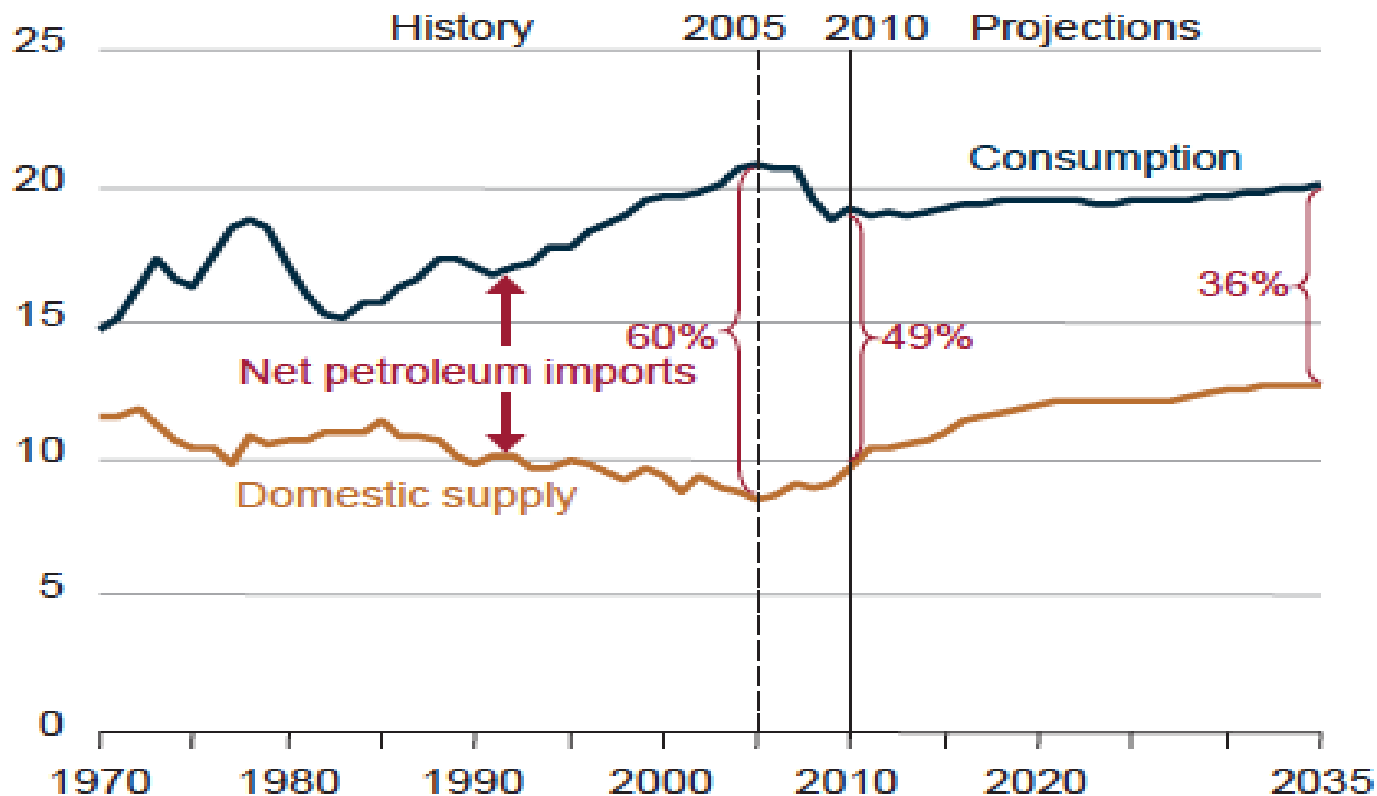
In 2035, the average real price of crude oil in the Reference case is about \$145 per barrel in 2010 dollars, or about \$230 per barrel in nominal dollars.

# US Liquid Fuels Production and Imports: 1950-2025



Source DOE, EIA; New York Times 23.3.12, <http://www.nytimes.com/interactive/2012/03/22/business/energy-environment/while-the-us-moves-toward-energy-independence.html?ref=energy-environment>

# DOE/EIA Estimate of US Strategic Dependence on Oil Imports Through 2035



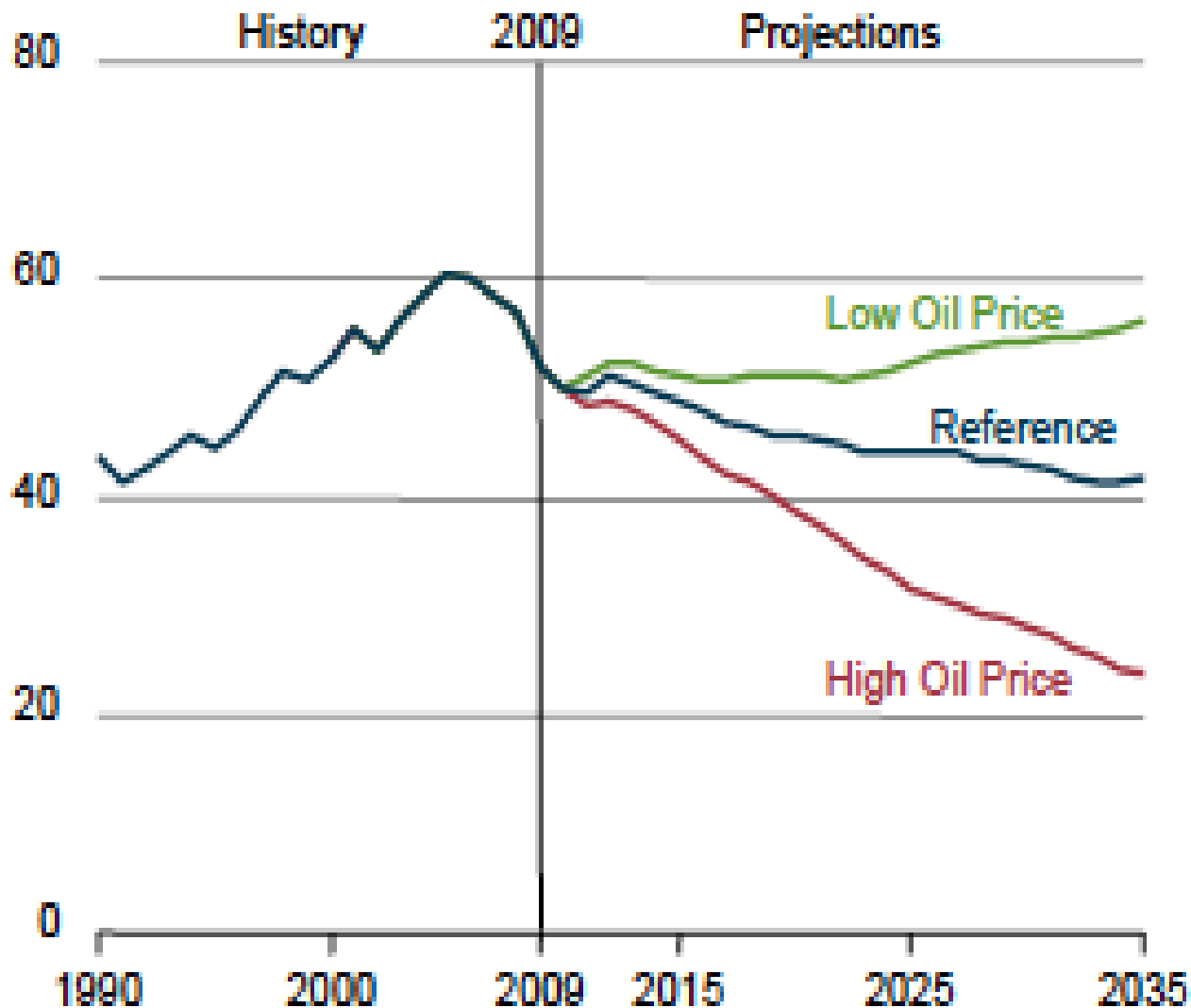
**US Total Consumption of All Types of Liquids and Share of *DIRECT* Imports in Million Barrels Per Day)**

**Direct imports *sharply understate US strategic dependence* in three key ways:**

- The US has massive *indirect* imports in the form of manufactured goods from Asia and other areas.
- The US pays global oil prices even for domestic production and any crisis immediately affects the US economy.
- The US economy, and every job in America, is dependent on a global economy that is steadily becoming even more dependent on the reliable flow of Gulf, MENA and other energy exports than the US.



# But, US Dependence is Highly Price & Scenario Dependent



**Net Share of Direct Imports as Percent of US Liquids Fuel Consumption in Different Scenarios: 1990-2035**

# *North Africa*

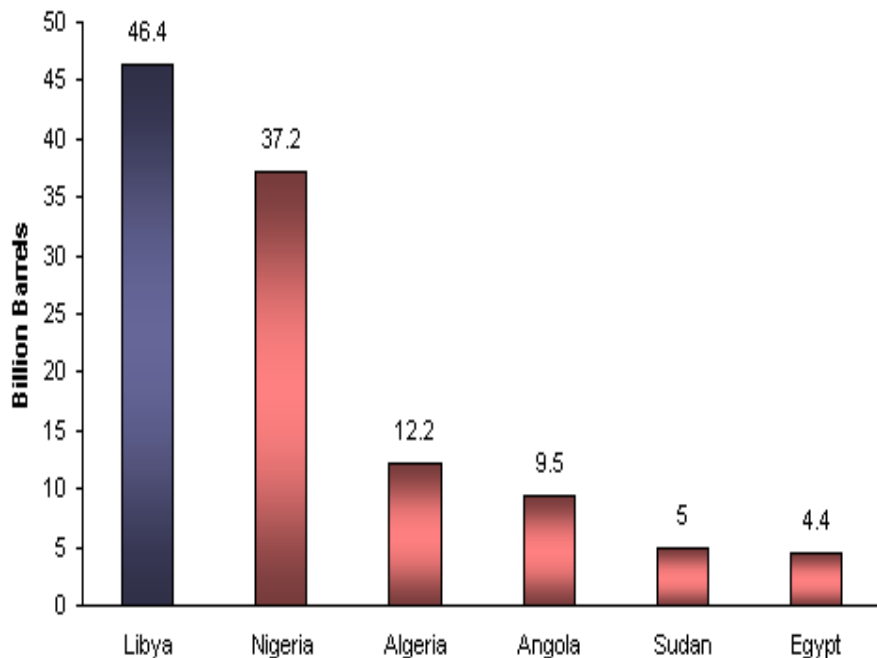
## North Africa

The projected growth in Algerian and Libyan oil and gas exports will be limited by global standards, but be of importance to Europe. Algeria and Libya are moderate risk countries because of the political uncertainties in each state and their uncertain ability to attract sustained energy investment over time. (The text describing current gas and oil trends is adapted from the EIA analysis from which given graphs and trend estimates are taken. The summary risk lists are the author's judgments)

- **North African Oil and Gas Reserves at Risk:** North Africa remains a major niche supplier of oil and gas exports to Europe. Libya and Algeria have enough proven oil reserves to give them the potential to their production significantly, and Algeria has major reserve of gas.
- **Libyan Energy Export Risks: Libya is a moderate risk energy exporter.** Libya faces moderate risks of internal instability following the end of the Qaddafi regime, and it is unclear how soon it can expand its oil and gas resources, whether tribalism and calls for federalism will lead to further violence, and how quickly it can reform its economy and the condition necessary to attract outside investment and technology. Libya did, however, produce some 3 MMBD in the past, and has brought its production up relatively quickly since Qaddafi's fall. Libya also desperately needs income to meet the expectations of its people, recover from the impact of the fighting, and more towards the kind of development that might produce improved unity. The EIA forecast that it will only produce 0.8 MMBD through 2035 seems far too pessimistic, and it seems unlikely that Libya will be unable to attract the need energy investment within several years. Similarly, Libya does seem likely to be able to continue to increase its gas production and exports back to its pre-revolutionary level of 1.6 MMBD by some point in 2013 – barring serious internal violence or political problems.
- **Algerian Energy Export Risks: Algeria is a moderate risk energy exporter.** Algeria remains a repressive state where the civil government is to some extent a facade for a military junta. It has not had a wave of serious popular protests, however, perhaps because the long brutal civil war between the ruling elite and Islamist extremists has large exhausted the desire to risk further violence. Algeria should be able to maintain its current level of exports, but it is unclear it can do so in the face of growing domestic demand. It should be able to make major increases in its gas exports as new fields and pipelines come on line. It is unclear, however, that it can maintain stability without far more serious internal reforms and development than has taken place to date

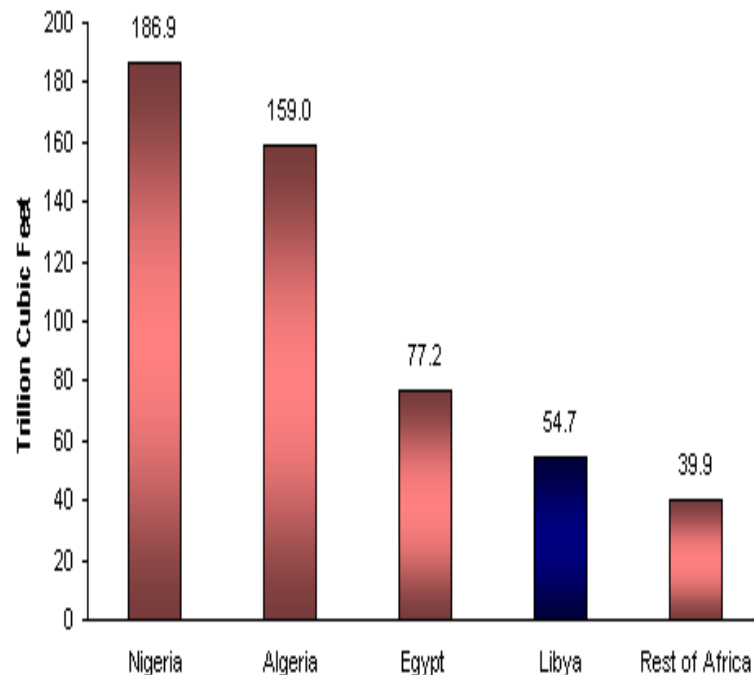
# North African Oil and Gas Reserves at Risk

**African Proven Oil Reserve Holders, 2011**



Source: Oil and Gas Journal

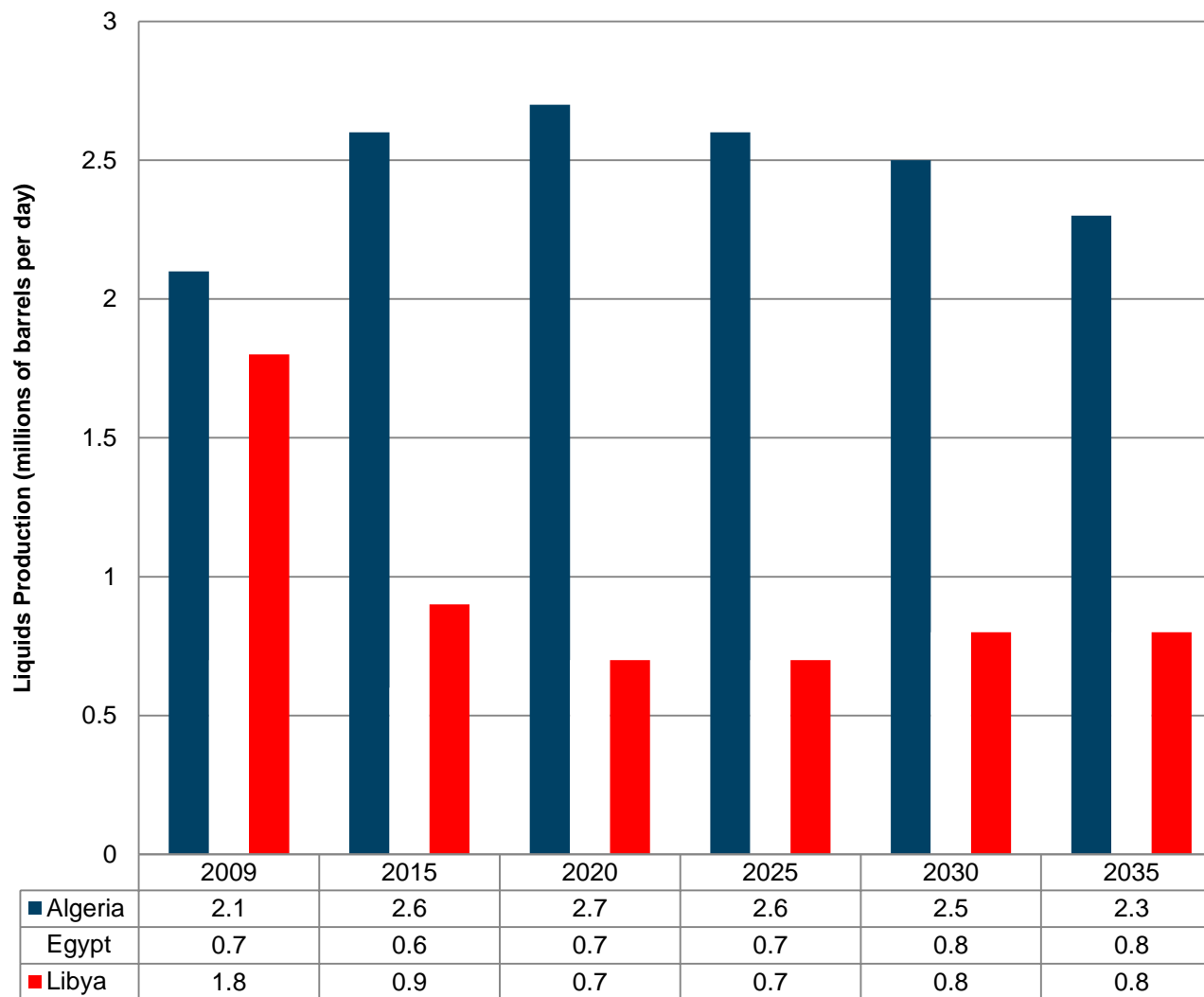
**African Proven Natural Gas Reserve Holders, 2011**



Source: Oil and Gas Journal

Source: <http://www.eia.gov/cabs/libya/Full.html>; DOE, EIA, International Energy Outlook, 2011, [http://www.eia.gov/forecasts/ieo/nat\\_gas.cfm](http://www.eia.gov/forecasts/ieo/nat_gas.cfm), [http://www.eia.gov/forecasts/ieo/liquid\\_fuels.cfm](http://www.eia.gov/forecasts/ieo/liquid_fuels.cfm)

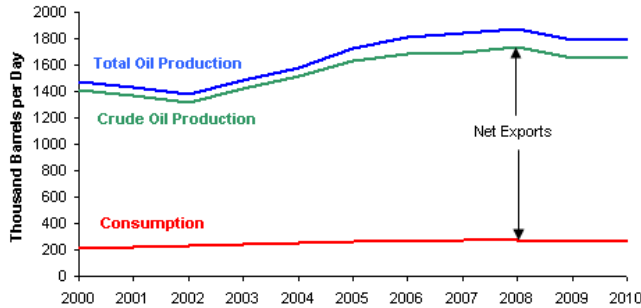
# North Africa Liquids Production: Recent and Projected



Source: U.S. Energy Information Administration, *International Energy Outlook 2011*

# Libyan Energy Export Risks

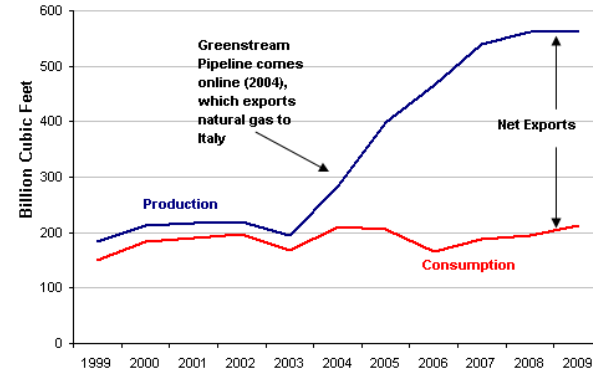
Libya's Oil Production and Consumption, 2000-2010



Source: EIA

Note: 2010 is a preliminary estimate based on Jan-Nov available data

Libya's Production and Consumption of Natural Gas, 1999-2009



Source: Energy Information Administration

## Key Risks

- Political and economic unrest
- East-west divisions, problems in south
- Divisions into local and tribal militias
- Perceived investment risk; barriers to foreign investment
- Political instability
- New strong man or military leader

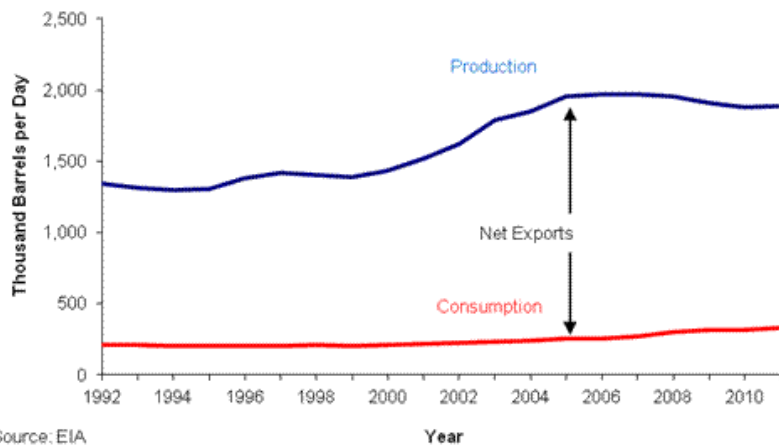
Oil & Gas Production: EIA estimates oil production capacity to go from 1.8 MMB/D in 2009 to 0.8 MMB/D in 2035

Despite Libya's oil reserves, oil production peaked at over 3 million bbl/d in the late 1960s and has since been in decline. The National Oil Corporation (NOC) would like to return oil production capacity back to 3 million bbl/d – a target that the NOC has delayed until 2017. Nonetheless, crude oil capacity has increased somewhat over the past decade from 1.43 million bbl/d in 2000 to 1.8 million bbl/d in 2010. Crude oil production in 2010 was approximately 1.65 million bbl/d, about 150,000 bbl/d below capacity but still above the production quota set by OPEC, currently at 1.47 million bbl/d. Most of the short-term oil production increases are expected to come from enhanced oil recovery (EOR) processes and any major new production in Libya will require additional pipeline capacity for exports. With domestic consumption estimated around 270,000 bbl/d in 2010, Libya's net exports (including all liquids) were slightly over 1.5 million bbl/d. According to the International Energy Agency (IEA) the vast majority (around 85 percent) of Libyan oil exports are sold to European countries namely Italy, Germany, France, and Spain. With the lifting of sanctions against Libya in 2004, the United States has increased its imports of Libyan oil. According to EIA January through November estimates, the United States imported an average of 71,000 bbl/d from Libya in 2010 (of which, 44,000 bbl/d was crude), up from 56,000 bbl/d in 2005 but a decline from 2007 highs of 117,000 bbl/d.

Libya's natural gas production has grown substantially in the last few years. According to EIA, Libya produced 1,034 billion cubic feet (Bcf) of gross natural gas in 2009 of which 562 Bcf was marketed dry natural gas – the remainder was vented, flared or re-injected to enhance oil recovery. In 2009, Libya consumed 212 Bcf and exported 349 Bcf of natural gas to Europe. The vast majority of this was exported by pipeline, with a small volume exported in the form of liquefied natural gas (LNG). Natural gas is piped from the Wafa concession and the offshore Bahr es Salam fields to Melitah, where it is treated for export. Natural gas exports to Europe have grown considerably over the past several years through the 370-mile "Greenstream" underwater natural gas pipeline from Melitah to Gela in Sicily. From Sicily, the natural gas flows to the Italian mainland. The Greenstream pipeline came online in October 2004 and is operated by Eni in partnership with NOC. Libya's LNG plant, at Marsa El Brega, was built in the late 1960s by Esso and has a nameplate capacity of about 125 Bcf per year. However, U.S. sanctions prevented Libya from obtaining necessary technology to separate out LPG from the natural gas, thereby limiting the plant's output by over half of capacity. In 2009, LNG exports increased slightly to 24.4 Bcf, all of which was exported to Spain.

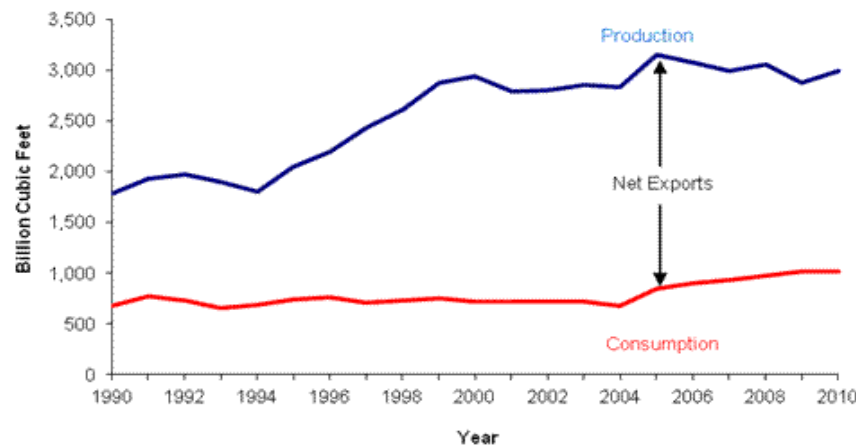
# Algerian Energy Export Risks

Algeria's Total Oil Liquids\* Production and Consumption, 1992-2011



Source: EIA  
\*Crude oil plus NGL and Condensate

Algeria's Dry Natural Gas Production and Consumption, 1990-2010



Source: EIA

Oil & Gas Production: EIA estimates oil production capacity to go from 2.1 MMB/D in 2009 to 2.3 MMB/D in 2035

## Key Risks

- Political and economic unrest
- Revival of civil conflict
- Political instability
- State barriers to investment
- AQIM, terrorism and sabotage

Algeria produced an estimated average of 1.27 million barrels per day (bbl/d) of crude oil in 2011, about the same as it produced in 2010. Together with 270,000 bbl/d of condensate and 340,000 bbl/d of natural gas liquids, which are not included in its OPEC quota, Algeria averaged 1.88 Mmb/d of total oil liquids production during 2011. In 2011, Algeria's estimated crude oil exports were 750,000 bbl/d, of which the largest portion went to North America, mainly to the United States. In 2010, Algeria's estimated total oil exports (including all liquids) were 1.5 million bbl/d. According to EIA estimates, the United States imported an average of 510,000 bbl/d from Algeria in 2010, of which 328,000 bbl/d was crude oil. The United States was the largest single importer of Algerian crude oil in both years.

Algeria's gross natural gas production in 2010 was 6.8 Tcf compared with 6.9 Tcf in 2009. Of this amount, 3.2 Tcf was reinjected for enhanced oil recovery, 3.5 Tcf was marketed, while 0.2 Tcf was vented/flared. Algeria is in the process of developing its Southwest Gas Project, which includes the Repsol-led 102 billion cubic feet per year (Bcf/y) Reggane Nord fields, the 56 Bcf/y Timimoun project led by Total, and GDF Suez's 159 Bcf/y Touat project. According to Cedigaz estimates, Algeria's natural gas exports totaled 1.97 Tcf in 2010, up from 1.86 Tcf in 2009. About 65 percent of Algeria's total natural gas exports, or 1.29 Tcf, moved through the natural gas pipelines connecting Algeria with Italy and Spain, while 35 percent, or 0.682 Tcf, was exported by tanker in the form of LNG. Algeria was the third largest natural gas supplier to Europe after Russia and Norway in 2010.

# *Egypt and the Levant*

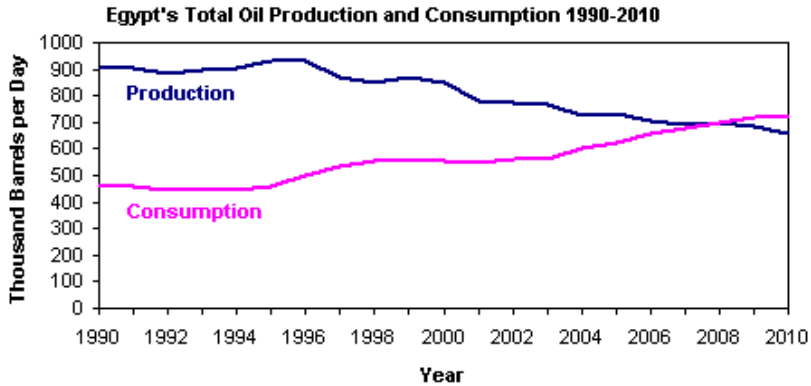


## Egypt and the Levant

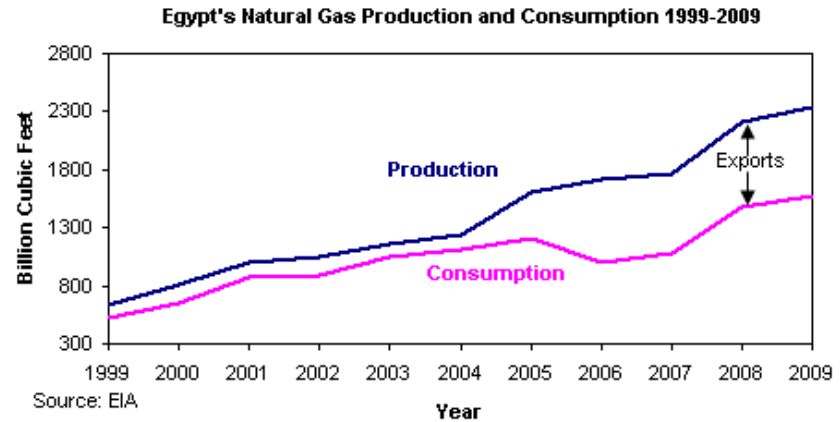
Egypt and Syria are minor energy producers but MENA standards, although Egypt has significant gas resources. Their exports are more important in terms of internal stability, and the needs of Israel in Egypt's case, than any impact of world markets – where both countries are in the “noise level” of global exports. The only major shift likely in the near future is the potential production of a new gas field off the coast of Israel – which could reduce its imports – and whether a gas field off the coast of Gaza will come into production.

- **Egyptian Energy Export Risks: Egypt is a moderate risk energy exporter.** Egyptian domestic oil demand now exceeds its production and Egypt is an importer. Egypt is, however, a growing gas exporter and LNG producer, and the Arab Gas Pipeline allows it to increase exports. Egypt is, however, in a state of political turmoil, and some form of serious political unrest presents a moderate risk of some form of disruption of its efforts to expand its gas production. As is the case with Algeria and Libya, however, Egypt desperately needs export earnings and it is unclear that any current faction would target its energy exports.
- **Egypt: Suez Canal and Sumed Pipeline** Egypt also is important to world energy exports because of the Suez Canal and Sumed pipeline. Even in 2010, with a weak global economy, total petroleum transit volume through the Canal was close to 2 million bbl/d, or just below five percent of seaborne oil trade. The SUMED pipeline accounted for 1.15 million bbl/d of crude oil flows along the route over the same period. LNG transit through the Suez Canal has been on the rise since 2008, with the number of tankers increasing from approximately 430 to 760, and volumes of LNG traveling northbound (laden tankers) increasing more than four-fold. It is unclear that there is any risk to the Canal, although expansion plans to allow larger tankers to pass through the Canal may experience a slight marginal increase in risk.
- **Syrian Energy Export Risks: Syria is a marginal, high-risk oil exporter** by world standards whose production and exports are likely to steadily decline with time. The EIA estimates total production will drop from 0.4 MMB/D in 2009 to 0.3 MMB/D in 2020 and 0.2 MMB/D by 2035. Syria is a net importer of gas, and its imports are likely to increase faster than its domestic production. Syria's repressive regime, acute unrest and domestic violence, and dysfunctional economic system and investment climate make it a moderate to high risk energy producer, but it is unclear that this matters to anyone outside Syria.

# Egyptian Energy Export Risks



Source: EIA



Source: EIA

## Key Risks

- Political and economic unrest
- Revival of civil conflict
- Growing domestic demand
- Political instability
- State barriers to investment
- Perceived as investment risk
- Insecurity in Gaza, tensions with Israel
- Uncertain security and development of Suez Canal and Sumed pipeline

Oil & Gas Production: EIA estimates oil production capacity to go from 0.7 MMB/D in 2009 to 0.8 MMB/D in 2035

In 2010, Egypt's total oil production averaged 660,000 (bbl/d), of which approximately 540,000 bbl/d was crude oil. Despite new discoveries and enhanced oil recovery (EOR) techniques at mature fields, crude oil production continues its decline. At the same time, new natural gas field production has led to increases in the production of natural gas liquids and lease condensates which have offset some of the declines in total oil liquids production. Oil consumption is estimated to be close to 710,000 bbl/d, slightly higher than production. Oil imports are expected to continue with some refined product exports in the short-term, but are still contingent on domestic demand growth. Domestic demand for petroleum products continues to grow. The government had been planning to reduce demand growth by gradually lifting subsidized prices and targeting subsidies more effectively. This is a politically sensitive issue that will be difficult to fully implement.

Egypt's natural gas sector is expanding rapidly with production quadrupling between 1998 and 2009. According to the *Oil and Gas Journal*, Egypt's estimated proven gas reserves stand at 77 trillion cubic feet (Tcf), an increase from 2010 estimates of 58.5 Tcf and the third highest in Africa after Nigeria (187 Tcf) and Algeria (160 Tcf). In 2009, Egypt produced roughly 2.3 Tcf and consumed 1.6 Tcf. With the ongoing expansion of the Arab Gas Pipeline, and LNG facilities, Egypt will continue to be an important supplier of natural gas to Europe and the Mediterranean region.

Egyptian began exporting natural gas in the mid-2000s with the completion of the Arab Gas Pipeline (AGP) in 2004 and the startup of the first three LNG trains at Damietta in 2005. In 2009, Egypt exported close to 650 billion cubic feet (Bcf) of natural gas, around 70 percent of which was exported in the form of LNG and the remaining 30 percent via pipelines.

Egyptian pipeline exports travel through the Arab Gas Pipeline (AGP) that provides gas to Lebanon, Jordan and Syria with further additions being planned. The Arish-Ashkelon pipeline addition, which branches away from the AGP in the Sinai Peninsula and connects to Ashkelon, Israel began operations in 2008. Domestic pressure over contracts, pricing for exports to Israel, and technical problems caused interruptions. Egypt has three LNG trains: Segas LNG Train 1 in Damietta and Egypt LNG trains 1 and 2 in Idku. The combined LNG export capacity is close to 600 Bcf per year with plans to expand in the near future pending export policy changes and legislation

# Egypt: Suez Canal and Sumed Pipeline



In the first 11 months of 2010, petroleum (both crude oil and refined products) as well as liquefied natural gas (LNG) accounted for 13 and 11 percent of Suez cargos, measured by cargo tonnage, respectively. Total petroleum transit volume was close to 2 million bbl/d, or just below five percent of seaborne oil trade in 2010.

Almost 16,500 ships transited the Suez Canal from January through November of 2010, of which about 20 percent were petroleum tankers and 5 percent were LNG tankers. With only 1,000 feet at its narrowest point, the Canal is unable to handle the VLCC (Very Large Crude Carriers) and ULCC (Ultra Large Crude Carriers) class crude oil tankers. The Suez Canal Authority is continuing enhancement and enlargement projects on the canal, and extended the depth to 66 ft in 2010 to allow over 60 percent of all tankers to use the Canal.

Closure of the Suez Canal and the SUMED Pipeline would divert oil tankers around the southern tip of Africa, the Cape of Good Hope, adding approximately 6,000 miles to transit, increasing both costs and shipping time. According to a report released by the International Energy Agency (IEA), shipping around Africa would add 15 days of transit to Europe and 8-10 days to the United States.

The 200-mile long SUMED Pipeline, or Suez-Mediterranean Pipeline provides an alternative to the Suez Canal for those cargos too large to transit the Canal (laden VLCC's and larger). The pipeline has a capacity of 2.3 million bbl/d and flows north from Ain Sukhna, on the Red Sea coast to Sidi Kerir on the Mediterranean. The SUMED is owned by Arab Petroleum Pipeline Co., a joint venture between the Egyptian General Petroleum Corporation (EGPC), Saudi Aramco, Abu Dhabi's National Oil Company (ADNOC), and Kuwaiti companies.

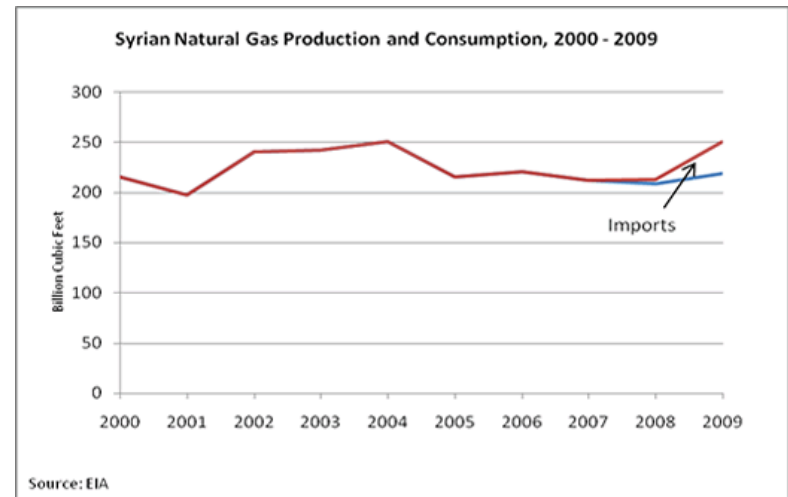
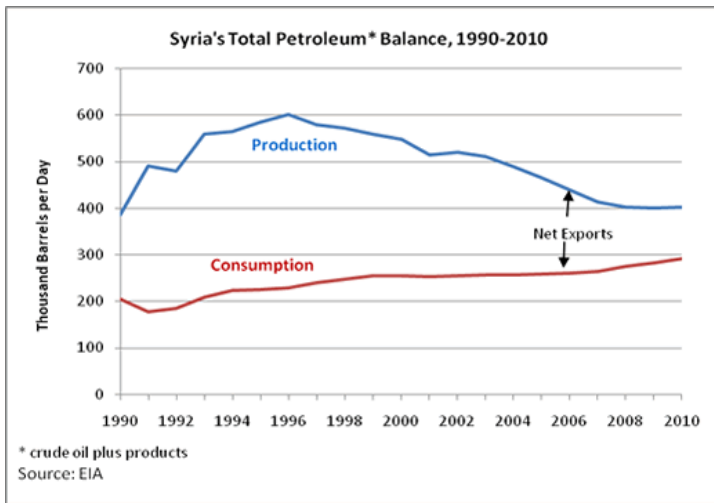
The majority of crude oil flows transiting the Canal travel northbound, towards markets in the Mediterranean and North America. Northbound canal flows averaged approximately 428,000 bbl/d in 2010. The SUMED pipeline accounted for 1.15 million bbl/d of crude oil flows along the route over the same period. Combined, these two transit points were responsible for over 1.5 million bbl/d of crude oil flows into the Mediterranean, with an additional 307,000 bbl/d travelling southbound through the Canal. Northbound crude transit represented a decline from 2008 when 940,000 bbl/d of oil transited northbound through the Canal and an additional 2.1 million travelled through the SUMED to the Mediterranean.

Total oil flows from the Suez Canal declined from 2008 levels of over 2.4 million bbl/d in 2008 to just under 2 million bbl/d on average in 2010. Flows through the SUMED experienced a much steeper drop from approximately 2.1 million bbl/d to 1.1 million bbl/d over the same period. The year-on-year difference reflects the collapse in world oil market demand that began in the fourth quarter of 2008 which was then followed by OPEC production cuts (primarily from the Persian Gulf) causing a sharp fall in regional oil trade starting in January 2009. Drops in transit also illustrate the changing dynamics of international oil markets where Asian demand is increasing at a higher rate than European and American markets, while West African crude production is meeting a greater share of the latter's demand. At the same time, piracy and security concerns around the Horn of Africa have led some exporters to travel the extra distance around South Africa to reach western markets.

Unlike oil, LNG transit through the Suez Canal has been on the rise since 2008, with the number of tankers increasing from approximately 430 to 760, and volumes of LNG traveling northbound (laden tankers) increasing more than four-fold. Southbound LNG transit originates in Algeria and Egypt, destined for Asian markets while northbound transit is mostly from Qatar and Oman, destined for European and North American markets. The rapid growth in LNG flows over the period represents the startup of five LNG trains in Qatar in 2009-2010. The only alternate route for LNG tankers would be around Africa as there is no pipeline infrastructure to offset any Suez Canal disruptions. Countries such as the United Kingdom and Italy received more than half of their total LNG imports via the Suez Canal in 2009 while over 90 percent of Belgium's LNG imports transited through the canal.



# Syrian Energy Export Risks



Oil & Gas Production Before the 2011 Upheavals: EIA estimates oil production capacity to go from 0.4 MMB/D in 2009 to 0.2 MMB/D in 2035

## Key Risks

- Political upheavals economic unrest
- Ongoing civil conflict
- Growing domestic demand
- Sanctions
- State barriers to investment
- Perceived as investment risk

While Syrian oil production and exports have been declining since the mid-1990's, Syrian oil demand has been gradually rising, spurred in part by Syria's policy of petroleum product subsidies. According to the *Middle East Economic Survey*, Syria spent \$3 billion on petroleum product subsidies in 2010. Much of these refined products had to be imported, and by 2008, the net value of Syria's oil exports and imports had a negative balance of \$100 million, down from a positive balance of \$1.9 billion in 2006. Syria had announced a long-term plan to phase out these subsidies, but the onset of political turmoil in 2011 in Syria forced a delay in these plans. Since peaking at 582,000 bbl/d in 1996, Syrian crude oil production (including lease condensate) declined to an estimated 387,000 bbl/d in 2010. Heavy oil accounts for about 60 percent of Syria's oil production. The SPC has undertaken efforts to reverse the trend toward declining oil production and exports by increasing oil exploration and production in partnership with foreign oil companies. However, previous US sanctions have excluded U.S. companies from participating, and Syria has been working with Chinese, Indian, as well as European companies.

Roughly one-fourth of Syrian gross natural gas production was reinjected into oilfields in 2009, with most of the rest distributed to power generators and other domestic users. All of Syria's oil-fired power stations are being converted to natural gas, and Syria's domestic gas demand is expected to more than double by 2020. Although Syrian natural gas production is expected to rise, it will be insufficient to meet expected demand, and Syria is developing plans to import more natural gas.

# *The Gulf and Arabia*

## The Gulf and Arabia

The Gulf states dominate MENA oil and gas production and exports, and are the largest single group of energy exporters in the world. The DOE estimates that they will have a growing share of the production of liquids and natural gas product and export through 2035, in spite of major discoveries and increase in the production of non-conventional liquids and gas. There have, however, been three major wars in the area since 1980. Iran has had major revolution, Iraq is still dealing with the outcome of the US-led invasion that toppled Saddam Hussein, and Yemen is in a state of turmoil and near civil war. There is a significant risk of a major clash in the near future and another serious conflict involving Iran will be a constant possibility unless Iran gives up the programs that might allow it to produce nuclear weapons, and ceases its arms race in asymmetric forces and long-range ballistic missiles.

**Gulf Oil and Gas Reserves at Risk:** There are many different estimates of oil and gas reserves, and different definitions of proven and possible reserves. Some Gulf countries like Iran and Iraq have also made highly political claims about expanded reserves for which there is little analytic justification – seeking to expand their influence and attract investment. EIA estimates do indicate, however, the Gulf and the Middle East dominate proved oil reserves, and are the largest single bloc of natural gas reserves. MENA states have nearly half of the world’s provide oil reserves – concentrated largely in the Gulf. They also have more than one-third of all the world’s proven natural gas reserves.

**Gulf Oil and Gas Exports at Risk:** There are no “normal” years for oil and gas exports, but EIA figures for 2009 show just how large a share Gulf exports were of total Gulf oil production, and how important four Gulf gas exporters – Qatar, Oman, the UAE, and Iran – were to world exports of natural gas.

**Iran Energy Export Risks:** Iran is the highest energy risk energy exporter in the Gulf and the Middle East. This is not simply because of its regional ambitions and competition with the US. Iran’s political stability is uncertain, growing sanctions sharply limit its oil and gas production and expansion plans, and it offers poor terms and incentives for outside investment. This is why – even before much tighter sanctions were applied in late 2011 – the EIA estimated oil production capacity would drop from 4.1 MMBD in 2009 to 3.9 MMBD in 2035 – largely because of political and sanctions-related investment and development problems. The EIA does not seem to take these factor in to consideration in its of natural gas production: These rise from 4.6 Tcf in 2009 to 7.8 Tcf in 2015, 7.4 Tcf in 2025, and 9.4 Tcf in 2035.

**Iraq Energy Export Risks: Like Iran, Iraq is a high-risk energy producer and exporter.** It does not face the same risk of external conflict as Iran, but its current level of violence is close to that of Afghanistan, and it has potentially explosive tensions between Sunni and Shi'ite and Arab and Kurd. A violent power struggle is taking place at the top of an ineffective government. Investment security is poor, as is the protection of oil and gas facilities and production. The laws affecting energy investment, business practices, taxation, and property ownership are not adequate to attract the level of investment needed, and corruption is a major issue. Iraq will probably increase oil exports in spite of these problems, but at a far lower rate than the 12 MMBD its plans call for. The EIA estimates oil production capacity will only go from 2.4 MMBD in 2009 to 6.3 MMBD in 2035. The EIA estimates natural gas production will rise from less than .05 Tcf in 2009 to 0.8 Tcf in 2035, but this is a far lower figure than a more stable and investment friendly Iraq could achieve.

**Kuwait Energy Export Risks: Kuwait is a low-to-moderate risk energy exporter,** in part because of its proximity to Iran and Iraq and the risk it might become involved in a future conflict. This risk seems minimal, given the US military presence in Kuwait and the Gulf, and US and Kuwaiti security ties. At the same time, Kuwait's political system is undergoing growing tensions and divisions, some which could paralyze needed growth and development. Its oil company has been blocked from developing Kuwait's northern fields and proper modernization of exploration and production. Its factional, service politics limit its quality of governance and encourage ethnic and sectarian tensions – although these now are more a matter of politics than serious internal divisions. The EIA does estimate, however, that Kuwait's oil production capacity will rise from 2.5 MMBD in 2009 to 3.0 MMBD in 2015, 3.3 MMBD in 2025, and 4.0 MMBD in 2035. This seems credible, assuming Kuwait is not caught up in military action by its neighbors and it can overcome the self-destructive character of some aspects of its politics. Kuwait has no current prospects of bring a meaningful gas exporter.

**Oman Energy Export Risks: Oman is a low risk energy exporter.** Oman faces limited energy risks in the case of a regional conflict involving Iran. It does face some potential problems with its political leadership and the succession to Sultan Qabus, and has had some protests stemming from its lack of job creation and youth employment problems, coupled to a high dependence on foreign labor. These problems still, however, present only a limited risk. Oman has managed its energy development relatively well, and created a good investment climate. The EIA estimates that oil production will slowly rise from 0.8 MMBD in 2009 to 1.0 MMBD in 2015, and then drop to 0.7 MMBD in 2025, and 0.6 MMBD in 2035 – but because of the limits of its reserves. Oman's gas reserves do not support major increase in further production, and domestic demand may force gradual cuts in future exports. Oman is, however, of major potential strategic importance to the Southern Gulf states in offering export facilities directly on the Indian Ocean and by passing the Strait of Hormuz.

**Qatar Energy Export Risks: Qatar is a low risk energy exporter.** Qatar does face a limited risk in the case of conflict involving Iran and from Iranian pressure to limit development of its gas field in the Gulf. In general, however, Qatar can count on US protection and provides the largest US airbase in the Gulf. It has a small native population with the highest per capita income in the world, and its leaders have made steady reforms to win popular support. It has a history of both successful national planning and energy development. Its oil reserves are limited, but the EIA estimates that Qatar's oil production capacity will rise from 1.2 MMBD in 2009 to 1.7 MMBD in 2015, 2.1 MMBD in 2025, and 2.2 MMBD in 2035. Qatar is one of the world's largest and most important gas exporter and the EIA estimates that its natural gas production will rise from 3.2 Tcf in 2009 to 6.3 Tcf in 2015, 7.4 Tcf in 2025, and 8.1 Tcf in 2035.

**Saudi Arabia Energy Export Risks: Saudi Arabia is a low risk energy exporter.** It does face a growing military challenge from Iran, problems in dealing with Yemen, and a continuing low-level threat from AQAP, but like the other Southern Gulf states, Saudi Arabia has strong security support from the US. Moreover, Saudi Arabia has taken the lead in building up the security forces of the Gulf Cooperation Council. Saudi Arabia does face domestic challenge in dealing with its Shi'ite minority, and its growing population of young men and women who often lack jobs or meaningful employment. It has reacted to the political upheavals that began in 2011, however, with a wide range of programs to deal with housing, employment, education, and social services and has begun gradual political and legal reforms. These currently seem to be moving at pace that will produce continued stability. As long as the Saudi royal family moves forward with such programs, political and education reforms, and anti-corruption measures the Kingdom should remain stable. The main risk to energy exports may, in fact, come from rising levels of domestic demand unless Saudi Arabia establishes fair market prices for its own use of oil and gas. Output should not be a near to mid-term risk. Like Qatar, Saudi Arabia has one of the most effective mixes of state planning and energy companies in the world. The EIA estimates that Saudi oil production capacity will rise from 9.6 MMBD in 2009 to 11.6 MMBD in 2015, 13.9 MMBD in 2025, and 15.4 MMBD in 2035. Saudi Arabia is a major gas producer and the EIA estimates that its natural gas production will rise from 2.8 Tcf in 2009 to 3.3 Tcf in 2015, 4.2 Tcf in 2025, and 5.2 Tcf in 2035.

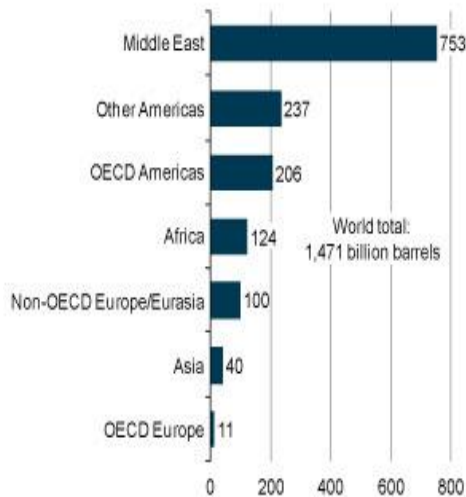
**UAE Energy Export Risks: The UAE is a low risk energy exporter.** Once again, it faces a potential threat from Iran. Like the other Southern Gulf states, however, it has close security ties to the US – as well as France and Britain. Like Saudi Arabia, the UAE is building up powerful security forces of its own. The UAE has a small native population, no meaningful signs of unrest from foreign labor, and the wealth to ensure stability. It does face some problems from economic differences between its emirates, and it is unclear that Dubai has fully put an end to the “bubble” aspects of its economy. The UAE also has some problems with the quality of its management of its oil and gas development. These do not seem significant enough, however, to alter its risk rating. The EIA estimates that UAE oil production capacity will rise from 2.8 MMBD in 2009 to 3.6 MMBD in 2015, and then drop to 3.5 MMBD in 2025, and 3.2 MMBD in 2035.



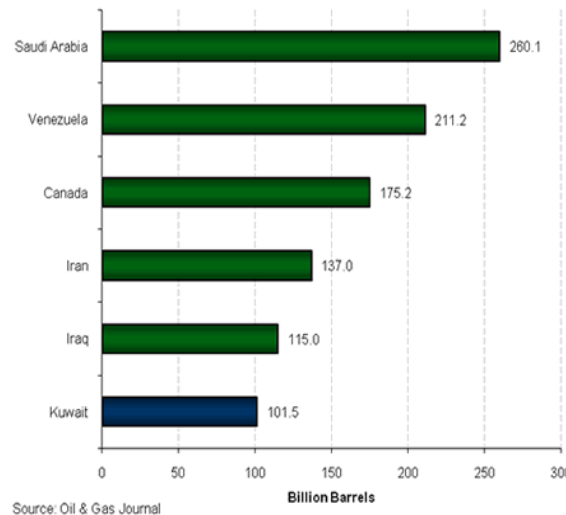
**Yemen Energy Export Risks: Yemen is a marginal, high-risk energy exporter.** It is undergoing serious internal tensions and conflict, with a power struggle in its capital, a Houthi rebellion in the north along the Saudi border, a growing threat from AQAP and Islamist extremists, and a serious North-south split that threatens another round of regional conflict and that could under worst-case conditions divide the country. Yemen is one of the poorest countries in the world with one of the least effective governments and worst managed economies. It faces a major water crisis as well as critical problems in terms of youth and general unemployment and underemployment. The EIA estimates that Yemeni oil production capacity will drop from only 0.3 MMBD in 2009 to 0.23 MMBD in 2015, 0.1 MMBD in 2025, and 0.1 MMBD in 2035.

# Gulf Oil and Gas Reserves at Risk

Figure 39. World proved oil reserves by geographic region as of January 1, 2011 (billion barrels)

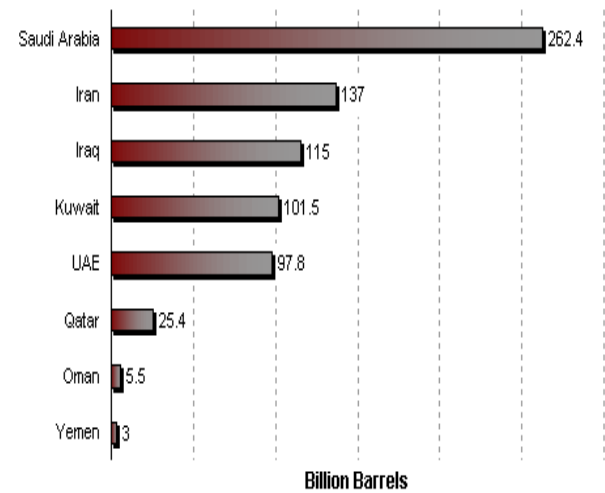


Top Global Proven Oil Reserves by Country, 2011



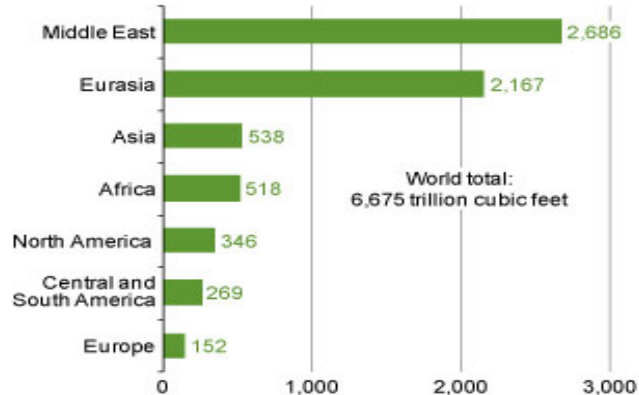
Source: Oil & Gas Journal

Selected Middle East Proven Oil Reserves, Jan. 1, 2011

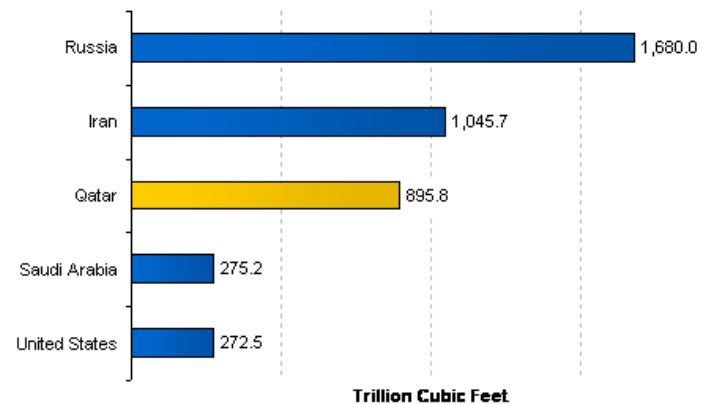


Source: Oil & Gas Journal

Figure 64. World natural gas reserves by geographic region as of January 1, 2011 (trillion cubic feet)

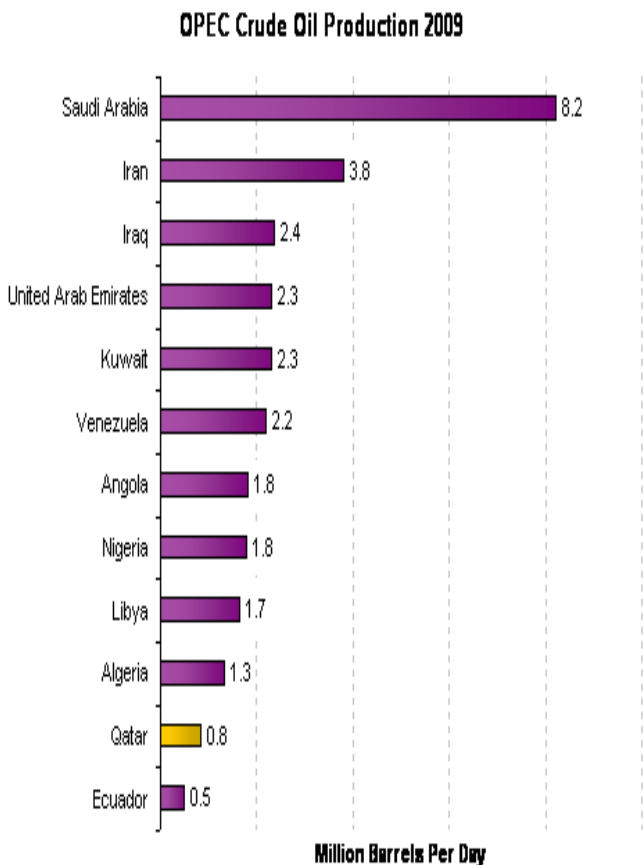


World Natural Gas Reserves by Country, January 1, 2011

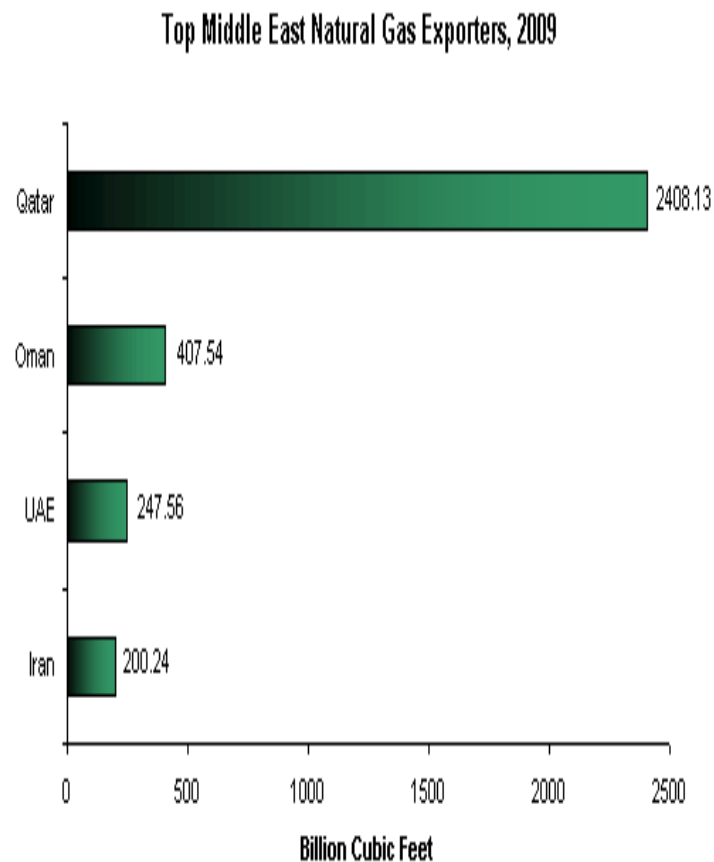


Source: Oil & Gas Journal, Jan. 1, 2011 and EIA, *Natural Gas Navigator* (U.S. only), Dec. 31, 2009.

# Gulf Oil and Gas Exports at Risk

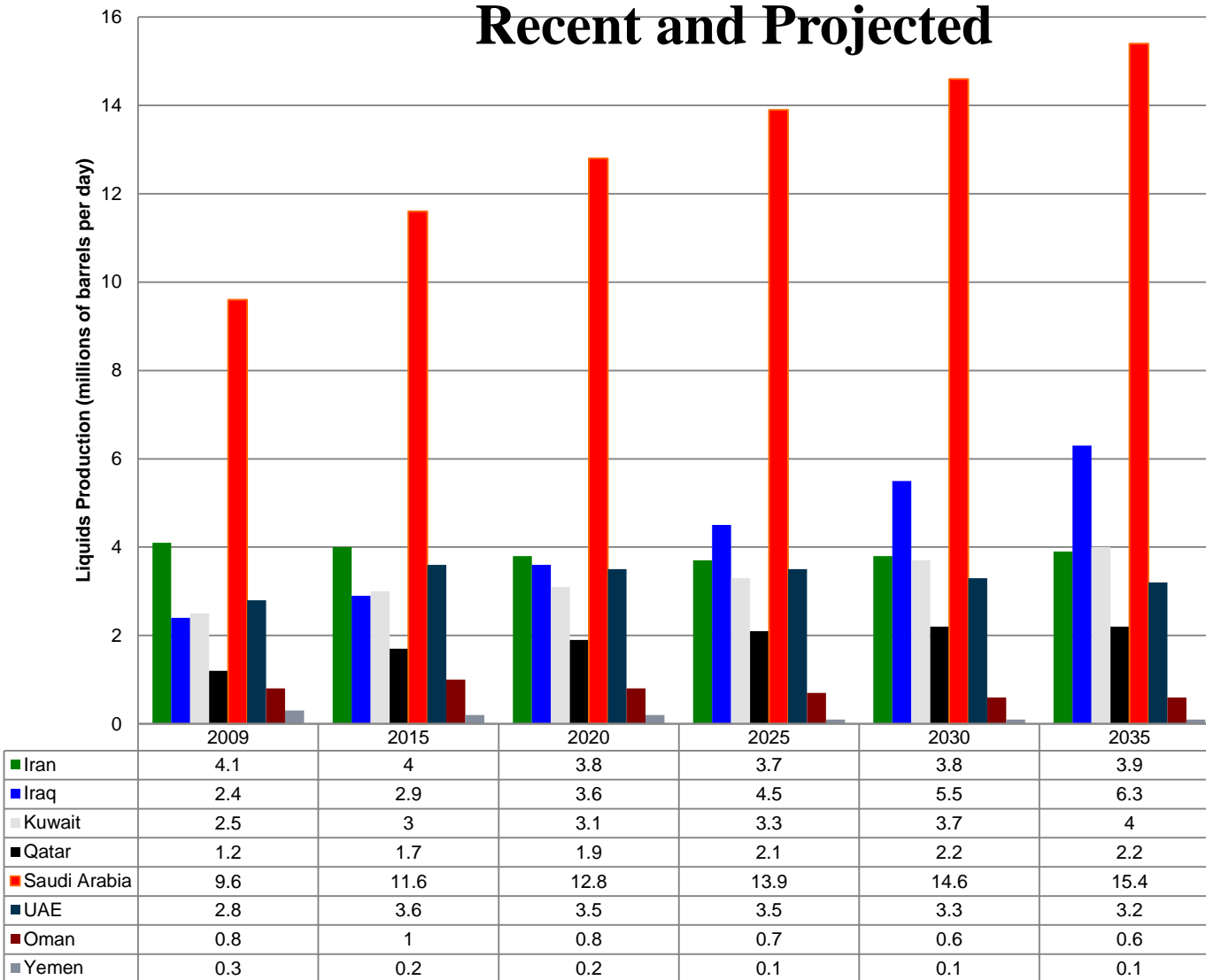


Source: EIA Short Term Energy Outlook, December 2010. Production values do not include lease condensate.



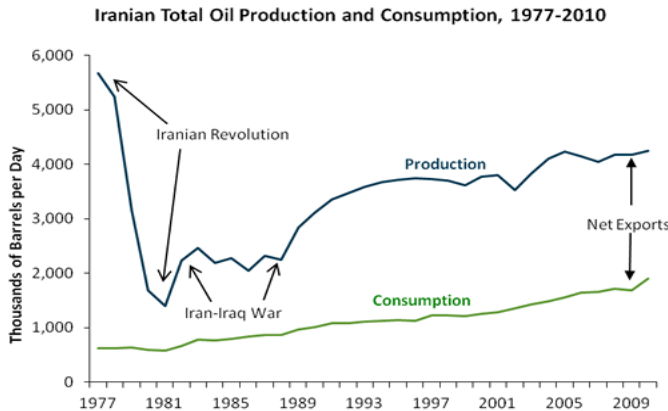
Source: EIA

# Gulf Oil and Energy Liquids Production: Recent and Projected

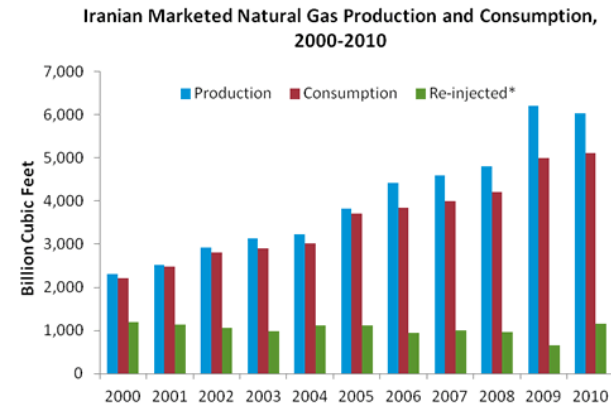


Source: U.S. Energy Information Administration, International Energy Outlook 2011

# Iran Energy Export Risks



Source: U.S. Energy Information Administration



Source: U.S. Energy Information Administration

\*not included in consumption data

## Key Risks

- Political instability, economic problems
- Sanctions
- Problems with domestic demand
- State barriers to investment
- Perceived as investment risk
- Refinery shortfalls
- Risk of conflict

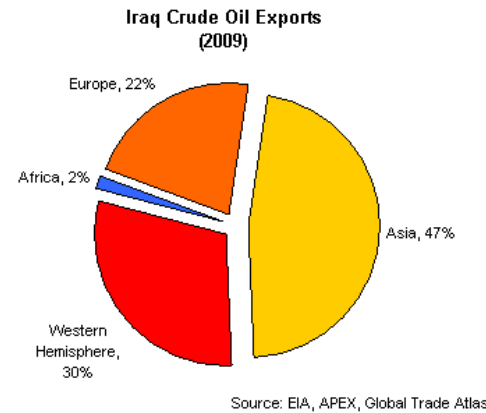
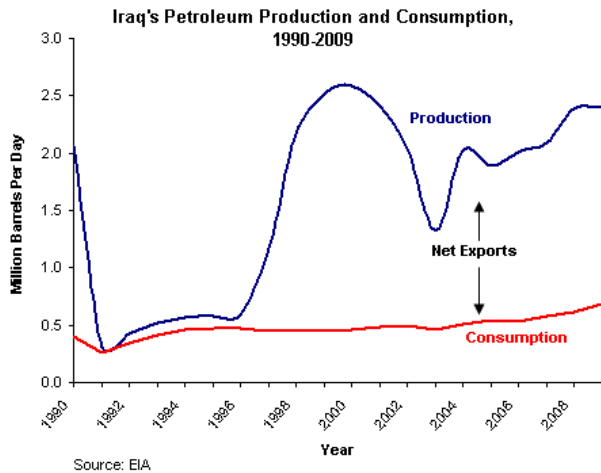
EIA estimates oil production capacity would drop from 4.1 MMB/D in 2009 to 3.9 MMB/D in 2035 – largely because of political and sanctions-related investment and development problems. The EIA does not seem to take these factors into consideration in its of natural gas production: These rise from 4.6 Tcf in 2009 to 7.8 Tcf in 2015, 7.4 Tcf in 2025, and 9.4 Tcf in 2035

In 2010, Iran exported approximately 2.2 million bbl/d of crude oil. Iranian Heavy Crude Oil is Iran's largest crude export followed by Iranian Light. In 2010, Iran's net oil export revenues amounted to approximately \$73 billion. Oil exports provide half of Iran's government revenues, while crude oil and its derivatives account for nearly 80 percent of Iran's total exports. Data through the end of June 2011 show that Iranian exports are on track to remain over 2.2 million bbl/d, should exports continue at the same pace for the second half of the year. Based on the 6-month data, China, India, South Korea, and Turkey have increased their imports of Iranian crude oil thus far this year, as crude oil volumes are reallocated to the countries that have imposed less stringent sanctions on them. At the same time, export volumes to Italy and the UK have decreased at least in part due to sanctions imposed on the Iranian energy sector. Iran's oil exports also have been affected by sanctions. In 2011, Iran experienced significant problems with receiving payments from India for its exports, when the Reserve Bank of India halted a clearing mechanism due to sanctions. Some of the payments have been cleared through Turkish and UAE. Iran is the second-largest oil consuming country in the Middle East, second only to Saudi Arabia. Iranian domestic oil demand is mainly for diesel and gasoline. Total oil consumption was approximately 1.8 million bbl/d in 2010, about 10 percent higher than the year before. Iran has limited refinery capacity for the production of light fuels, and consequently imports a sizeable share of its gasoline supply. Iran's total refinery capacity in January 2011 was about 1.5 million bbl/d, with its nine refineries operated by the National Iranian Oil Refining and Distribution Company (NIORDC), a NIOC subsidiary.

Iran's natural gas production has increased by over 550 percent over the past two decades, and the consumption has kept pace. As demand growth rates persist, the potential for shortfalls in natural gas supply grows. Iran's natural gas exports likely will be limited due to rising domestic demand, even with future expansion and production from the massive South Pars project, and other development projects.

In 2010, Iran produced an estimated 6 Tcf of marketed natural gas and consumed an estimated 5.1 Tcf. A sizeable volume of the gross natural gas produced (7.7 Tcf in 2010) was reinjected (1.2 Tcf). As Iran implements its plans for increased crude production through EOR techniques, however, the share of natural gas used for re-injection is expected to increase dramatically. Iran imports natural gas from its northern neighbor Turkmenistan. According to FGE imports jumped to 1.1 Bcf/d between January and October 2011 as a result of completion of the Daulatabad-Hasheminejad pipeline. Iran has been importing natural gas from Turkmenistan since 1997. Iran exports natural gas to Turkey and Armenia via pipeline. Turkey, an importer since 2001, received 762 MMcf/d in 2010, while exports to Armenia totaled 24 MMcf/d in 2010.

# Iraq Energy Export Risks



*EIA estimates oil production capacity to go from 2.4 MMB/D in 2009 to 6.3 MMB/D in 2035. EIA estimates Natural gas exports will rise from 0.0 Tcf in 2009 to 0.6 Tcf in 2035.*

## Key Risks

- Political instability, violence, AQIM, extremist groups
- Ethnic, sectarian tensions
- Kurdish issue
- State barriers to investment
- Perceived as investment risk
- Risk of conflict

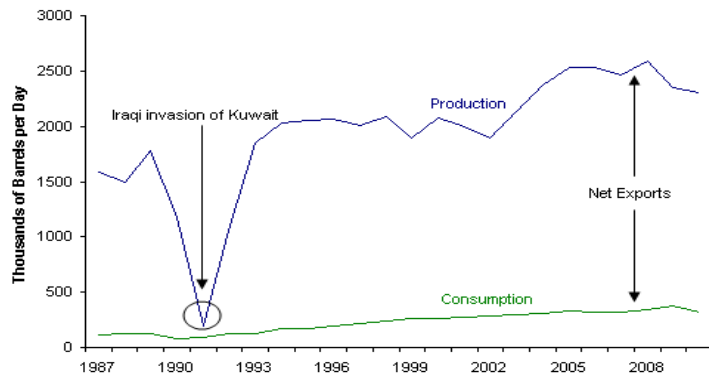
Iraq's crude oil production averaged 2.4 million barrels per day (bbl/d), about the same as 2008 levels, and below its pre-war production capacity level of 2.8 million bbl/d in 2003. About two-thirds of production comes from the southern fields, with the remainder from the north-central fields near Kirkuk. At present, the majority of Iraqi oil production comes from just three giant fields: North and South Rumaila in southern Iraq, and Kirkuk. Total effective export capacity is 2.5 million bbl/d, far lower than installed capacity because of disruptions, lack of maintenance, and because some facilities have been closed for years and are unlikely to be re-opened. Iraq exported 1.8 million bbl/d of crude oil in 2009. About 1.5 million bbl/d of this came from Iraq's Persian Gulf ports, with the rest exported via the Iraq-Turkey pipeline in the north. Iraq increases its liquids production by 3.7 percent per year in the *IEO2011* Reference case, the largest annual average growth in total liquids production among all OPEC members. The projection assumes that political, legislative, logistical, investment, and security uncertainties in Iraq will be resolved in the long term, and that OPEC constraints and resource availability will be the factors with the strongest influence on Iraq's willingness and ability to increase production.

In addition to political and legislative uncertainty, import and export infrastructure also are expected to limit production growth in Iraq to 0.6 million barrels per day from 2008 to 2015. If the country is able to achieve long-term political and economic stability and expand the capacity of import and export routes as projected in the Reference case, investment in production capacity could rise by an average of 4.2 percent per year from 2015 and 2030 before slowing to a more modest 3.0 percent per year from 2030 to 2035. The fact that Iraq has the resources necessary to support such growth in the long run, yet produced only 2.4 million barrels per day in 2008, illustrates the significant impacts that the political environment and other above-ground constraints can have on production projections.

Plans to export natural gas remain controversial due to the amount of idle and sub-optimally-fired electricity generation capacity in Iraq – much a result of a lack of adequate gas feedstock. Prior to the 1990-1991 Gulf War, Iraq exported natural gas to Kuwait. The gas came from Rumaila through a 105-mile, 400-MMcf/d pipeline to Kuwait's central processing center at Ahmadi. In 2007, the Ministry of Oil announced an agreement to fund a feasibility study on the revival of the mothballed pipeline. Iraq has eyed northern export routes such as the proposed Nabucco pipeline through Turkey to Europe, and in July 2009 Prime Minister Nouri al-Maliki suggested that Iraq could be exporting 530 Bcf per year to Europe by 2015. A second option is the Arab Gas Pipeline (AGP) project. The proposed AGP pipeline would deliver gas from Iraq's Akkas field to Syria and then on to Lebanon and the Turkish border sometime in 2010, and then on to Europe. Other proposals have included building LNG exporting facilities in the Basra region.

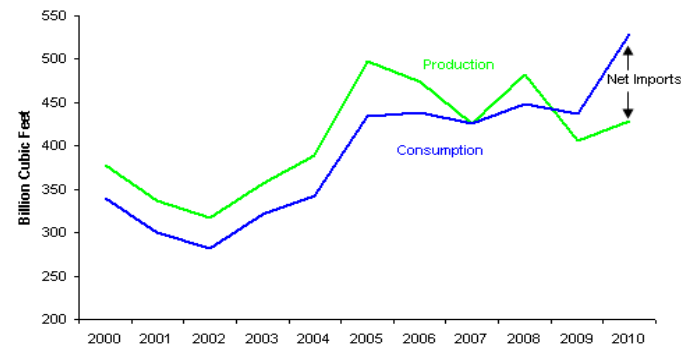
# Kuwait Energy Export Risks

Kuwaiti Oil Production and Consumption, 1987-2010



Source: EIA

Kuwaiti Natural Gas Production and Consumption, 2000-2010\*



Source: EIA

\*2010 estimate

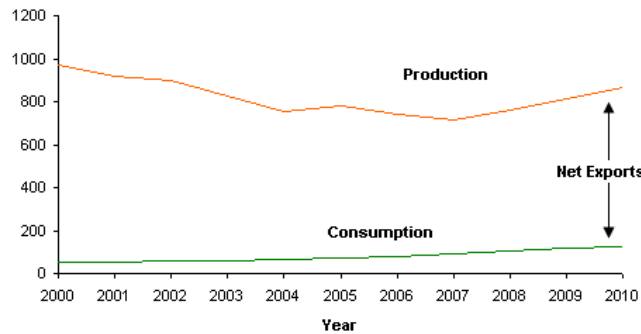
## Key Risks

- Threat from Iran
- Threat from Iraq? Sectarian issues?
- Poor petroleum sector development
- Overdependence on foreign labor
- Feuds in Royal Family?
- Dysfunctional legislature and service politics.

The EIA estimates, that Kuwait's oil production capacity will rise from 2.5 MMbbl/d in 2009 to 3.0 MMbbl/d in 2015, 3.3 MMbbl/d in 2025, and 4.0 MMbbl/d in 2035. In 2010, Kuwait's total oil production was approximately 2.5 million barrels per day (bbl/d), including its share of approximately 250,000 bbl/d production from the PNZ. Of the country's 2010 production, approximately 2.3 million bbl/d was crude and 200,000 bbl/d was non-crude liquids. Slightly over half of Kuwaiti crude production in 2010 came from the southeast of the country, largely from the Burgan field; production from the north has increased to approximately 800,000 bbl/d. As a member of OPEC, Kuwait's total production is constrained by the organization's production targets, which in 2010 meant the country maintained about 320,000 bbl/d of spare crude oil production capacity. KPC has initiated a \$90 billion expansion plan encompassing both the upstream and the downstream. Included in this are plans to upgrade Kuwait's production and export infrastructure and its tanker fleet, expand exploration, and build downstream facilities, both domestically and abroad, which is expected to boost oil production capacity to 4 million bbl/d by 2020. The Partitioned Neutral Zone (PNZ) encompasses a 6,200 square-mile area and contains an estimated 5 billion barrels of oil and 1 trillion cubic feet (Tcf) of natural gas. Oil production capacity in the PNZ is currently about 600,000 barrels per day, all of which is divided equally between Saudi Arabia and Kuwait. Kuwaiti exports of total oil amounted to some 1.8 million bbl/d, of which 1.7 million bbl/d was crude oil. Kuwait's gas reserves are not significant and this has spurred an extensive drive in natural gas exploration. Vast discoveries of non-associated gas in the north of the country attracted interest from international oil companies (IOCs) however unattractive contract structures and political uncertainty remain principal impediments to any rapid expansion of both reserves and production. Additionally, new discoveries are geologically more complex, being mainly tight and sour gas deposits which require more sophisticated and costly development. In 2010, Kuwait consumed approximately 529 Bcf of natural gas, which is equal to 1.45 Bcf/d. Since 2008, Kuwait has consumed more natural gas than it has produced. This has compounded the problem of electricity outages by making the availability of feedstock precarious. In 2010, Kuwait imported 270 MMcf/d of LNG, largely from regional neighbors, Yemen and Oman. Re-exports of LNG from Qatar via Abu Dhabi were also necessary, as Saudi Arabia disallowed a pipeline directly linking Kuwait with Qatar three years ago. Kuwait's electricity demand, the generation of which is fueled increasingly by natural gas, has outpaced natural gas production during the summer months, resulting in the shutdown of refinery and petrochemical operations to meet the increased demand of electricity.

# Oman Energy Export Risks

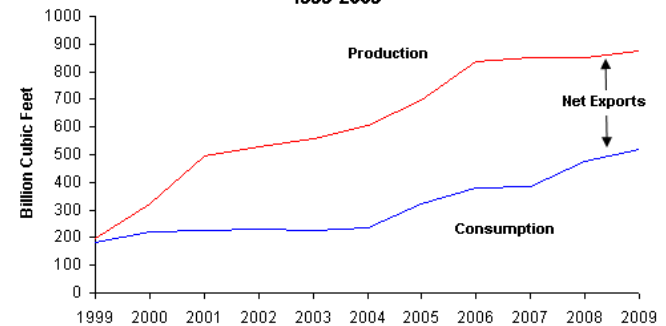
Omani Oil Production and Consumption, 2000-2010\*



Source: EIA International Energy Annual

\*2010 Consumption Estimate

Omani Natural Gas Production and Consumption, 1999-2009



Source: EIA

## Key Risks

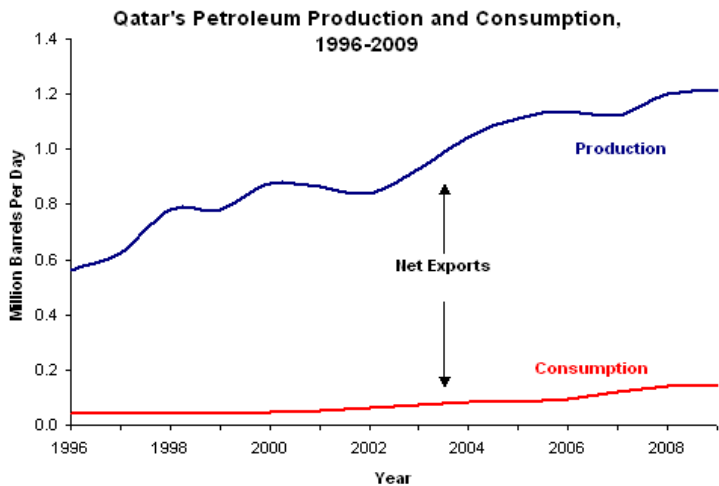
- Succession. Aging elite
- Threat from Iran
- Major demographic pressures
- Youth bulge and underemployment
- Overdependence on foreign labor
- Income distribution, cronyism
- Yemen?

The EIA estimates that oil production will slowly rise from 0.8 MMBD in 2009 to 1.0 MMBD in 2015, and then drop to 0.7 MMBD in 2025, and 0.6 MMBD in 2035 – but because of the limits of its reserves. Oman is a limited natural gas producer. Oman produced 863,000 barrels per day (bbl/d) of total petroleum liquids in 2010, 860,000 bbl/d of which was crude oil. Average oil production in Oman has increased by over 20 percent for the past three years, from a low of 714,000 bbl/d in 2007. In 2002, PDO initiated a review of its mature oil fields to determine the feasibility of enhanced oil recovery (EOR) techniques which would help boost production yet again. A massive EOR program was implemented, using varied techniques on a field-by-field basis, according to the geology. The future of Oman's oil sector is now dependent upon these EOR techniques. In 2009, Oman consumed approximately 115,000 bbl/d of petroleum products. Consumption has increased over the last decade, more than doubling from a level of 52,000 bbl/d in 2000. This has largely been attributable to Oman's industrialization and expanding petrochemical sector, along with better roadways and an expanding vehicle fleet. Though Oman is a significant net exporter of petroleum, they are not a member of OPEC. As is the case with other exports from the Gulf, Asia provides the main consumer markets for Omani crude, led by China and Japan.

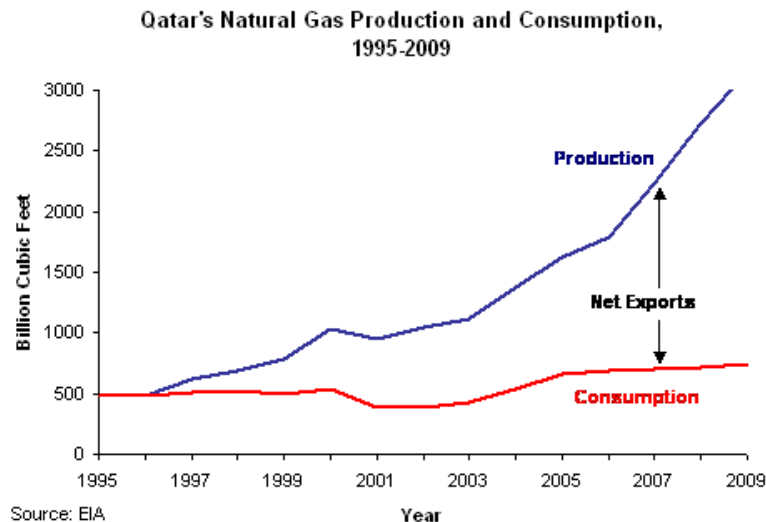
Oman produced a total of 875 billion cubic feet (Bcf) of natural gas, equal to about 2.4 billion cubic feet per day (Bcf/d) in 2010. Much of the remaining natural gas reserves are locked in geological formations that are smaller and more difficult to access. Natural gas consumption rose rapidly over the past decade, seeing a 135 percent increase from 1999 to a total of 520 Bcf in 2009. This increase is largely attributable to economic expansion and population growth, while re-injection of natural gas to increase oil production takes up a rising proportion of domestic production. A lack of natural gas resources has impeded progress in economic diversification, especially in the industrial sector. Although Oman is a net exporter of oil and natural gas, it also imports small volumes of natural gas. The Dolphin pipeline provides Oman's only natural gas imports, providing approximately 200 million cubic feet per day (Mcf/d). The Oman and Qalhat LNG projects are the sole source of natural gas exports from Oman, with a nameplate capacity of 506 Bcf per year, a daily average of 1,388 Bcf/d. In 2009, Oman exported a total of 408 Bcf. The gas for these projects is sourced from the Saih Rawl and Saih Nihayda gas fields in central Oman. The LNG exported from these projects is destined for Asian markets, principally South Korea and Japan. The Dolphin Pipeline system, which transports 2 billion cubic feet per day (Bcf/d) of natural gas from Qatar to neighboring UAE and eventually to Oman by way of the Fujairah –al-Ain pipeline, provides increasing natural gas supplies, around 200 Mcf/d, for use as feedstock in electricity generation. Before sanctions were implemented on Iran, Oman was also in talks with Iran over a pipeline which would bring 1 Bcf/d of natural gas from Iran's Kish gas field, with the possibility of increasing capacity to 3 Bcf/d. This natural gas pipeline would terminate at the Qalhat LNG plant for liquefaction and export. This would free domestic production to be connected to the domestic grid.



# Qatar Energy Export Risks



Source: EIA, *International Energy Statistics*



Source: EIA

## Key Risks

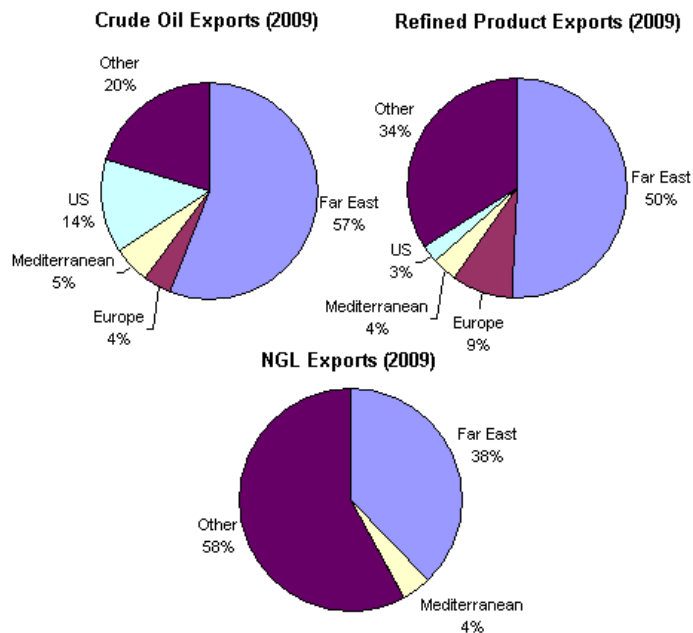
- Threat from Iran
- North Field Issues
- Overdependence on foreign labor
- Vulnerability of LNG Trains

The EIA estimates that Qatar's oil production capacity will rise from 1.2 MMBD in 2009 to 1.7 MMBD in 2015, 2.1 MMBD in 2025, and 2.2 MMBD in 2035. Qatar is one of the world's largest and most important gas exporter and the EIA estimates that its natural gas production will rise from 3.2 Tcf in 2009 to 6.3 Tcf in 2015, 7.4 Tcf in 2025, and 8.1 Tcf in 2035.

Qatar is the second smallest crude oil producer in OPEC, with its production exceeding only that of Ecuador. In 2009, Qatar produced approximately 1.2 million barrels per day (bbl/d) of total liquids: 830,000 bbl/d of crude and 380,000 bbl/d of non-crude liquids. Preliminary estimates for production in 2010 indicate total production of liquids to be about 1.4 million bbl/d: 850,000 bbl/d of crude and 590 bbl/d of non-crude liquids. The country's crude oil production capacity was estimated to be just over one million bbl/d in 2010, falling just below its condensate and natural gas liquids (NGL) production capacity for the same year. Qatar has three primary export terminals: Umm Said, Halul Island, and Ras Laffan. Ras Laffan is used mainly to export liquefied natural gas (see Natural Gas Section). The vast majority of Qatar's oil exports are sent to Asian economies. Japan is the single largest importer, though South Korea is also an important export market.

Qatar continues to expand natural gas production. In 2009, Qatar produced 3,154 billion cubic feet (Bcf) of natural gas, three times the amount produced in 2000. Although the increase in natural gas production fuels the growing natural gas requirements of domestic industry and its gas-to-liquids (GTL) projects, the bulk of this increase is going towards LNG exports. Qatar's natural gas consumption in 2009 was approximately 745 Bcf. During 2009, Qatar exported over 2,400 Bcf of natural gas, of which about 70 percent was liquefied natural gas (LNG). Qatar currently exports about 2 Bcf/d of natural gas to the UAE and Oman through the Dolphin pipeline. *Qatar is the world's leading LNG exporter:* Qatar is the world's leading LNG exporter. In 2009, Qatar exported nearly 1,800 Bcf of LNG. Japan, South Korea, and India were the primary destinations for Qatar's LNG exports, accounting for about 57 percent in 2009. European markets including Belgium, the United Kingdom and Spain were also significant buyers of Qatari LNG, accounting for an additional 33 percent.

# Saudi Energy Export Risks



Saudi Arabia remains the largest liquids producer in OPEC, with total production increasing from 10.7 million barrels per day in 2008 to 15.4 million barrels per day in 2035, as prices stabilize at historically high levels and world consumption continues to grow. Seventeen percent of the increase (0.8 million barrels per day) is expected to be NGPL production related to expansion of natural gas production. The total production increase equates to an average annual growth rate of 1.4 percent, based on the assumption that Saudi Arabia will continue with its current plan to maintain spare production capacity at levels between 1.5 and 2.0 million barrels per day. Iraq increases its liquids production by 3.7 percent per year in the *IEO2011* Reference case, the largest annual average growth in total liquids production among all OPEC members. The projection assumes that political, legislative, logistical, investment, and security uncertainties in Iraq will be resolved in the long term, and that OPEC constraints and resource availability will be the factors with the strongest influence on Iraq's willingness and ability to increase production.

Natural gas production in Saudi Arabia grows by an average of 2.3 percent per year, from 2.8 trillion cubic feet in 2008 to 5.2 trillion cubic feet in 2035. The Saudi national oil company, Saudi Aramco, has made several natural gas finds in the Persian Gulf that are not associated with oil fields. Three gas fields, the Karan, Arabiyah and Hasbah, are expected to begin producing in the next 5 years, adding at least 1.3 trillion cubic feet of production when fully operational. Both Arabiyah and Hasbah are offshore, and both are also sour natural gas fields, making them relatively expensive to produce, at an estimated cost of \$3.50 to \$5.50 per million Btu. The *IEO2011* Reference case assumes that Saudi Arabia's policy of reserving natural gas production for domestic use persists throughout the projection period, and that no natural gas is exported. Thus, in the long term, production is more dependent on domestic demand growth and domestic prices than on resource availability.

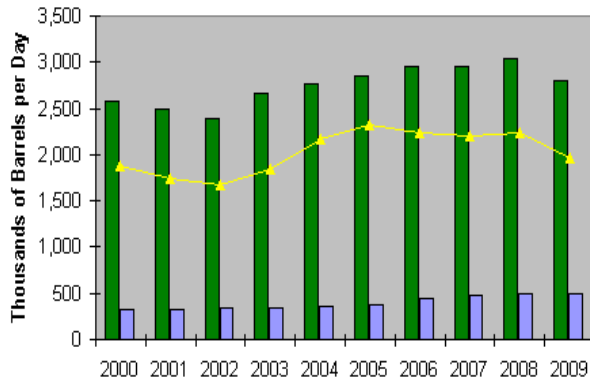
## Key Risks

- Threat from Iran, Yemen, AQAP
- Sectarian issues?
- Overdependence on foreign labor
- Need to meet popular expectations, youth needs for education and jobs.

Rapid reserve development of Saudi gas is necessary for Saudi Arabia's plans to fuel the growth of the petrochemical sector, as well as for power generation and for water desalination. Saudi Arabia had set a goal of meeting 10 percent of global petrochemical demand by 2015, with natural gas a primary feedstock. According to Saudi Aramco forecasts, natural gas demand in the kingdom is expected to more than double to 14.5 billion cubic feet per day (Bcf/d) by 2030, up from an estimated 7.1 Bcf/d in 2007. In order to free up petroleum for export, all current and future gas supplies (except natural gas liquids) reportedly remain earmarked for use in domestic industrial consumption and desalination. However, natural gas production (estimated at 2.7 Tcf in 2007) remains limited, as soaring costs of production, exploration, processing and distribution of gas have squeezed supply, while an estimated 13 to 14 percent of total production is lost to venting, flaring, reinjection and natural processes according to OPEC and other sources. Saudi Arabia has no net imports or exports of natural gas. According to Saudi Aramco, only 15 percent of Saudi Arabia has been "adequately explored for gas". Because most of its natural gas reserves are from associated gas, Saudi Arabia is constrained from boosting its gas production from these reserves because of OPEC crude oil production restraints. To meet growing domestic needs, the Petroleum Ministry and Saudi Aramco announced a \$9-billion strategy to add 50 Tcf of non-associated reserves by 2016 through new discoveries (and potentially another 50 Tcf of associated reserves).

# UAE Energy Export Risks

UAE Oil Production and Consumption, 2000-2009



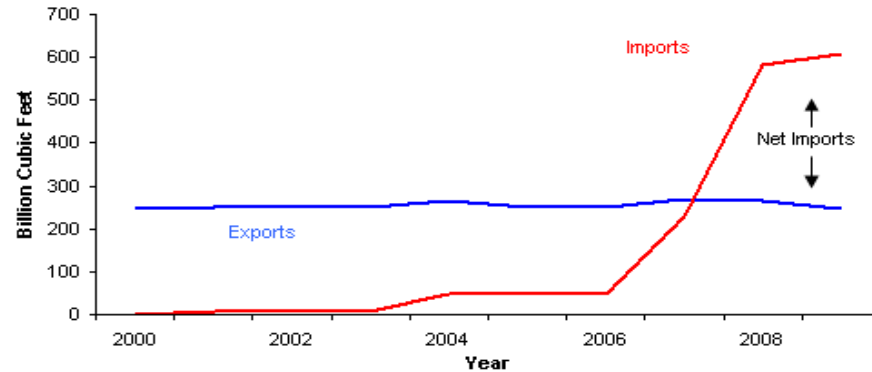
Source: EIA

## Key Risks

- Threat from Iran
- Overdependence on foreign labor
- Poor petroleum sector development
- Tensions and divisions in wealth between Emirates?
- Economic risks taking outside petroleum sector

Source: DOE/EIA, "UAE, Country Analysis," <http://205.254.135.7/countries/cab.cfm?fips=TC>.

UAE Natural Gas Trade Balance, 2000-2009

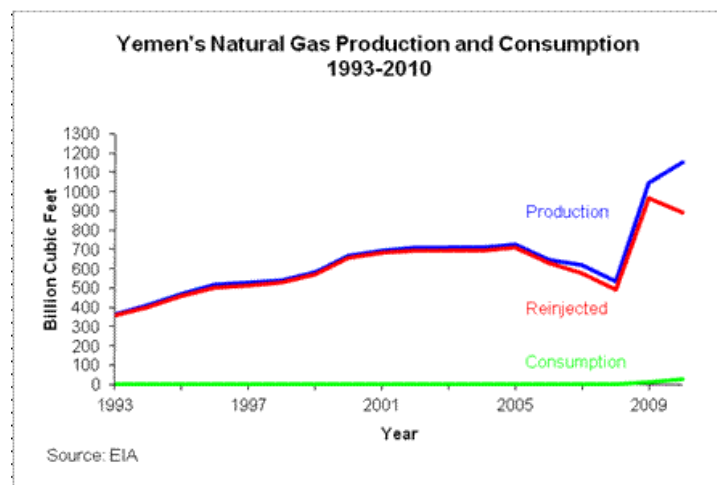
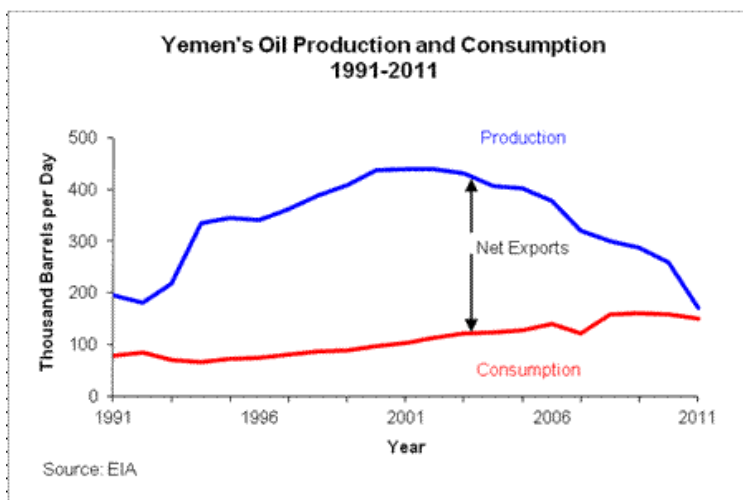


Source: EIA

The EIA estimates that UAE oil production capacity will rise from 2.8 MMB/D in 2009 to 3.6 MMB/D in 2015, then drop to 3.5 MMB/D in 2025, and 3.2 MMB/D in 2035. In 2010, the UAE produced approximately 2.81 million barrels per day (bbl/d) of total oil liquids, of which 2.3 million bbl/d was crude oil. Crude oil production capacity is currently estimated at 2.6 million bbl/d. However, increases in capacity have not affected production due to limits imposed by OPEC, which constrain UAE's production around the quota of 2.223 million bbl/d. The government has pushed back plans to increase capacity to 3.5 million bbl/d to 2018, pending acceptance of fellow OPEC members. Abu Dhabi, which have been in redevelopment to maximize output. The Umm Shaif and Lower Zakum offshore oil fields have a capacity of 520,000 bbl/d combined, although after an expansion at each they will have a production capacity of 425,000 bbl/d and 300,000 bbl/d, respectively. Two new oil fields have also come into development that will add a further 170,000 bbl/d capacity by 2018. Dubai and Sharjah produce relatively minor amounts of crude oil. Dubai adds 100,000 bbl/d from four separate fields, the older and more abundant Fateh and Southwest Fateh oil fields, with extra production from the Falah and Rashid fields. Sharjah's only significant oil field is the Mubarak field, which produces 60,000 bbl/d. Sharjah-based Crescent Petroleum operated this field for 35 years before handing control to the government in December 2009. In 2009, the UAE exported 2.32 million bbl/d, predominantly to Asian markets. Fujairah is rapidly expanding its export capability. A second oil terminal, composed of 3 moorings and a new 4-berth facility for tanker bunkering, has been built, as well as storage capacity and a 400,000 bbl/d terminal for refined products and petrochemicals, all of which are expected to be operational before the end of 2012. Due to its location on the coast of the Arabian Gulf, the UAE also has a number of ports for shipping its oil exports.

In 2009 the UAE exported 248 Bcf of natural gas whereas 609 Bcf (1.6 Bcf/d) were imported. This net deficit of 361 Bcf in natural gas will only continue to widen, unless new supplies are exploited. Despite the difficulties presented by such a concentration of sulfur, the government is advancing natural gas development in order to mitigate the amount necessary for importation and increase its volumes of sulfur exports. Exports are entirely in the form of liquefied natural gas (LNG) from the ADGAS project at Das Island. Imports are both piped and transported LNG, both mainly from Qatar. In 2001, Iran concluded an agreement spanning 25 years with Crescent Petroleum to build a subsea natural gas pipeline. This pipeline would deliver 525 million cubic feet per day (Mcf/d) to Sharjah and Dubai and allow some spare feedstock for times of peak electricity demand. Although the project was to come on-stream in 2005 and despite Crescent maintaining its development obligations, Iran refused to proceed without renegotiating the price, which had increased so much by 2005 that the Iranian parliament blocked the start-up. Crescent has announced that arbitration will be sought in the matter

# Yemen Energy Export Risks



## Key Risks

- Political upheavals economic unrest
- Ongoing civil conflict: Houthi rebels, AQAP
- Growing domestic demand
- State barriers to investment
- Perceived as investment risk
- Growing tension between north and south

The EIA estimates that Yemeni oil production capacity will drop from 0.3 MMBD in 2009 to 0.23 MMBD in 2015, 0.1 MMBD in 2025, and 0.1 MMBD in 2035

In 2011, Yemen's total oil production averaged about 170,000 barrels per day (bbl/d), down from 259,000 bbl/d estimated for 2010. Production has been declining steadily since reaching a peak of 440,000 bbl/d in 2001 due to a lack of sufficient new investment in exploration and inadequate maintenance of facilities. In 2011, anti-government strikes, attacks on pipelines, and the evacuation of foreign staff combined to reduce annual production to below 200,000 bbl/d. In March, the main crude oil export pipeline from the Marib and Shabwa fields to the Ras Isa terminal was blown up and remained offline until mid-July. In May, oil exports were reported by the Centre for Global Energy Studies as being less than 70 percent of their normal level. Further attacks on the pipeline occurred and by January 2012, Yemen was reliant on crude and product imports as its main refinery was shut in November.

Yemen has twelve main producing blocks, operated by nine international oil companies. Production at Norwegian DNO International's Block 47 began in 2011, despite the security situation in the country. In 2010, thirty-two blocks were under exploration by 16 oil companies in partnership with Yemen Oil Company. Exploration saw relative success in 2010, with discoveries announced at several blocks. Yemen had total oil exports of 108,000 bbl/d and total domestic consumption of 157,000 bbl/d in 2010, according to EIA estimates. Asian markets account for the majority of Yemen's oil exports. With growing domestic consumption and decreasing production, net exports are on a declining trend. Yemen imports some refined products: in 2008, the most recent data available, gross imports of refined products were estimated at 62,000 bbl/d, mainly distillate and residual oils, while 18,000 bbl/d of products were exported.

According to Cedigaz estimates, Yemen exported a total of 194 Bcf of LNG in 2010. The principal buyers were South Korea (38 percent), the United States (20 percent), and China (13 percent). According to Reuters, Yemen was able to meet all contractual commitments in 2011, despite the mid-October sabotage to the pipeline supplying the LNG facility. The Yemen LNG project at the port of Balhaf on the Gulf of Aden became commercially operational in October 2009. At a cost of \$4.5 billion, Yemen LNG is the largest industrial project in the country.

# The Bab El Mandab



**The Strait of Bab el-Mandab is a chokepoint between the horn of Africa and the Middle East, and a strategic link between the Mediterranean Sea and Indian Ocean. It connects the Red Sea with the Gulf of Aden and the Arabian Sea. Most exports from the Persian Gulf that transit the Suez Canal and SUMED pipeline also pass through the Bab el-Mandab.**

**An estimated 3.2 million bbl/d flowed through this waterway in 2009 (vs. 4 million bbl/d in 2008) toward Europe, the United States, and Asia. The majority of traffic, about 1.8 million bbl/d, moved northbound through the Bab el-Mandab en route to the Suez/SUMED complex.**

**The Bab el-Mandab is 18 miles wide at its narrowest point, making tanker traffic difficult and limited to two 2-mile-wide channels for inbound and outbound shipments. Closure of the Strait could keep tankers from the Persian Gulf from reaching the Suez Canal or Sumed Pipeline, diverting them around the southern tip of Africa. This would effectively engage spare tanker capacity, and add to transit time and cost.**

**The Strait of Bab el-Mandab could be bypassed via the East-West oil pipeline, which crosses Saudi Arabia with a nameplate capacity of 4.8 million bbl/d. However, southbound oil traffic would still be blocked. In addition, closure of the Bab el-Mandab would block non-oil shipping from using the Suez Canal, except for limited trade within the Red Sea region. In recent years, this region has also seen rising piracy, and Somali pirates continue to attack vessels off the northern Somali coast in the Gulf of Aden and southern Red Sea including the Bab el-Mandab.**

# *Closing the Gulf*

# Introduction

There is no way to assign a probability to a conflict or crisis in the Gulf that is triggered by the confrontation between Iran and the US, EU, and many Arab states over Iran's nuclear and missile programs, and by the steady build up of military forces in the Gulf. Iran has, however, made threats to "close the Gulf" over these issues. Moreover, in late December 2011 and early January 2012, Iran carried out military drills in the Gulf to demonstrate its stated capability to close the Strait of Hormuz, made threatening statements about the presence of the US' 5<sup>th</sup> Fleet in the region, and the Iranian parliament is considering a bill that would prohibit the presence of foreign warships in the Gulf without the permission of the Iranian navy.

## Iranian Threats to Close The Gulf

While Iran quickly backed down in regard to the movement of US navy warships through the Gulf, even a few excerpts from Iranian statements illustrate the risks involved:

*"Should the enemies desire to use the method and spirit of threats, we will naturally also threaten them. The (military) exercise by the armed forces of the Islamic Republic of Iran's Islamic Revolution, in fact, expresses the will to act against various types of threats that are targeting our national security."* - Hossein Salami, Revolutionary Guards Deputy, February 7, 2012. <http://www.farsnews.com/newstext.php?nn=13901118000917>

*"[T]he recent statements made by the US and the West about the Strait of Hormuz shows that they are frightened by the awe of the (Islamic) Revolution, otherwise the Iranian nation considers the Strait of Hormuz as the strait of peace. However, the Iranian nation is determined to cut the hand of those who seek adventurism in the Persian Gulf, the Sea of Oman and the Strait of Hormuz."* – Ali Larijani, Speaker of Iranian Parliament, February 1, 2012. <http://english.farsnews.com/newstext.php?nn=9010173255>

*"Tehran will not remain indifferent to US mischief in the region if Washington tries to cause problems for regional countries. The Strait of Hormuz is a region of peace and Iran has protected its peace for centuries and will continue to do so in order to maintain calm in it,"*-Ali Larijani, Speaker of Iranian Parliament, January 31, 2012. <http://www.presstv.ir/detail/223919.html>

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*"The US has given a role to Saudi Arabia, Qatar and Turkey to direct the regional developments in a way that they move towards these countries' interests in line with the US policies and opposite to Iran's policies. Owing to the fact that Iran's Islamic Revolution serves as a role model for the regional and world nations in their fight against the tyranny of their rulers and arrogant powers, the US and its allies are attempting to prevent Tehran's further political influence in the region."* - Major General Yahya Rahim Safavi, Senior Military Aide to the Supreme Leader, January 31, 2012. <http://english.farsnews.com/newstext.php?nn=9010173133>

*"The United States did not dare to direct its aircraft carrier through the Strait of Hormuz alone; this is why the carrier was "escorted" by military vessels of other nations. If the Strait is closed, the aircraft carriers will become the war booty of Iran."* - Javad Karimi Qodousi, parliamentary National Security Committee member, January 24, 2012.

<http://www.isna.ir/ISNA/NewsView.aspx?ID=News-1935908&Lang=P>

*"There is no decision to block and close the Strait of Hormuz unless Iran is threatened seriously and somebody wants to tighten the noose. All the options are on the table."* - Mohammad Khazaei, Iranian Ambassador to the United Nations, January 19, 2012.

<http://www.bloomberg.com/news/2012-01-19/iran-s-un-envoy-says-closing-strait-of-hormuz-is-an-option-if-threatened.html>

*"Our capability to provide security in the region, specially the Strait of Hormuz during sensitive times, will not experience any change due to the western warships' trafficking in the region."* -Gholam Reza Karami, Iranian lawmaker and Chairman of the Parliamentary Defense Committee, January 16, 2012. <http://english.farsnews.com/newstext.php?nn=9010171403>

*"Today the Islamic Republic of Iran has full domination over the region and controls all movements within it."* - Navy Rear Admiral Ali Fadavi, Commander of Iran's Islamic Revolution Guards Corps (IRGC), January 6, 2012.

<http://english.farsnews.com/newstext.php?nn=9007270592>

*"The Zolfaqar vessel is considered as a new model of the vessels of the same class which is capable of conducting operations in different marine conditions thanks to its sea-to-sea missiles and proper speed. The sea-to-sea cruise missile with high destructive capability and targeting power has immensely increased the vessel's power."* -Brigadier General Ahmad Vahidi , Iranian Defense Minister, January 2, 2012. <http://english.farsnews.com/newstext.php?nn=9007279956>

*"Iran has total control over the strategic waterway. Closing the Strait of Hormuz is very easy for Iranian naval forces."* -Rear Admiral Habibollah Sayyari, Iran's naval commander, December 28,

2011. <http://www.nytimes.com/2011/12/29/world/middleeast/noise-level-rises-over-iran-threat-to-close-strait-of-hormuz.html? r=2>

*"If they impose sanctions on Iran's oil exports, then even one drop of oil cannot flow from the Strait of Hormuz."* - Mohammad-Reza Rahimi, Iran's first vice president, December 27, 2011.

<http://www.nytimes.com/2011/12/28/world/middleeast/iran-threatens-to-block-oil-route-if-embargo-is-imposed.html?pagewanted=all>

*"Closure of the Strait of Hormuz is not on the Islamic Republic of Iran's agenda (at present), but if threats against Iran come to trample upon the rights of our nation while others use the strait for exporting their oil, then Iran will be entitled to the right to close the Strait of Hormuz. The international conventions reserve such rights for the Islamic Republic of Iran as well. For the time being, the Islamic Republic of Iran has not decided to close the strait, but this (closing the strait) depends on the conditions of the region."* - Mohammad Taqi Rahbar, Iranian lawmaker, December 19, 2011.

<http://english.farsnews.com/newstext.php?nn=9007277986>

*"According to the international laws, including Paragraph 4 of Article 14 of the Geneva Convention, in case Iranian oil is sanctioned, we will not allow even a single barrel of oil to pass through to reach the hostile countries".* -Isa Jafari, Senior Iranian lawmaker, December 18, 2011. <http://english.farsnews.com/newstext.php?nn=9007277872>



# *Closing the Gulf: The Conditions that Shape Military Energy Risk:*

*The Challenge of Export Vulnerability: Petroleum  
Exports, Key Infrastructure, and Key Imports*

## Closing the Gulf: Conflict, Negotiations, or An Open-ended Arms Race?

While it is not possible to make any meaningful prediction of the timing, nature, or intensity of a conflict in the Gulf, it is possible to illustrate the options, the Iranian forces involved, and the kinds of escalation that might take place.

- **Risk to Gulf Liquids Production by Country Through 2035:** Petroleum production capacity is a rough measure of Gulf export capacity, although four Gulf states are major gas producers, and growing domestic consumption limits export capability, as does an increase focus on down stream product exports. A future conflict with Iran might involve any combination of Gulf states over different periods of time. EIA estimates indicate, however, that any serious interruption in Gulf supply would affect roughly 30% of World liquids production through 2035. Since importer would compete on a world market, subject to existing contracts when a conflict began, it is not possible to estimate the impact on national economies or the global economy in any detail. It is clear, however, that Asian states are exceptionally dependent on Gulf oil and gas exports, and that any contingency this broad would so threaten the global economy that it would almost certainly lead to a massive military response to both secure Gulf exports and ensure that Iran could not repeat such a threat at any point in the foreseeable future.
- **Most Alternative Routes Have Little or No Surplus Capacity or Are Not Operating:** The Gulf is a unique chokepoint, largely because there no clear alternative routes that are not currently being used or that would take impractical time periods to activate. According to EIA online reporting as off March 2012:
  - The Saudi Trans-Arabian Pipeline (Tapline) from Qaisumah to Sidon, Lebanon, completed in 1974, has been mothballed, in part, since 1984 (the portion to Jordan was closed in 1990, through there has been talk of reopening this portion). Also, a 1.65 million-bbl/d, 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) to the port of Mu'ajjiz, just south of Yanbu, was built in 1989, but closed indefinitely following the August 1990 Iraqi invasion of Kuwait. In June 2001, Saudi Arabia seized ownership of IPSA. Theoretically, IPSA could be used for Saudi oil transport to the Red Sea, although the Saudis have reported that the pipeline has been converted to carry gas as part of the Master Gas System. A private Saudi company has offered to rehabilitate the IPSA oil pipeline, but this idea has not gone beyond the proposal state.
  - Two trans-national pipelines across Syria have been built to transport oil from Saudi Arabia and Iraq to terminals on the Mediterranean. The 500,000 bbl/d Tapline was built during the 1940's to transport Saudi crude oil to an export terminal in Lebanon, but was closed during the 1970's because it had become uneconomical. Proposals have been made to rehabilitate the Tapline, but the pipeline remains closed. The second was built during the 1950's to transport oil from Kirkuk in northern Iraq to the Baniyas terminal in Syria and to Tripoli in Lebanon. This approximately 800 kilometer (500 mile) pipeline system had been re-habilitated in 2000, but closed in 2003 during the war in Iraq. Syrian and Iraqi ministers have discussed rehabilitating this pipeline, as well as building new ones. In June 2011, Syria and Iraq signed yet another Memorandum of Understanding to repair the existing 800,000 bbl/d pipeline system, and to build two new ones, including a 1.5 million bbl/d pipeline to carry heavy Iraqi crude oil, as well as a 1.25 million bbl/d pipeline to transport light crude oil from Iraq.

- Iraq has one major crude oil export pipeline, the Kirkurk-Ceyhan (Iraq-Turkey) pipeline, which transports oil from the north of Iraq to the Turkish Mediterranean port of Ceyhan. This pipeline has been subject to repeated disruptions this decade, limiting exports from the northern fields. Iraq signed an agreement with Turkey to extend the operation of the 1.6 million bbl/d pipeline, as well as to upgrade its capacity by 1 million bbl/d. In order for this pipeline to reach its design capacity, Iraq would need to receive oil from the south via the Strategic Pipeline, which was designed to allow flows of crude oil from the south of Iraq to go north via Turkey, and vice-versa. Iraq has proposed building a new strategic line from Basra to the northern city of Kirkuk, with the line consisting of two additional crude oil pipelines. The Iraq-Syria-Lebanon Pipeline has been closed and the Iraqi portion reported unusable since the 2003 war in Iraq. Discussions were held between Iraqi and Syrian government officials to re-open the pipeline, which had a design capacity of 700,000 bbl/d, although actual volumes never reached this level. The Russian company Stroytransgaz accepted an offer to fix the pipeline in December 2007, but no follow-up was made. Iraq and Syria have discussed building several new pipelines, including a 1.5 million bbl/d pipeline carrying heavy crude oil, and a 1.25 million bbl/d pipeline for carrying light crudes. The 1.65 million bbl/d Iraq Pipeline to Saudi Arabia (IPSA) has been closed since 1991 following the Persian Gulf War. There are no plans to reopen this line.
  - The UAE has the largest export pipeline project in development: the Abu Dhabi Crude Oil Pipeline (ADCOP) Project. The International Petroleum Investment Corporation (IPIC) is spearheading the project, along with the China Petroleum Engineering & Construction Corporation (CPECC), a subsidiary of the China National Petroleum Corporation (CNPC). The 230-mile pipeline is scheduled for completion by August 2011 and will transport 1.5 million bbl/d from ADCO's Habshan facility to the Fujairah export terminals. This will allow more than half of UAE's exports to bypass the strategic chokepoint at the [Strait of Hormuz](#). This pipeline's capacity, however, will soon be exceeded by increases in Gulf oil production, and the export terminals are potentially vulnerable to Iran.
  - Oman's pipeline system is mostly focused on delivering crude oil to the country's only oil export terminal at Mina al-Fahal. Located near the capital, Muscat, both the export terminal at Mina al-Fahal and the Main Oil Line feeding the facilities are run by PDO. Pipelines also feed industrial complexes and petrochemical plants, which form an integral part of economic diversification and Oman's expansion into downstream activities. PDO operates about 1,000 miles of oil pipelines which run throughout the country.
- **Hormuz: Breaking the Bottle at the Neck:** This makes the Strait of Hormuz is the world's most important oil chokepoint due to its daily oil flow of almost 17 million barrels in 2011, up from between 15.5-16.0 million bbl/d in 2009-2010. Flows in 2011 were roughly 35 percent of all seaborne traded oil, or almost 20 percent of oil traded worldwide.
  - **Abu Musa:** Abu Musa in one of three islands in the Gulf shipping channels that Iran seized from the UAE. A satellite photo shows Iran has built a major air strip on the island and it can rapidly deploy force, mines, and anti-ship missiles.
  - **But, Bottles Don't Need to be Broken at the Neck: Vulnerability of Gulf Oil & Gas Fields:** That said, conflict can occur anywhere in the Gulf and even low-level threats and "wars of attrition" can affect petroleum cost and tanker movements, put political pressure on Gulf states, focus on key coastal or off-shore loading areas and targets.

- **Iran's Energy Access to the Gulf:** Each Gulf country faces a different problem in terms of its distance from the Strait, tanker and shipping routes, dependence on the free movement of ships through the Gulf. As the “tanker war” of 1987-1988 demonstrates, it also is not clear that Iran could not single out a given country for attack. Iran too, however, is vulnerable. It needs to export, it needs product and other imports, and it has no major alternatives to the Strait.
- **Iran's Strategic Depth:** Iran does, however, have an advantage that most Gulf states lack. It has considerable strategic depth, as well as mountains near its coast that limit radar coverage of its air operations. Some targets in Iran are more than 500 miles from the coast – a long distance for strike fighters. Others are well over 500 miles from the nearest entry point Israel could use in preventive attacks. Moreover, Iran has vast spaces in which to conceal missiles, disperse forces, and secret nuclear facilities, and 2,440 kilometers of coastline to conceal small ships and other naval asymmetric forces, as well as numerous islands and offshore facilities.
- **The Military Geography of the Strait of Hormuz:** The military geography of the Gulf raises additional issues. The Strait of Hormuz is only part of the “chokepoint” at the entry to the Gulf. Tanker channels extend nearly 100 miles to the West part Iranian and Iranian held Islands. Long-range anti-ship missiles can be land based and target by small craft in the Gulf. As is the case in the rest of the Gulf – which is never deeper than the length of US nuclear attack submarine --Current and depth affect mine operations and submersible operations, and “noise” can conceal submarines and submersibles.
- **Vulnerability of the Upper Gulf:** As became all too clear during the Iran-Iraq War, the upper Gulf present special vulnerability problems, particularly for Kuwait and Iraq which have small coast lines, limited export terminals, and relatively shallow waters. There are many facilities and areas where Iran can deploy small ships and elements of its Revolutionary Guards, and free floating or moored mines can present major challenges.
- **Vulnerability of the Arabian Sea:** Iran is not limited to operating in the Gulf. It can use its submarines best in the Gulf of Oman and Arabian Sea. It can use its long-range patrol aircraft, UAVs/UCAVs, smart mines, small craft with or without anti-ship missiles, and long-range guided torpedoes.
- **Iranian Gulf Military Installations:** There are no accurate unclassified lists of Iranian military facilities in the Gulf, but even a partial list shows that Iran has facilities along its entire coastline inside and outside the Gulf.
- **Saudi Arabian Oil Vulnerability:** Saudi Arabia not only has major oil loading facilities, but many offshore targets, and major facilities where it runs a risk of raids or sabotage. The military geography of the Gulf extends beyond the coastline and include civil as well as petroleum and military facilities.

- **Ras Tanura** is a critical Saudi oil export facility. A satellite photo shows it provides both a larger area target and a facility where a precision attack or sabotage could do major damage. The Ras Tanura complex alone has approximately 6 million bbl/d capacity, and is the world's largest offshore oil loading facility. It includes the 2.5-million bbl/d port at Ras Tanura. More than 75 percent of exports are loaded at the Ras Tanura Facility. Saudi Arabia does, however, also have The Yanbu' terminal on the Red Sea, from which most of its remaining 25 percent is exported, with a loading capacity of approximately 4.5 million bbl/d crude and 2 million bbl/d for NGL and products. The facility is reportedly not used to full capacity. These and a dozen other smaller terminals throughout the country, appear capable of exporting up to 14-15 million bbl/d of crude and refined products, 3-4 million bbl/d higher than Saudi Arabia's current crude oil production capacity
- **Desalination Plant.** The Southern Gulf states have a unique vulnerability in that their water and much of their power comes from desalination plants, and there is no quick way to ship in or truck water. Iran, however, also has a major vulnerability in its refineries and gas and electric grids.

# Risk to Gulf Liquids Production by Country Through 2035

(Million Barrels Per Day)

Region/country	History (estimates)			Projections					Average annual percent change, 2008-2035
	2007	2008	2009	2015	2020	2025	2030	2035	
<b>OPEC*</b>	<b>34.4</b>	<b>35.6</b>	<b>33.4</b>	<b>38.6</b>	<b>40.8</b>	<b>43.1</b>	<b>45.0</b>	<b>46.9</b>	<b>1.0</b>
<b>Middle East</b>	<b>23.1</b>	<b>24.2</b>	<b>22.5</b>	<b>27.0</b>	<b>28.9</b>	<b>31.2</b>	<b>33.3</b>	<b>35.2</b>	<b>1.4</b>
Iran	4.0	4.2	4.1	4.0	3.8	3.7	3.8	3.9	-0.3
Iraq	2.1	2.4	2.4	2.9	3.6	4.5	5.5	6.3	3.7
Kuwait	2.6	2.7	2.5	3.0	3.1	3.3	3.7	4.0	1.4
Qatar	1.1	1.2	1.2	1.9	2.1	2.3	2.5	2.5	2.7
Saudi Arabia	10.2	10.7	9.6	11.6	12.8	13.9	14.6	15.4	1.4
United Arab Emirates	2.9	3.0	2.8	3.6	3.5	3.5	3.3	3.2	0.2
<b>North Africa</b>	<b>4.0</b>	<b>4.1</b>	<b>3.9</b>	<b>3.5</b>	<b>3.4</b>	<b>3.4</b>	<b>3.3</b>	<b>3.2</b>	<b>-0.9</b>
Algeria	2.2	2.2	2.1	2.6	2.7	2.6	2.5	2.3	0.3
Libya	1.8	1.9	1.8	0.9	0.7	0.7	0.8	0.8	-3.0
<b>Middle East (Non-OPEC)</b>	<b>1.5</b>	<b>1.5</b>	<b>1.5</b>	<b>1.6</b>	<b>1.4</b>	<b>1.3</b>	<b>1.1</b>	<b>1.1</b>	<b>-1.3</b>
Oman	0.7	0.8	0.8	1.0	0.8	0.7	0.6	0.6	-1.1
Syria	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	-1.9
Yemen	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	-3.3
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.6
<b>Gas-to-Liquids</b>									
Qatar	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	15.5
<b>Total world</b>	<b>84.9</b>	<b>85.7</b>	<b>83.9</b>	<b>93.3</b>	<b>97.6</b>	<b>103.2</b>	<b>108.0</b>	<b>112.2</b>	<b>1.0</b>
OPEC share of world production	40%	42%	40%	41%	42%	42%	42%	42%	
Persian Gulf share of world production	27%	28%	27%	29%	30%	30%	31%	31%	

\*OPEC=Organization of the Petroleum Exporting Countries (OPEC-13).

Note: Conventional liquids include crude oil and lease condensates, natural gas plant liquids, and refinery gains.

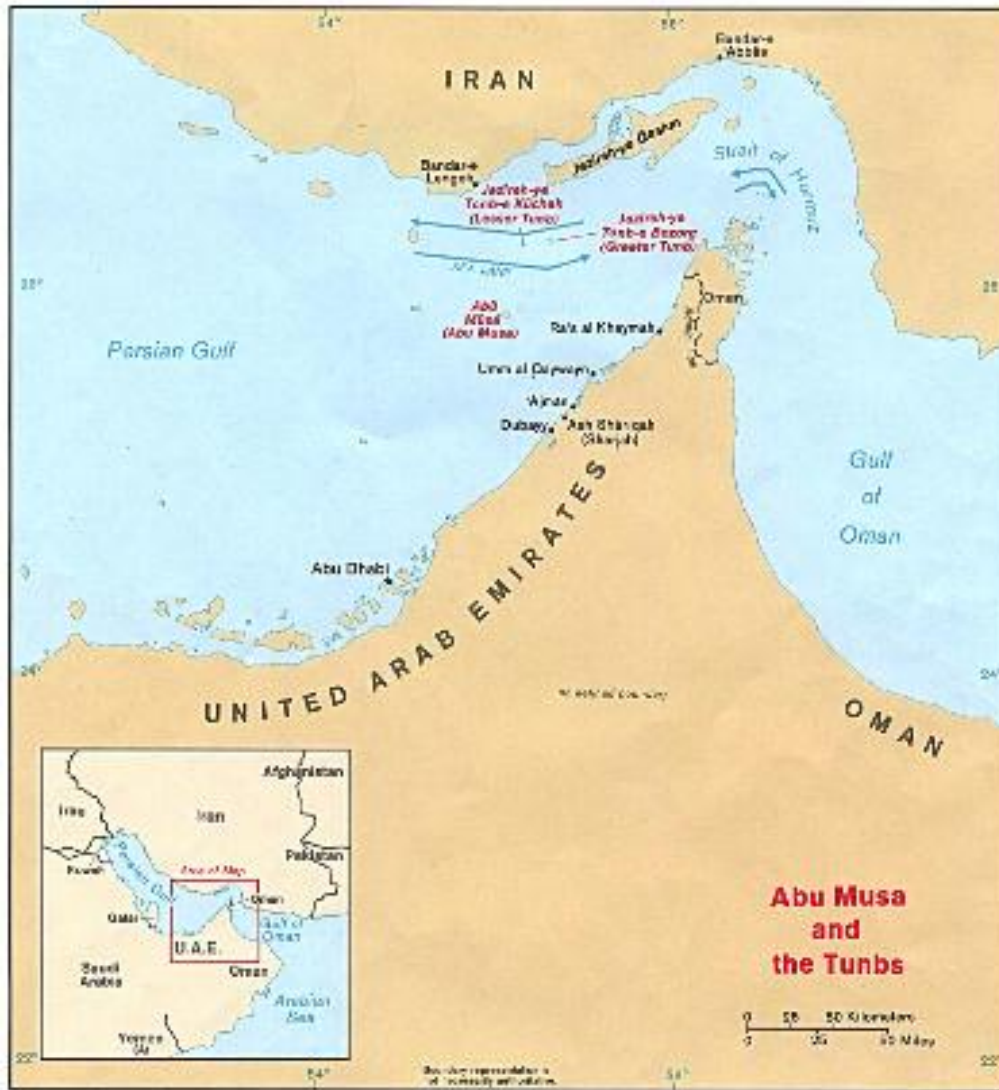
Sources: History: U.S. Energy Information Administration (EIA), Office of Energy Markets and End Use. Projections: EIA, Generate World Oil Balance Model (2008).

Selected Oil and Gas Pipeline Infrastructure in the Middle East



Most Alternative Routes to the Straits of Hormuz Have Little or No Surplus Capacity or Are Not Operating

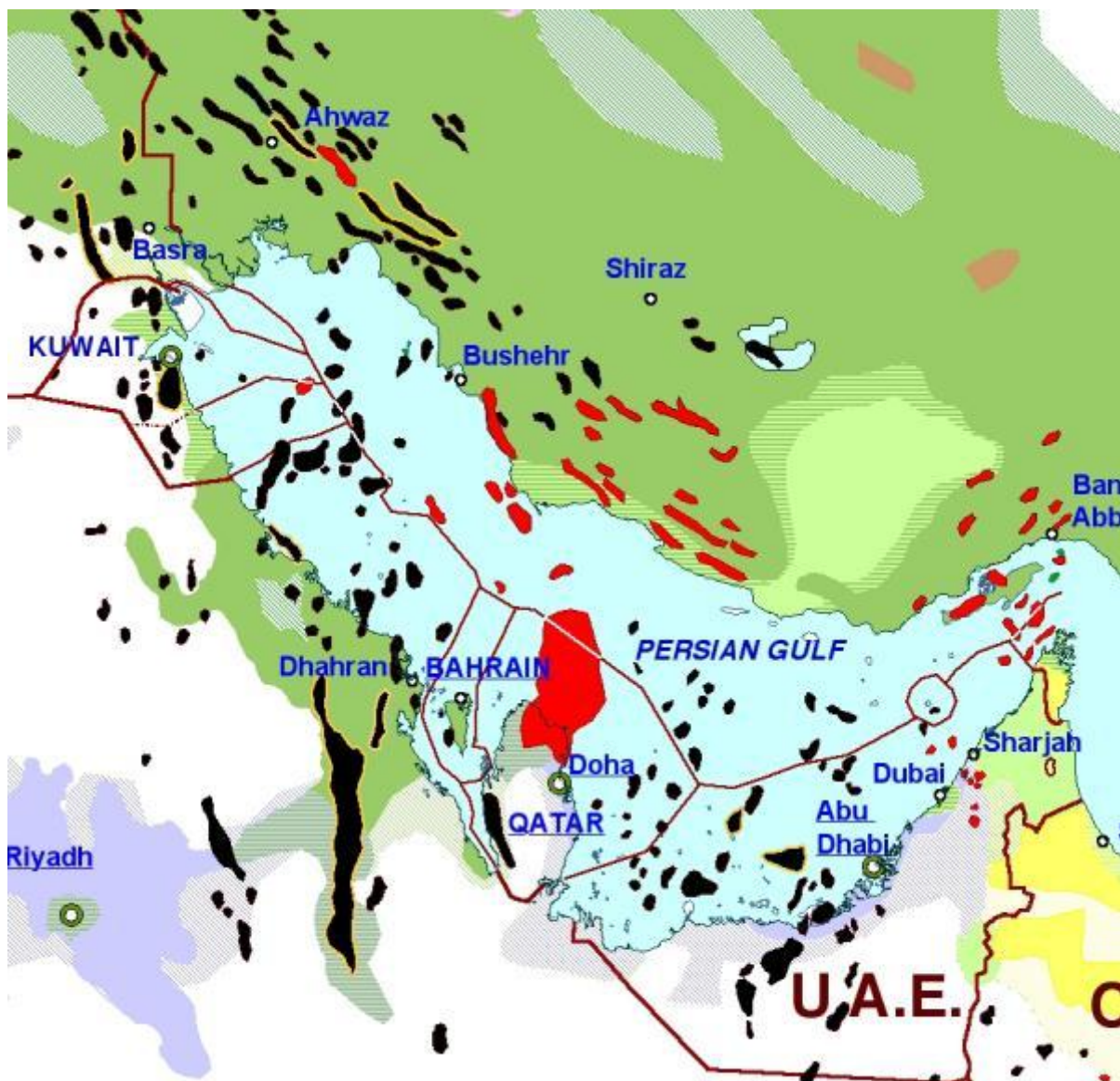
# Hormuz: Breaking the Bottle at the Neck






- In 2011, total world oil production amounted to approximately 88 million barrels per day (bbl/d), and over one-half was moved by tankers.
- Strait of Hormuz is the world's most important oil chokepoint due to its daily oil flow of almost 17 million barrels in 2011, up from between 15.5-16.0 million bbl/d in 2009-2010.
- Flows in 2011 were roughly 35 percent of all seaborne traded oil, or almost 20 percent of oil traded worldwide.
- On average, 14 crude oil tankers per day passed through the Strait in 2011, with a corresponding amount of empty tankers entering to pick up new cargos. More than 85 percent of these crude oil exports went to Asian markets, with Japan, India, South Korea, and China representing the largest destinations.
- At its narrowest point, the Strait is 21 miles wide, but the width of the shipping lane in either direction is only two miles, separated by a two-mile buffer zone. The Strait is deep and wide enough to handle the world's largest crude oil tankers, with about two-thirds of oil shipments carried by tankers in excess of 150,000 deadweight tons.
- Closure of the Strait of Hormuz would require the use of longer alternate routes at increased transportation costs.










# But, Bottles Don't Need to be Broken at the Neck: Vulnerability of Gulf Oil & Gas Fields






**Primary Oil and Gas Deposits in the Middle East and the Shia Majority Areas.**

-  A Major Oil field
-  A Super-Giant Oil field
-  A Major Gas field

**Islam:**

-  Shiism (to include Alevis/Alawis)
-  Sunnism (Hanafi, Shafi'i, Maliki)
-  Hunbli
-  Ibadism
-  Christianity
-  Judaism
-  Other

-  Mixed population areas
-  Sparsely populated areas
-  Uninhabited areas

# Iran's Energy Access to the Gulf



Charge Island, the site of the vast majority of Iran's exports, has a crude storage capacity of 20.2 million barrels of oil and a loading capacity of 5 million bbl/d. Lavan Island is the second-largest terminal with capacity to store 5 million barrels and loading capacity of 200,000 bbl/d. Other important terminals include Kish Island, Abadan, Bandar Mahshar, and Neka (which helps facilitate imports from the Caspian region).

Khatam Al-Anbia Construction Headquarters (KACH), controlled by Iran's Islamic Revolutionary Guard Corps (IRGC), is constructing three other pipelines that will deliver crude oil and petroleum products. These include the Nayeen-Kashan, Rafsanjan-Mashhad, and Bandar Abbas-Rafsanjan pipelines.

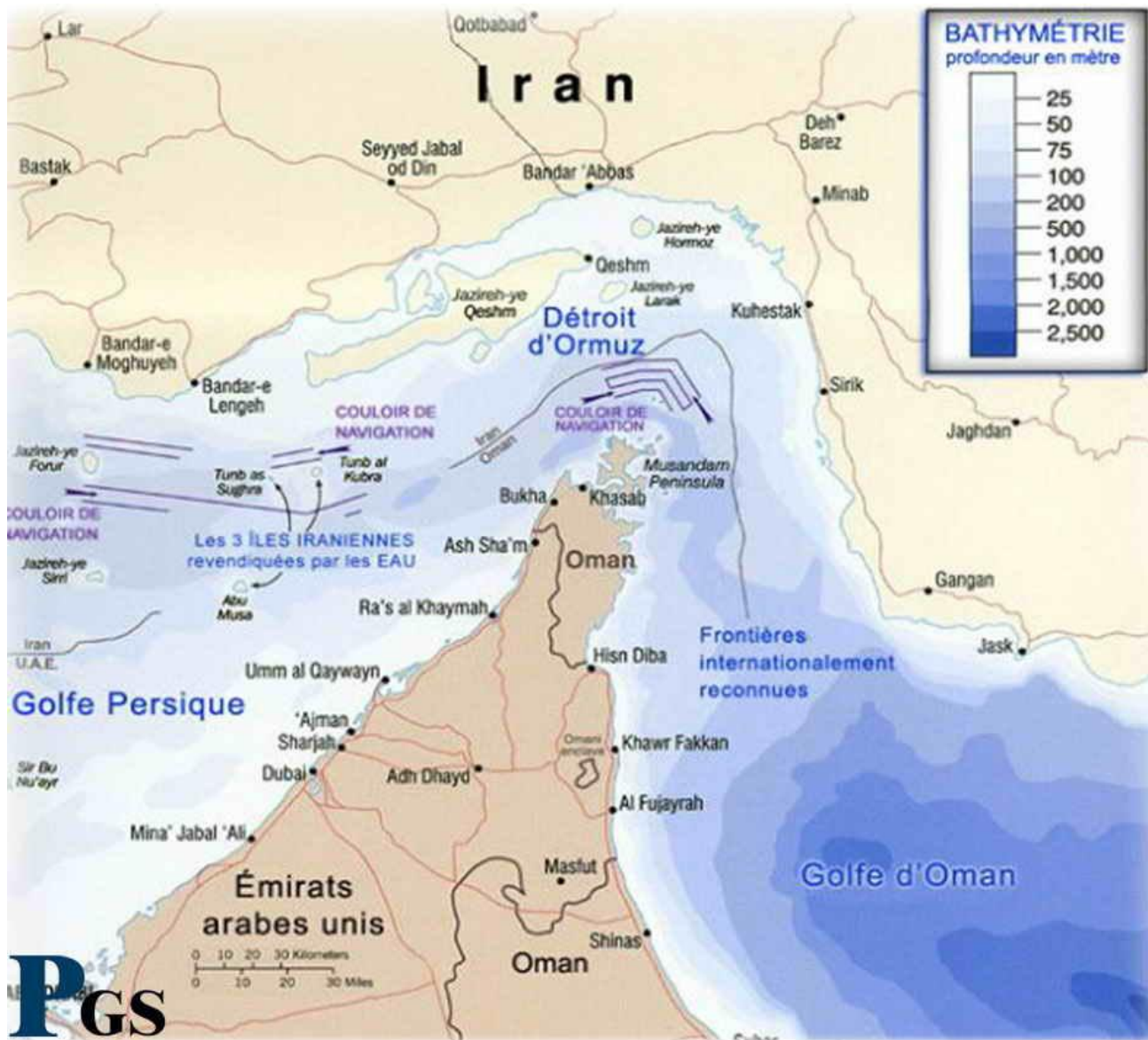
Iran exports natural gas via pipeline to Turkey and Armenia. The Iran-Turkey pipeline began exports in 2001 with 34 million cubic feet (MMcf) per day and exports gradually rose to 762 MMcf per day in 2010. Exports to Armenia totaled 24 MMcf per day of gas in 2010 in exchange for electricity. Pipeline exports to Armenia are expected to increase to 224 MMcf per day in 2020.

# Iran's Strategic Depth



Boundary representation is not necessarily authoritative.  
Base 802512 (R01078)-9/96

# The Military Geography of the Strait of Hormuz



- 280 km long, 50 km wide at narrowest point.
- Traffic lane 9.6 km wide, including two 3.2 km wide traffic lanes, one inbound and one outbound, separated by a 3.2 km wide separation median
- Antiship missiles now have ranges up to 150 km.
- Smart mines, guided/smart torpedoes,
- Floating mines, small boat raids, harassment.
- Covert as well as overt sensors.



# Abu Musa



# Vulnerability of the Upper Gulf



# Vulnerability of the Arabian Sea



# Iranian Gulf Military Installations

Bandar-e Khomeini (30° 25'41.42" N, 49° 4'50.18" E)

Bandar-e Mahshahr (30° 29'43.62" N, 49° 12'23.91" E)

Khorramshahr (30° 26'2.71" N, 48° 11'34.25" E)

Khark Island (29° 14'48.01" N, 50° 19'48.88" E)

Bandar-e Bushehr (28° 58'2.58" N, 50° 51'50.74" E)

Asalouyeh (27° 27'21.08" N, 52° 38'15.55" E)

Bandar-e Abbas (Naval base: 27° 8'35.79" N, 56° 12'45.61" E; IRGCN missile boat base: 27° 8'30.91" N, 56° 12'5.58" E; IRGCN torpedo & MLRS boat base: 27° 8'21.13" N, 56° 11'53.28" E; Hovercraft base and nearby naval air strip: 27° 9'15.68" N, 56° 9'49.97" E)

Jask (25° 40'40.90" N, 57° 51'4.54" E)

Bostanu (27° 2'58.22" N, 55° 59'3.22" E)

Chabahar

IRGCN base. It is the farthest east of all of Iran's military port facilities.

Qeshm (26° 43'10.09" N, 55° 58'30.94" E)

Sirri Island (25° 53'40.20" N, 54° 33'7.82" E)

Abu Musa (25° 52'22.32" N, 55° 0'38.62" E)

Occupied by Iran but claimed by the UAE. Suspected to house a small number of IRGCN forces. Also known to house HAWK SAMs and HY-2 "Silkworm" anti-ship missiles.

Greater Tunb and Lesser Tunb (GT: 26° 15'54.33" N, 55° 19'27.75" E; LT: 26° 14'26.08" N, 55° 9'21.18" E)

Occupied by Iran but claimed by the UAE. Home to heavily fortified airstrips and AA guns.



# Saudi Arabian Oil Vulnerability



260 billion barrels of proven oil reserves (plus 2.5 billion barrels in the Saudi-Kuwaiti shared "Neutral" Zone), amounting to around one-fifth of proven, conventional world oil reserves.

- Although Saudi Arabia has around 100 major oil and gas fields (and more than 1,500 wells), over half of its oil reserves are contained in only eight fields, including the giant 1,260-square mile Ghawar field (the world's largest oil field, with estimated remaining reserves of 70 billion barrels). The Ghawar field alone has more proven oil reserves than all but six other countries.

Saudi Arabia maintains the world's largest crude oil production capacity, estimated by U.S. Energy Information Administration (EIA) at over 12 million bbl/d at end-2010. Over 2 million bbl/d of capacity was added in 2009 with the addition of increments at Khurais, AFK (Abu Hadriya, Fadhili and Khursaniyah), Shaybah, and Nu'ayyim. For 2010, the EIA estimates that Saudi Arabia produced on average 10.2 million bbl/d of total oil

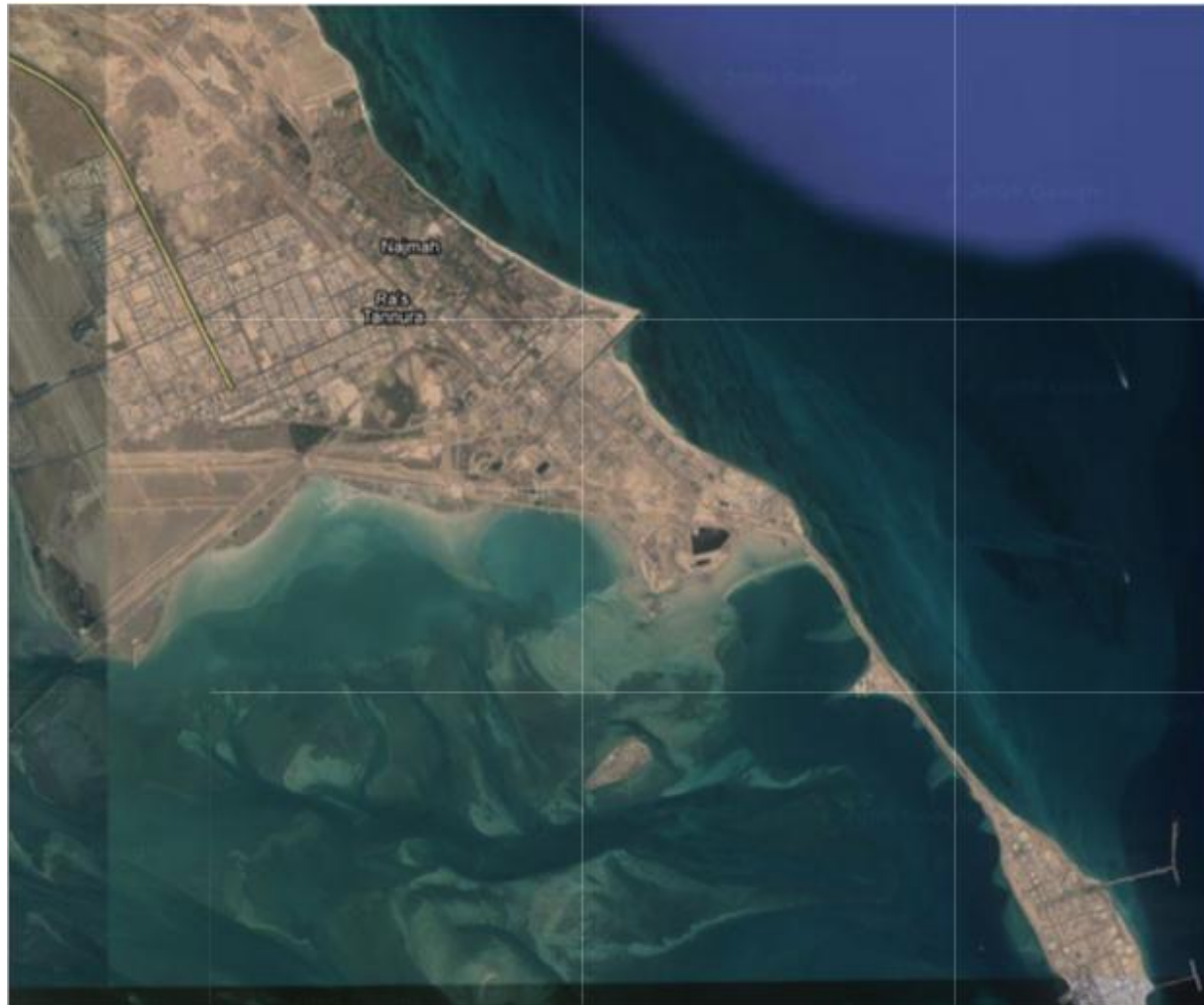
Saudi Arabia exported an estimated 7.3 million bbl/d of petroleum liquids in 2009 (7.5 million bbl/d in 2010), the majority of which was crude oil. Asia now receives an estimated 55 percent of Saudi Arabia's crude oil exports, as well as the majority of its refined petroleum product and natural gas liquids (NGL) exports.

In 2009, Saudi Arabia exported an average of 1 million bbl/d of petroleum liquids to the United States, (down from 1.5 million bbl/d in 2008) accounting for 9 percent of total U.S. petroleum imports. For this time period, Saudi Arabia ranked fourth after Canada, Mexico, and Venezuela as a petroleum exporter to the United States. Other major Saudi customers in 2009 included Japan (1.2 million bbl/d), South Korea (850,000 bbl/d), and China (839,000 bbl/d).

Saudi Arabia has three primary oil export terminals:

- The Ras Tanura complex has approximately 6 million bbl/d capacity, and the world's largest offshore oil loading facility. It includes the 2.5-million bbl/d port at Ras Tanura. More than 75 percent of exports are loaded at the Ras Tanura Facility.
- The 3 to 3.6-million bbl/d Ras al-Ju'aymah facility on the Persian Gulf.
- The Yanbu' terminal on the Red Sea, from which most of the remaining 25 percent is exported, has loading capacity of approximately 4.5 million bbl/d crude and 2 million bbl/d for NGL and products. The facility is reportedly not used to full capacity. These and a dozen other smaller terminals throughout the country, appear capable of exporting up to 14-15 million bbl/d of crude and refined products, 3-4 million bbl/d higher than Saudi Arabia's current crude oil production capacity.

# Ras Tanura



# Desalination Plant



# *The Challenge of Asymmetric Warfare:*

*Intimidation, Deterrence, and Warfighting*

# The Challenge of Asymmetric Warfare: Intimidation, Deterrence, and Warfighting

It is difficult to put the complexity of the military threats to the Gulf into the proper perspective. A summary of Iran's forces and Southern Gulf and US capabilities can easily run over several hundred pages, and there is no way to know how a clash or war might start, the pattern of escalation, and what forces and target might become involved over time. It is important to understand, however, that Iran is scarcely the hegemon of the Gulf. It is a relatively weak conventional power relative to the Southern Gulf states even without US, British, and French reinforcements. At the same time, Iran has built up massive capabilities of asymmetric warfare, can attempt to deter escalation or carry out political or terror strikes with conventionally armed missiles, and would have far more capability to deter the US and Southern Gulf states from responding to its use of asymmetric forces if it had nuclear armed missile forces.

There are a number of key points that must be kept in mind:

- **Iran already poses a threat or acts as “competitor” with a wide range of tools inside the Gulf and on far broader regional and geographic basis.**
- **The Broader Patterns in Iranian Activity reveal a wide range of Iranian national security actors and potential allies or “proxies.”**
- **Most Likely Iranian Threats Are Not Formal Conflicts:** They are the direct and indirect threats of using force. (I.e. Iranian efforts at proliferation) and the use of irregular and “proxy” forces and asymmetric attacks
- **Closing the Gulf:” An Escalation Ladder:** This leads to a wide range of possible scenarios, depending on Iran's reactions to sanctions, “accidents,” and preventive strikes.
- **Growing IRGC Land and Air Forces:** The Iranian Islamic Revolutionary Guards have built up major capabilities for land and naval operations, and are developing air and missile capabilities. While some estimates over-rate the IRGC land forces in terms of conventional force numbers, they are becoming a steadily more effective force for unconventional warfare of all kinds and now deploy many of Iran's longer range surface-to-surface and air to surface missiles.
- **IRGC Naval Forces:** The IRGC has a naval branch consists of approximately 20,000 men, including marine units of around 5,000 men. It is now a major force with extensive numbers of small boats that can be used to swarm or in wars of attrition, anti-ship missiles, mine warfare capabilities, and the ability to attack tankers, offshore facilities, and coastal facilities.
- **Rapid Expansion of IRGC Naval Forces:** These forces would now lead naval operations in the Gulf, and are steadily expanding their capabilities and exercise training for a wide range of potential forces of attack or warfare.

- **The Iranian Al Qods Force** is a force designed to train, advise, arm, fund, and partner foreign forces like the Hezbollah and Sadr militia in Iran. It gives Iran a unique ability to develop partners or proxies and conduct war by indirect means and with limited attribution. It works closely in some areas with the Sevak and Iranian diplomats.

***Iran's Conventional Forces: Better Equipped to Support Asymmetric Warfare than Conduct Conventional Operations***

Iran has upgraded and modernized some elements of its conventional forces, but they are much better equipped to resist an invasion – or support asymmetric warfare operations -- than conduct conventional naval, air, or land operations against the US, Southern Gulf, or other allied forces. Most key major weapons platforms date back to the time of the Shah or are aging or low grade imports from the FSU, Russia, and China.

- **Iranian Naval Threats:** Iran can pose conventional naval threats, but would be far more effective in using its navy in unconventional warfare.
  - **Key Iranian and Gulf Ships for Asymmetric Warfare:** Iran's naval strength is now tailored around submarines and smaller surface suited for concealment, missions like mine laying and raids, or "swarming." Its larger surface ships cannot compete or survive in air-sea combat with other Gulf and the US Navy. Iran can also use any of the dhows and hundreds of smaller ships crossing the Gulf.
  - **Missile-Armed Combat Warships: 2011:** Iran has a lead in smaller missile craft, but Southern Gulf navies have a lead in larger vessels.
  - **Iranian Support Ships and Submarines Relative to Total Naval Strength :** Iran does have an advantage over other Gulf navies in support ships for extended operations, and in submarines and midget submarines.
  - **Iranian Mine Warfare Ships:** Iran has a major lead in conventional and smart mines. It can use a wide range of civilian and military ships, dhows, small craft and aircraft for mine laying, including the use of free floating mines.
  - **Amphibious Ships & Landing Craft:** Ferries and cargo vessels can provide substantial additional lift if Iran can secure ports in target countries.
  - **Midget Submarines:** Iran has a growing number of midget submarines, submersibles, and unmanned underwater vehicles.
- **Iranian Air/ Surface-to-Air Missile Threats:** Iran has significant air assets, although it has problem making some fully operations and could not sustain high sortie rates.

- **Range of Iran's Air Power:** Iran has a number of long-range strike fighters, and could attack most Gulf targets. It would need secure refueling for longer range strikes against Israel, however, have to stage out of bases in Syria, or fly one-way missions.
- **Comparative Gulf Fixed Wing Combat Air Strength:** Iran has extensive holdings of combat aircraft, but 40% to 60% of Iranian inventory is not normally fully operational
- **Comparative High Quality Fighter/Attack Aircraft:** Iran is heavily dependent on aircraft it had at the time of the Shah and aging Soviet export versions of designs from the 1980s. It cannot compete with today's Southern Gulf air forces in high quality combat aircraft, much less the US. This could be decisive in any major clash or air-sea combat.
- **Gulf Reconnaissance and AWACS Aircraft in 2011:** Iran has some maritime patrol aircraft, electronic warfare, and intelligence aircraft, and a growing number of UAVs and some UCAVs, but cannot compete with the US in intelligence, surveillance, and reconnaissance (IS&R) or any aspect of force enablers, and in quality with aircraft like the Saudi E-3s.
- **Gulf Attack & Naval Helicopters:** Iran still has significant helicopter forces but they are aging badly, their operational status is often uncertain, and their avionics and subsystems are dated. The Southern Gulf, US, and allied forces would have a significant lead, but Iran has enough assets for raids and surprise attacks in the Gulf.
- **Gulf Armed Helicopters:** Iran appears to have large numbers of attack helicopters, but readiness, avionics, and armament are all problems and real world capability for a serious engagement is limited.
- **Gulf Land-Based Air Defenses:** Iran's surface-to-air missiles and other land-based defense often have ingenious work-arounds, but its SAMs, data systems, and sensors have significant vulnerabilities to countermeasures, electronic warfare, and ARMs. Many of its systems date back to the Shah or are aging Soviet bloc and PRC designs.
- **Illustrative Iranian UAV Projects /Assets:** Iran is steadily improving its UAV and UCAV capabilities, and already showed the ability to use them innovatively in the fighting between Israel and the Hezbollah.
- **Iranian Army Threats:** Iran has a large Army with large numbers of functioning – if usually aging – weapons systems. It does not compete with the US and Southern Gulf in modern artillery and armor, however, and trains more as counterinvasion and defensive forces than a maneuver force. Selected elements do exercise in asymmetric combat and could be effective working with the IRGC.

- **Comparative Armored Forces:** As in other areas, Iran has a large inventory, but much dates back to the Shah, was worn in the Iran-Iraq War, and is dated or even obsolescent. The Southern Gulf state and US have far more modern and sustainable armor and better ability to support it in defensive maneuver operations than Iran has in any power projection case outside its borders. Iran's lack of effective forward air support and air cover would also be a critical problem.
- **Comparative Gulf Artillery:** Iran acquired a massive towed artillery and rocket force in the relatively static battle it fought with Iraq during the Iran-Iraq War. It has since created its own impressive rocket forces. It is not, however, organized to use most artillery in rapid armored maneuvers. Its self-propelled systems are aging, and it is not properly equipped for rapid precision and counterbattery fire at the levels of US forces.
- **The Iran-Iraq Challenge:** The one key area where Iran would have a conventional combat advantage is in the case of Iraq. The US invasion destroyed Iraq's ability to defend and deter, and Iraq would need immediate and massive aid from US airpower in any contingency where Iran threatened or invaded.



# Iran: Threat or “Competitor”

## Non-Military Competition

- *Ideology, religion, and political systems*
- *“Terrorism” and violent extremism vs. “counterterrorism”*
- *Energy, sanctions, and global economic impacts*
- *Arms control, arms exports, and arms imports*
- *International diplomacy*

## Military Competition

- *Weapons of mass destruction*
- *Conventional forces*
- *Asymmetric and irregular warfare*
- *Proxy use of state and non-state actors*
- *Threat and intimidation*

## Nations and Sub-Regions of Competition

- *Gulf Cooperation Council countries*
- *Yemen*
- *Iraq*
- *Jordan*
- *Syria*
- *Lebanon*
- *Israel*
- *Gaza and West Bank*
- *Pakistan*
- *Turkey*
- *Afghanistan*
- *Central Asia*
- *Europe*
- *Russia*
- *China*
- *Japan and Asia*
- *Venezuela, Cuba, Brazil*

# The Broader Patterns in Iranian Activity

Iranian Actors	Related States/ Non-State Actors	Target/Operating Country
Revolutionary Guards	Iran	Iraq
Al Qaeda force	Syria	Israel
Vevak/other intelligence	Hezbollah	Egypt
Arms transfers	Hamas	Kuwait
Military and security advisors	Mahdi Army	Bahrain
Clerics, pilgrims, shrines	Yemeni Shi'ites	Yemen
Commercial training	Bahraini Shi'ites	Lebanon
Finance/investment	Saudi Shi'ites	Afghanistan
Investment/training companies		Venezuela
Education: scholarships, teachers		
Cultural exchanges		
Athletic visits		

## Most Likely Iranian Threats Are Not Formal Conflicts

- Direct and indirect threats of using force. (I.e. Iranian efforts at proliferation)
- Use of irregular forces and asymmetric attacks.
- Proxy conflicts using terrorist or extremist movements or exploiting internal sectarian, ethnic, tribal, dynastic, regional tensions.
- Arms transfers, training in host country, use of covert elements like Quds force.
- Harassment and attrition through low level attacks, clashes, incidents.
- Limited, demonstrative attacks to increase risk, intimidation.
- Strike at critical node or infrastructure.

# Closing the Gulf:” An Escalation Ladder

- Clash or minor incident – no escalation, but oil market panic.
- Non-attributable or deniable of responsibility attack: sabotage. Oil slick, free floating mines, IRGC raid excused as “rogue,” accidental missile firing.
- Proxy conflicts using terrorist or extremist movements or exploiting internal sectarian, ethnic, tribal, dynastic, regional tensions.
- Deliberate, systematic harassment and war of attrition through low level attacks, clashes, incidents.
- Strike(s) or raids at critical node, infrastructure, offshore facility. Use of mine or missile to sink a tanker, closing of sea access to key port or facility.
- Actual effort to “close the Strait of Hormuz using IRGC, Navy, Air Force, land-based missiles.
- Broadly based war in entire Gulf and Gulf of Oman using full range of Iranian conventional and asymmetric assets.

# IRGC Land and Air Forces

- The IRGC has small elements equipped with armor and has the equivalent of conventional army units, and some units are trained for covert missions and asymmetric warfare, but most of its forces are lightly equipped infantry trained and equipped for internal security missions.
- These forces are reported to have between 120,000 and 130,000 men, but such totals are uncertain as are all unclassified estimates of the strength, organization, equipment, and industrial base of the IRGC. This manpower pool includes conscripts recruited from the same pool as regular army conscripts, and training and retention levels are low.
- Some sources, like the International Institute for Strategic Studies (IISS), report a force structure with 20 “divisions,” but most IRGC units seem to be large battalion-sized elements. According to a *Jane’s* report, estimates of the IRGC’s organization differ sharply.
- Some sources claim that there are two armored, five mechanized, 18 infantry, and one Special Forces division, and about 15-20 independent brigades. The report concludes that many alleged divisions are equivalent to large brigades and the personnel numbers of the IRGC could support only three to five divisions.
- The total manpower pool of the IRGC could support only about five to six light infantry divisions. There is supposedly also one airborne brigade.
- The IRGC often claims to conduct large exercises, sometimes with 100,000 men or more. The exact size of such exercises is unclear, but they are often a small fraction of what the IRGC claims. With the exception of a limited number of more elite elements, training is limited and largely suitable for internal security purposes.
- The air force of the IRGC is believed to operate Iran’s three Shahab-3 intermediate-range ballistic missile units, and may have had custody of its chemical weapons and any biological weapons. The IRGC may operate Iran’s ten EMB-312 Tucanos. It also seems to operate many of Iran’s 45 PC-7 training aircraft, as well as some Pakistani-made trainers at a training school near Mushak
- Most forces would require substantial refresher training to act in any mission other than static infantry defense and using asymmetric warfare tactics like hit-and-run operations or swarming elements of forces when an invader appears vulnerable.

# Growing IRGC Land and Air Forces

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# IRGC Naval Forces

The IRGC has a naval branch consists of approximately 20,000 men, including marine units of around 5,000 men.

The IRGC is now reported to operate all mobile land-based anti-ship missile batteries and has an array of missile boats; torpedo boats; catamaran patrol boats with rocket launchers; motor boats with heavy machine guns; mines as well as Yono (Qadir)-class midget submarines; and a number of swimmer delivery vehicles.

The IRGC naval forces have at least 40 light patrol boats, 10 Houdong guided missile patrol boats armed with C-802 anti-ship missiles.

The IRGC controls Iran's coastal defense forces, including naval guns and an HY-2 Seersucker land-based anti-ship missile unit deployed in five to seven sites along the Gulf coast.

The IRGC has numerous staging areas in such places and has organized its Basij militia among the local inhabitants to undertake support operations.

IRGC put in charge of defending Iran's Gulf coast in September 2008 and is operational in the Gulf and the Gulf of Oman, and could potentially operate elsewhere if given suitable sealift or facilities.

Can deliver conventional weapons, bombs, mines, and CBRN weapons into ports and oil and desalination facilities.

Force consists of six elements: surface vessels, midget and unconventional submarines, missiles and rockets, naval mines, aviation, and military industries.

Large numbers of anti-ship missiles on various types of launch platforms.

Small fast-attack craft, heavily armed with rockets or anti-ship missiles.

# Rapid Expansion of IRGC Naval Forces

- More fast mine-laying platforms.
- Enhanced subsurface warfare capability with various types of submarines and sensors.
- More small, mobile, hard-to-detect platforms, such as semi-submersibles and unmanned aerial vehicles.
- More customized or purpose-built high-tech equipment.
- Better communications and coordination between fighting units.
- More timely intelligence and effective counterintelligence/deception.
- Enhanced ability to disrupt the enemies command, control, communications, and intelligence capability.
- The importance of initiative, and the avoidance of frontal engagements with large US naval surface warfare elements.
- Means to mitigate the vulnerability of even small naval units to air and missile attack.
- Numerous staging areas in such places and has organized its Basij militia among the local inhabitants to undertake support operations.
- The naval branch has bases and contingency facilities in the Gulf, many near key shipping channels and some near the Strait of Hormuz. These include facilities at Al-Farsiyah, Halul (an oil platform), Sirri, Abu Musa, Bandaer-e Abbas, Khorramshahr, and Larak.
- 
- Iran recently started constructing new naval bases along the coasts of the Gulf and the Sea of Oman for an “impenetrable line of defense.”

On October 27, 2008, Iran opened a new naval base at Jask, located at the southern mouth of the Strait of Hormuz, a strategic chokepoint for Persian Gulf oil.



# The Iranian Al Qods Force

- Comprised of 5,000 –15,000 members of the IRGC (Increased size of force in 2007)
- Equivalent of one Special Forces division, plus additional smaller units
- Special priority in terms of training and equipment
- Plays a major role in giving Iran the ability to conduct unconventional warfare overseas using various foreign movements as proxies
- Specialize in unconventional warfare mission
- Control many of Iran’s training camps for unconventional warfare, extremists, and terrorists
- Has offices or “sections” in many Iranian embassies throughout the world
- Through its Al Qods Force, Iran provides aid to Palestinian terrorist groups such as Hamas, Lebanese Hezbollah, Iraq-based militants, and Taliban fighters in Afghanistan.
- Despite its pledge to support the stabilization of Iraq, Iranian authorities continued to provide lethal support, including weapons, training, funding, and guidance through its Al Qods Force.
- Al Qods Force continues to provide Iraqi and Afghani militants with:
  - specialized training, funding,
  - Iranian-produced advanced rockets, sniper rifles, automatic weapons, mortars,
  - Improvised Explosive Devices (IEDs) and explosively formed projectiles (EFPs) that have a higher lethality rate than other types of IEDs
  - Since 2006, Iran has arranged a number of shipments of small arms and associated ammunition, rocket propelled grenades, mortar rounds, 107mm rockets, and plastic explosives, possibly including man-portable air defense systems (MANPADs), to the Taliban.
  - Israeli defense experts continue to state that they believe the IRGC and Al Qods Force not only played a major role in training and equipping Hezbollah, but may have assisted it during the Israeli-Hezbollah War in 2006, and played a major role in the Hezbollah anti-ship missile attack on an Israeli Navy Sa’ar-class missile patrol boat.
  - The Al Qods Force is widely believed to have been behind the plot to assassinate Saudi Arabia’s ambassador to the US, Adel al-Jubeir in 2011.
- **Role of MOIS/Vevak?**

# *Iran's Conventional Forces*

*Better Equipped to Support Asymmetric Warfare  
than Conduct Conventional Operations*

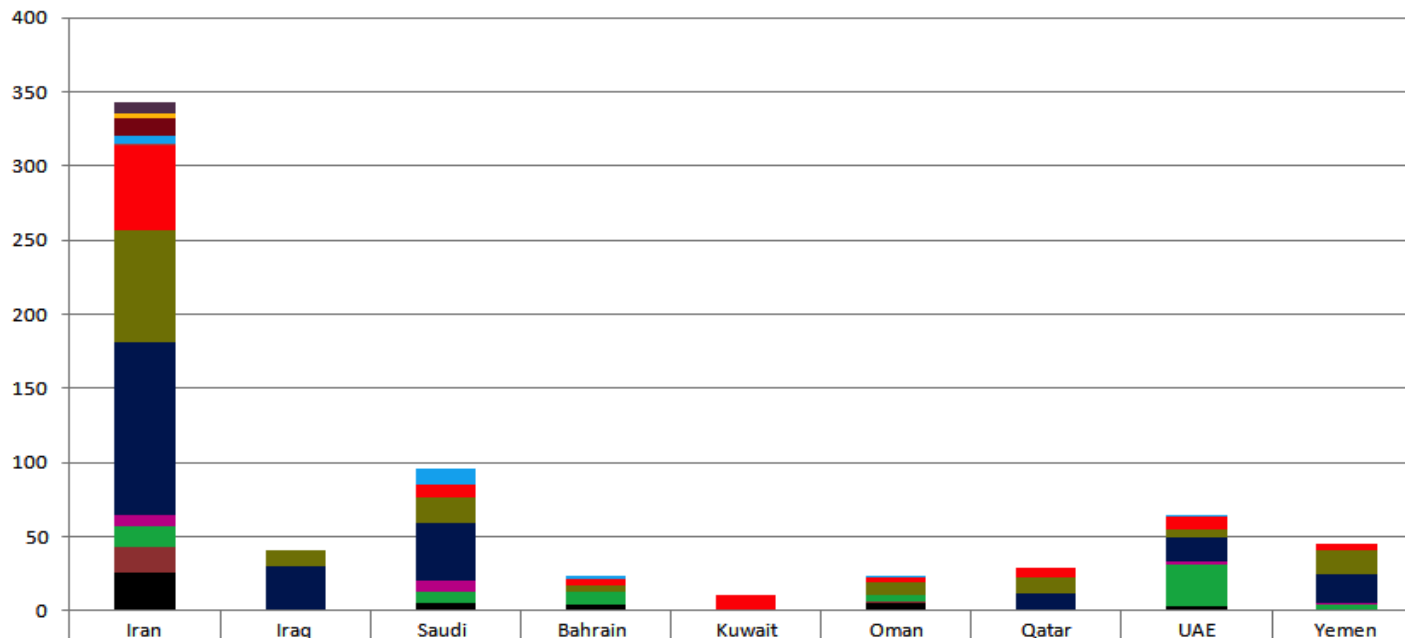
## Iranian Naval Threats

- Iranian effort to “close the Gulf.”
- Iranian permissive amphibious/ferry operation.
- Variation on 1987–1988 “Tanker War”
- Raids on offshore and critical shore facilities.
- “Deep strike” with air or submarines in Gulf of Oman or Indian Ocean.
- Attacks on US facilities

### *But:*

- *Low near-term probability.*
- *High risk of US and allied intervention.*
- *Limited threat power projection and sustainability.*
- *Unclear strategic goal.*

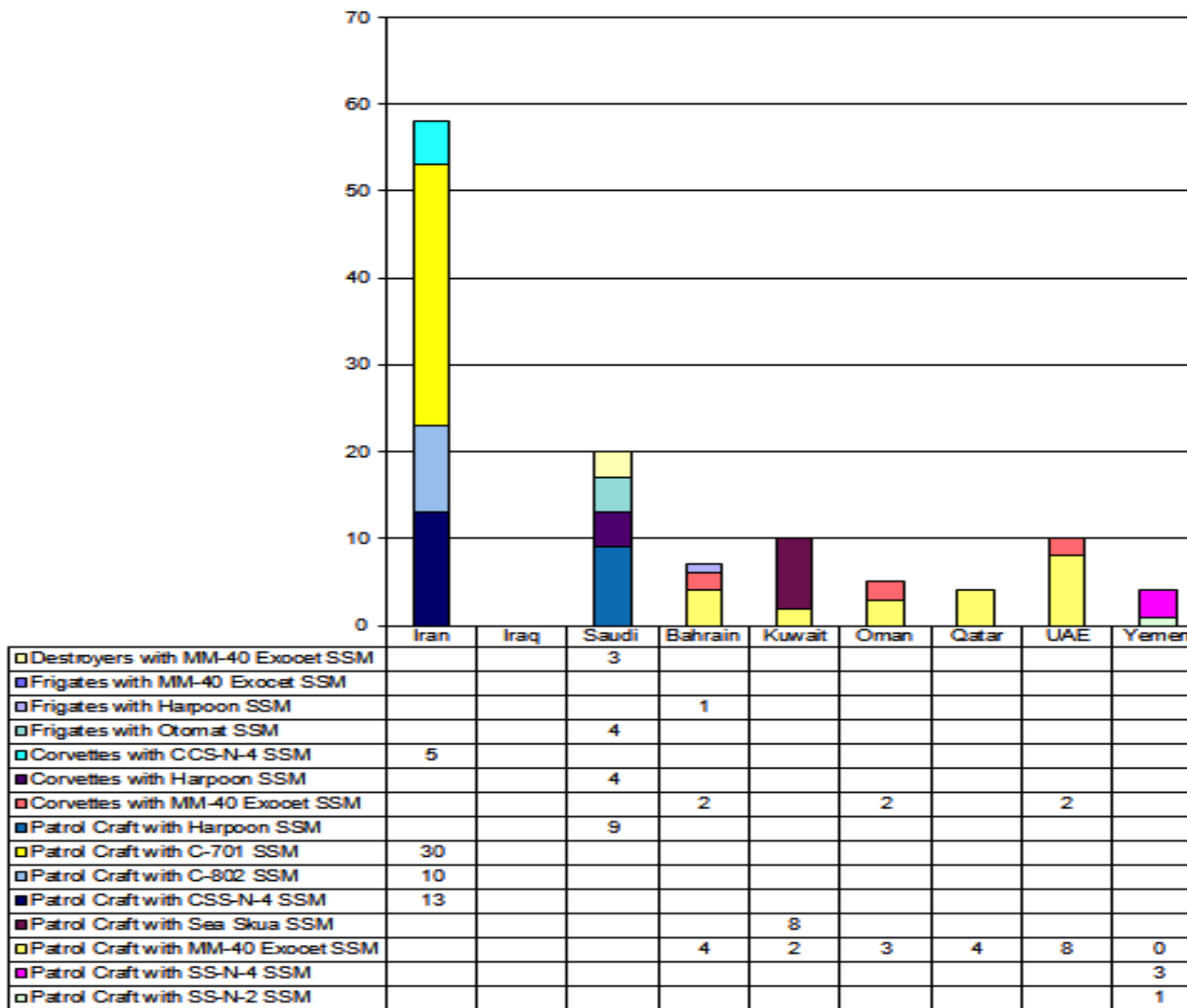
# Key Iranian and Gulf Ships for Asymmetric Warfare



	Iran	Iraq	Saudi	Bahrain	Kuwait	Oman	Qatar	UAE	Yemen
SDVs	8								
Submarines	3								
Midget Submarines	12								
Major Missile Combat	5		11	3		2		2	
Major Other Combat	1								
Missile Patrol	57		9	4	10	3	7	8	4
Other Patrol	76	11	17	4		8	10	6	16
Armed Boats	117	30	39				11	16	20
Mine	7		7					2	1
Landing Craft	14		8	9		5		28	3
Amphibious Ships	17					1	1		1
Support	26		5	4	1	5		3	

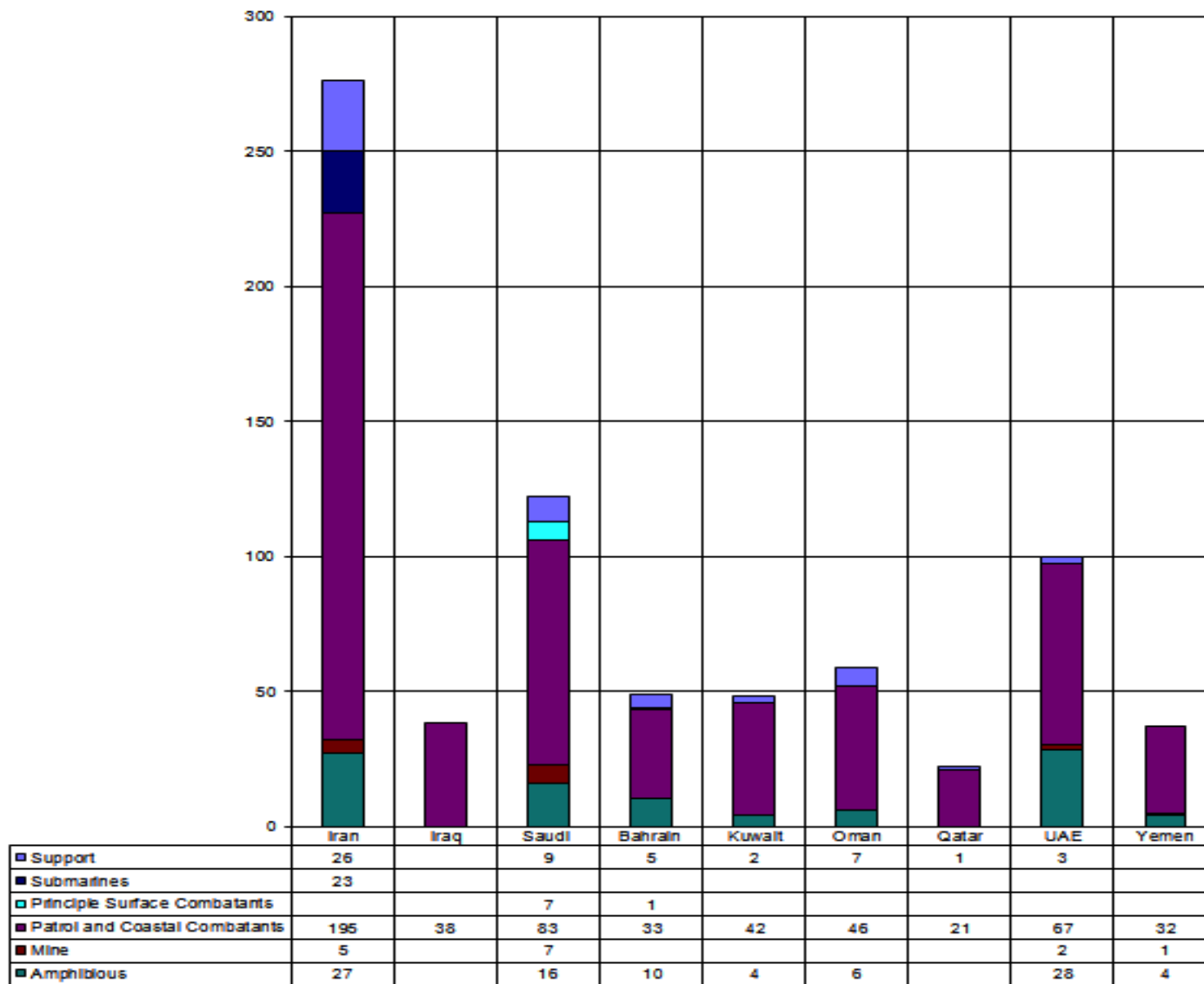
Source: Adapted by Anthony H. Cordesman from IISS, The Military Balance, various editions; Jane's Sentinel series; Saudi experts

# Missile-Armed Combat Warships: 2011

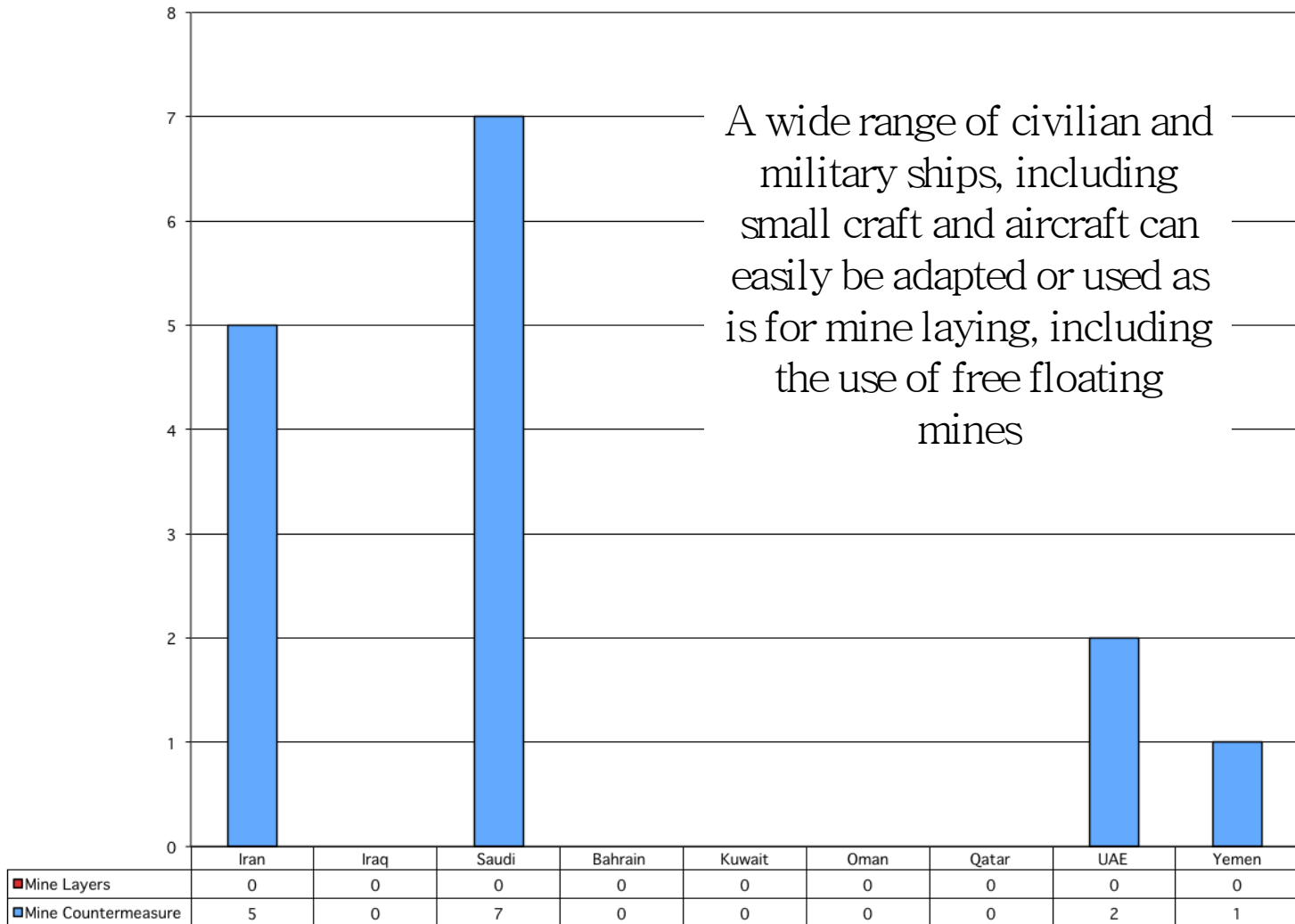


Source: Adapted from IISS, [The Military Balance](#), [Periscope](#), JCSS, [Middle East Military Balance](#), [Jane's Sentinel](#) and [Jane's Defense Weekly](#). Some data adjusted or estimated by the author.

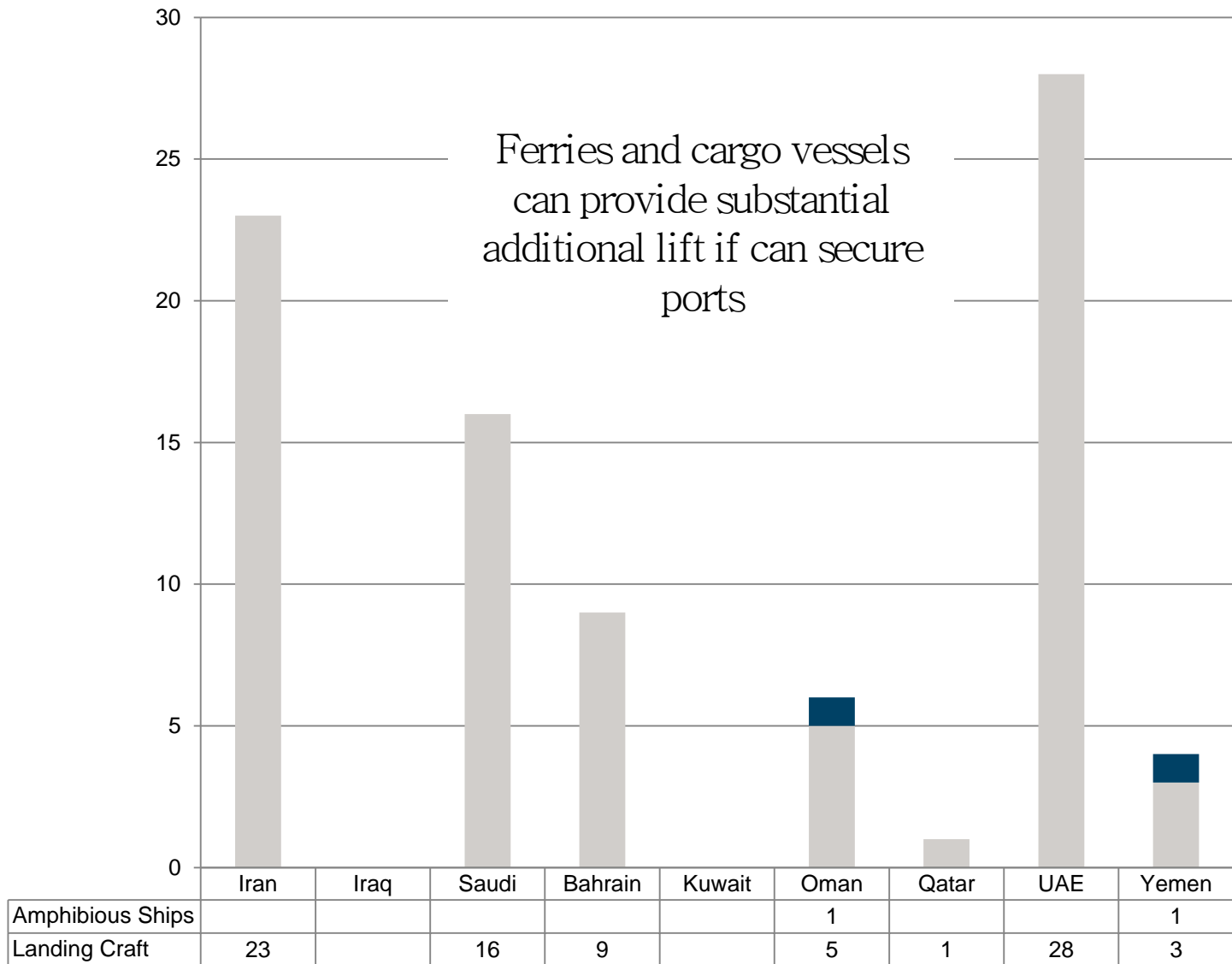
# Iranian Ships and Submarines Relative to Total Naval Strength



# Iranian Mine Warfare Ships



# Amphibious Ships & Landing Craft



Source: Adapted by Anthony H. Cordesman from IISS, *The Military Balance*, various editions, Jane's Sentinel series, and material provided by US and Saudi experts.



# Midget Submarines

## IS-120 Ghadir “midget” submarine

Number in Service: 11-14

Displacement: 120 tons

Speed: 11 kts surfaced/8 kts submerged

Max Depth: Unknown

Armament: 2 x 533 mm torpedoes. Can carry mines instead of torpedoes.

Some reporting indicates that MANPADs are carried aboard.

Electronics: I Band surface search or navigation

Sonar: Active/Passive

## *Nahong*-class:

Number in Service: 1

Displacement: 100 tons

Speed: 8kts

Max Depth: 200 m

Armament: 2 x 533 mm torpedoes in drop collars. Can also carry 4 MDM-6 or EM-52 smart mines.

Electronics: Surface search or navigation radar.

Sonar: Bow-mounted active/passive sonar.

EW: ESM mast similar to Russian “Stop Light” type.

Note: The *Nahong* is reportedly stationed in the Caspian Sea, but can be transported overland to the Gulf.

# Iranian Air/Missile Threats

- Precision air strikes on critical facilities: Raid or mass attack.
- Terror missile strikes on area targets; some chance of smart, more accurate kills.
- Variation on 1987–1988 “Tanker War”
- Raids on offshore and critical shore facilities.
- Strikes again tankers or naval targets.
- Attacks on US-allied facilities
- Use of UAVs as possible delivery systems (conventional or Unconventional munitions)

## *But:*

- *Low near-term probability.*
- *High risk of US and allied intervention.*
- *Limited threat power projection and sustainability.*
- *Unclear strategic goal.*

# Range of Iran's Air Power



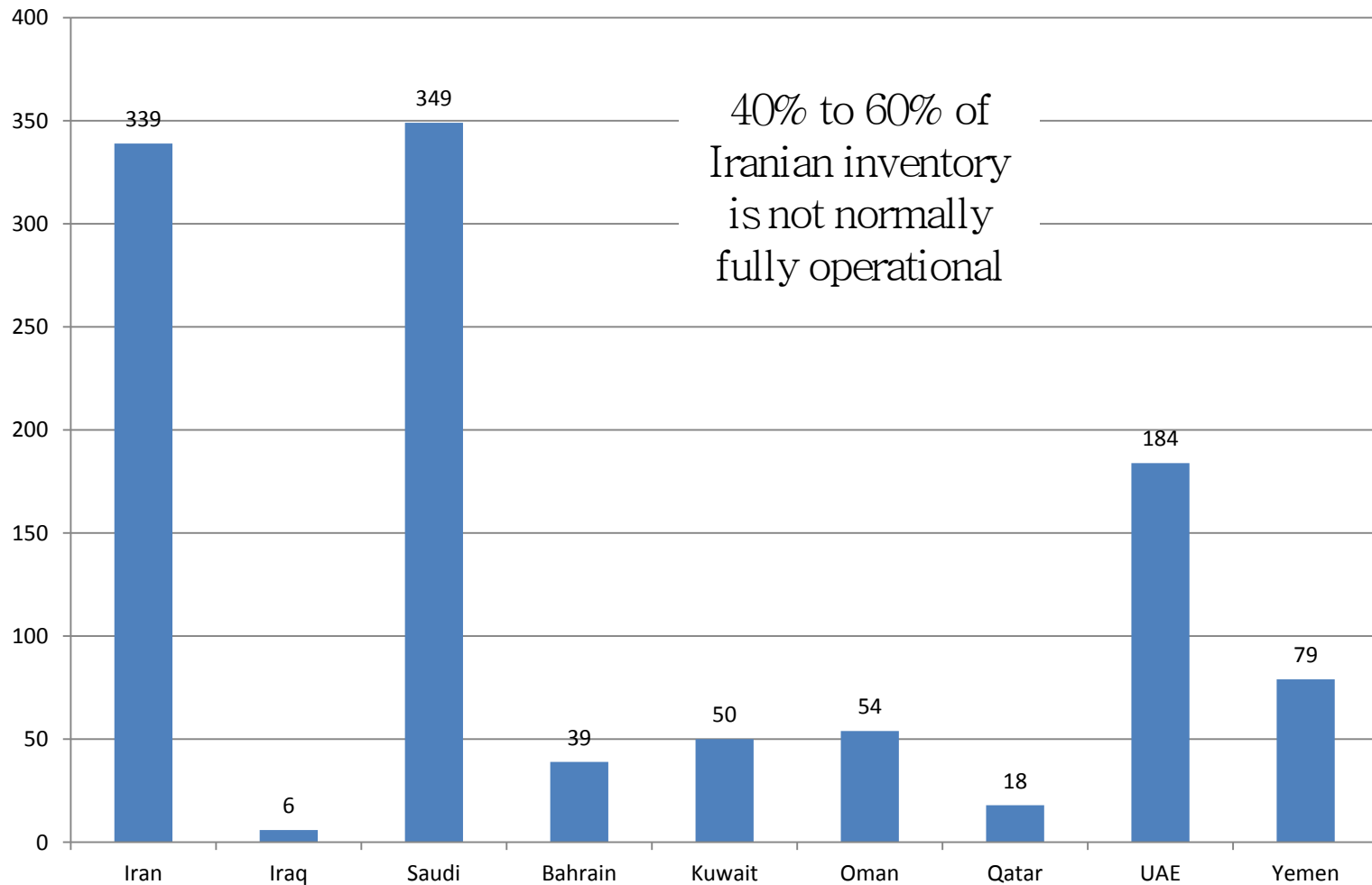
## Mission Profile: Hi-Lo-Hi

F-4E (Bushehr):  
(4) MK83 1000lb Bombs  
(1) 600 Gallon Fuel Tank  
10 Minutes loiter time  
Range = 400 nmi

SU-24 (Shiraz):  
(4) 500 kg/1000 lb Bombs  
(1) 400 gallon tank  
10 minutes loiter time  
Range = 590 nmi

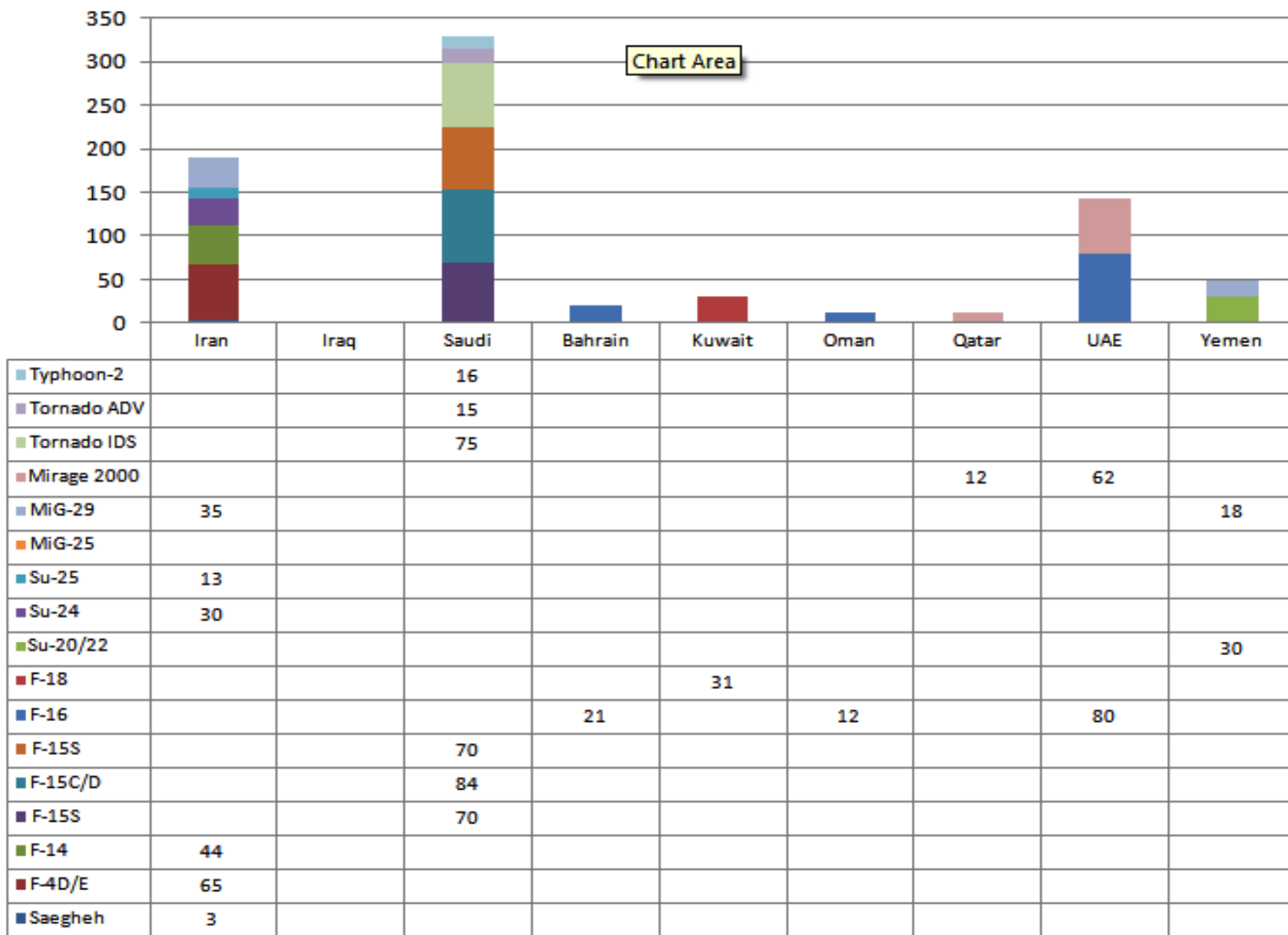
SU-25 (Shiraz):  
(4) 500kg/1000lb Bombs  
(1) 400 gallon tank  
(2) 10 minutes loiter time  
Range = 600 nmi

# Comparative Gulf Fixed Wing Combat Air Strength



Note: Only armed or combat-capable aircraft are counted, not trainers, recce or other aircraft. Iraq has 6 Cessna AC-208Bs fulfilling dual recce and attack roles.

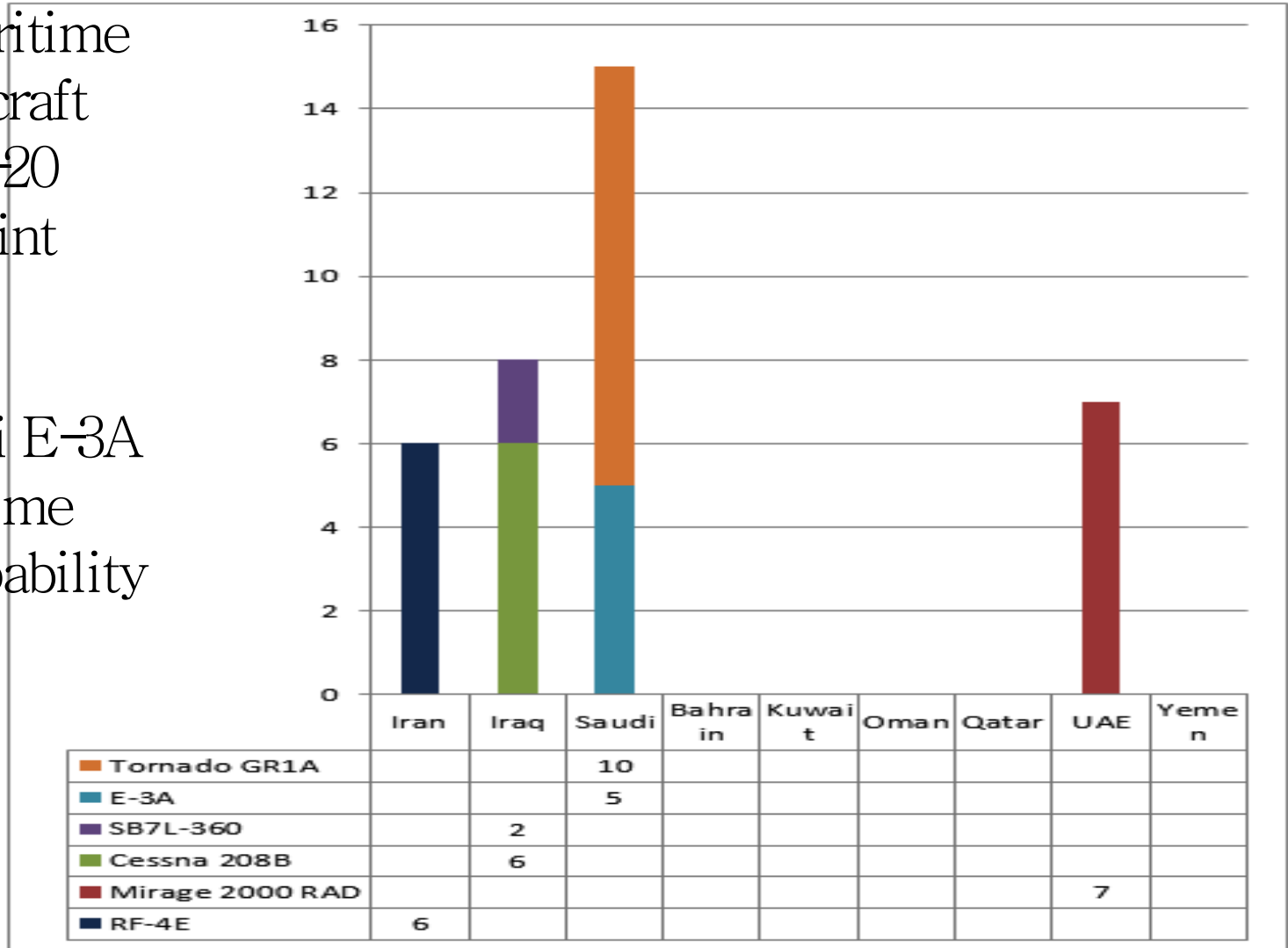
# Comparative High Quality Fighter/Attack Aircraft



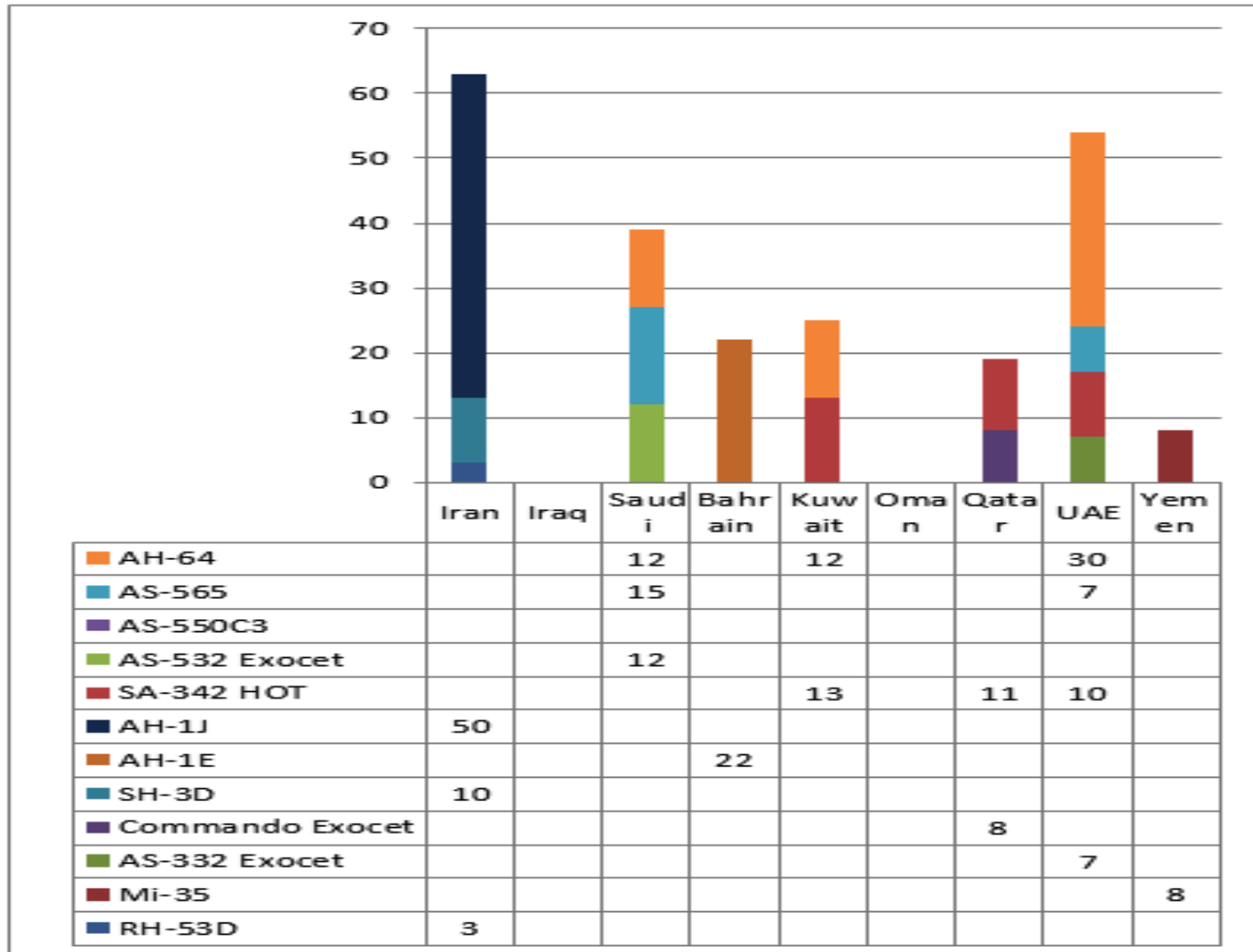
# Gulf Reconnaissance and AWACS Aircraft in 2011

Iran has 3 P-3F Orion maritime patrol aircraft and 3 Da-20 Falcon Elint aircraft

The Saudi E-3A has maritime patrol capability

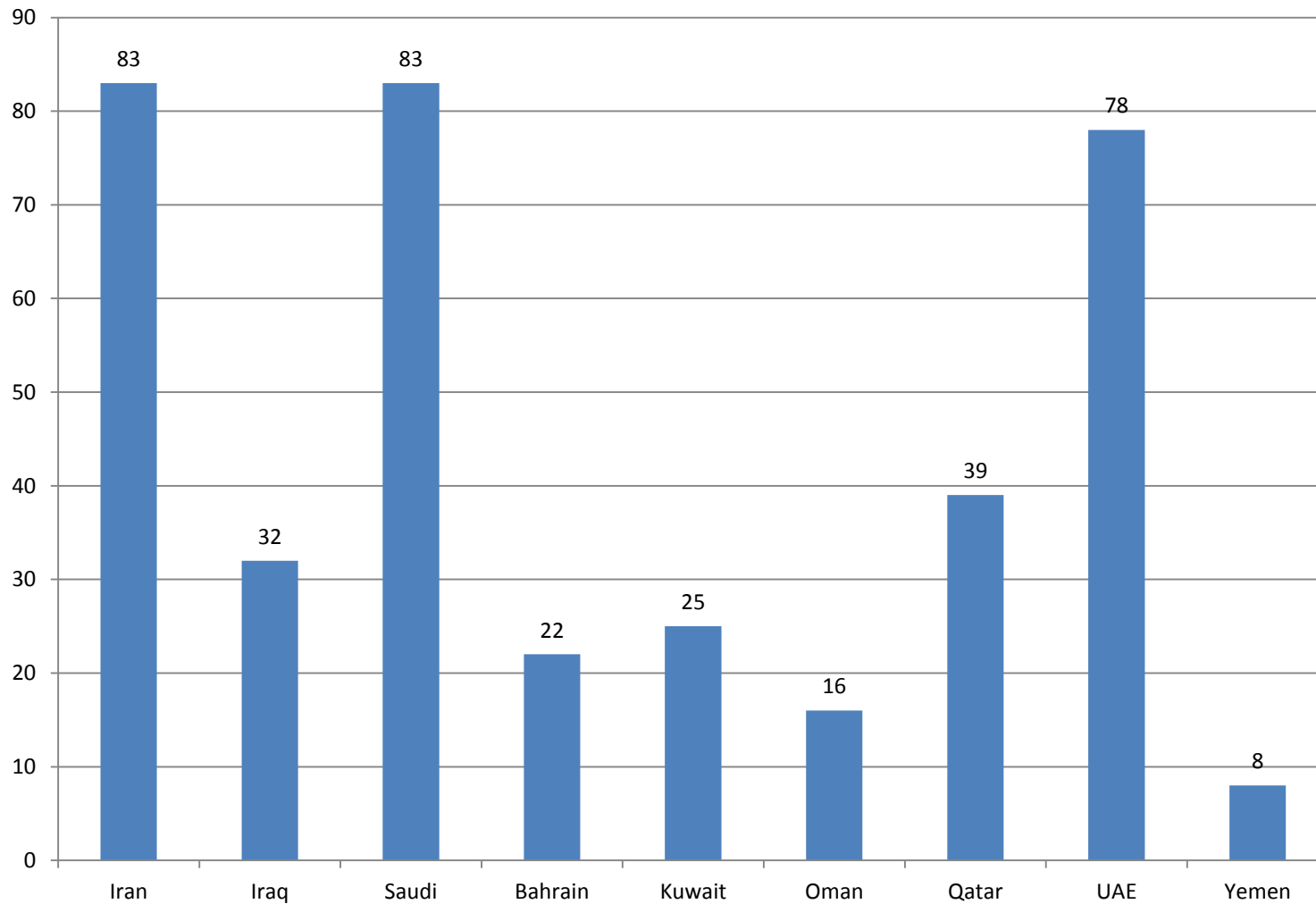


# Gulf Attack & Naval Helicopters



Source: Adapted from IISS, The Military Balance, 2011, Periscope, JCSS, Middle East Military Balance, Jane's Sentinel and Jane's Defense Weekly. Some data adjusted or estimated by the author.

# Gulf Armed Helicopters



Source: Adapted from IISS, [The Military Balance, 2011](#), [Periscope](#), JCSS, [Middle East Military Balance](#), Jane's [Sentinel](#) and [Jane's Defense Weekly](#). Some data adjusted or estimated by the author.



# Gulf Land-Based Air Defenses In 2011

Country	Major SAM	Light SAM	AA Guns
Bahrain	8 Hawk MIM-23B	60 R BS-70 18 FIM-92A Stinger 7 Crotale	15 27 guns Oerlikon 35 mm 12 L70 40 mm
Iran	16/150 I Hawk 3/10 SA-5 45 SA-2 Guideline	SA-7/14/16, HQ-7 29 SA-15 Some QW-1 Misaq 29 TOR-M1 Some HN-5 5/30 Rapier 10 Pantsyr (SA-22) Some FM-80 (Ch Crotale) 15 Tigercat Some FIM-92A Stinger	1,700 Guns ZSU-23-4 23mm ZPU-2/4 23mm ZU-23 23mm M-1939 37mm S-60 57mm ZSU-57-2
Iraq			
Kuwait	5 / 24 I Hawk Phase III 5/40 Patriot PAC-2	12 Aspide 12 St a rburst Aspide Stinger	12 Oerlikon 35mm
Oman	None	Blowpipe 8 Mistral 2 SP 12 Panstsy r S1E  34 SA-7 6 Blindfire S713 Martello 20 Javelin 40 Rapier	26 guns 4 ZU-23-2 23 mm 10 GDF-005 Skyguard 35  12 L-60 40 mm
Qatar	None	10 Blowpipe 12 FIM-92A Stinger 9 Roland II 24 Mistral 20 SA-7	?
Saudi Arabia	16/128 I Hawk 4-6/16-24 Patriot 2 17/73 Shahine Mobile	40 Crotale 5 00 Stinger (ARMY) 5 00 Mistral (ADF)	9 2 1,220 guns M-163 Vulcan 20 mm 30 M-167 Vulcan 20 mm
(NG)	16/96 PAC-2 launchers 17 ANA/FPS-117 radar 73/68 Crotale/Shahine	500 5 00 FIM-43 Redeye Redeye (ADF) 7 3 -141 Shahine static	1 2 8 8 50 AMX-30SA 30 mm G DF Oerlikon 35mm 1 50 L-70 40 mm (in store) 130 M-2 90 mm (NG)
UAE	2/6/36 I Hawk	20+ Blowpipe 20 Mistral Some Rapier Some Crotale Some RB-70 Some Javelin Some SA-18	62 guns 42 M-3VDA 20 mm SP 20 GCF-BM2 30 mm
Yemen	Some SA-2, 3 Some SA-6 SP	Some 800 SA-7 Some SA-9 SP Some SA-13 SP Some SA-14	530 guns 20 M-163 Vulcan SP 20mm 50 ZSU-23-4 SP 23 mm 100 ZSU-23-2 23 mm 150 M-1939 37 mm 50 M-167 20mm 120 S-60 57 mm 40 M-1939 KS-12 85 mm

Source: Adapted by Anthony H. Cordesman from IISS, [The Military Balance](#), [Periscope](#), JCSS, [Middle East Military Balance](#), Jane's [Sentinel](#) and [Jane's Defense Weekly](#). Some data adjusted or estimated by the author.

# Illustrative Iranian UAV Projects /Assets

Prime Manufacturer	Designation	Development/ Production	Operation	Payload Wt.	Endurance (hr)	Range	Ceiling (ft)	Mission
Asr-e Talai	Alamdar MAV	Underway						Surveillance
Famas	Black Eagle							
	Unknown							
	Unknown							
Faraz Asia Technologies Company	Faraz-2 MAV				0.5	10		Surveillance
FARC	Sobakbal	Underway	Deployed	.35	2	2.7-13.5 mi	19,686 ft	Surveillance
Ghods Aviation Industries	Ababil (Swallow)	Completed	Deployed	45		240	4,268	Attack (RPGs)
	Mohajer-1/2/3/4	Completed	Deployed			30-150	3,352	Aerial Target
	(Mirsad-1, Hodhod)	Doma, Completed	Deployed					Target drone – aka “Target 3000”
	Saeqeh-1/2		Deployed					
	Tallash (Endeavor and Hadaf)							
	Mohajer-5							
	Shekarchi (Hunter)							
HESA (aka IAMI)	Ababil variants (?)	Completed	Deployed		1.5+	30-120	3,048	Aerial target; RSTA; long-range surveillance
	Hadaf-1	Underway						Aerial Target
Unknown	Karrar (Striker)	Underway		Disputed, 115-700		1,000		Hunter-killer
	Nazir (Harbinger)							Hunter-killer
Unknown	R’ad (Thunder)							Hunter-killer
Unknown	Pehpad	Underway	Testing			700		Hunter-killer
	Stealth	Underway	Deployed					R/S – announced 2/10/2007
Sharif University of Technology	Shahbal	Underway		5.5		12	3,000	Reconnaissance/ surveillance

# Iranian Army Threats

The Army has some 350,000 men (220,000 conscripts) organized into four corps,

It has four armored divisions, six infantry divisions, six artillery groups, two commando divisions, an airborne division, aviation groups, and other smaller independent formations.

These latter units include independent armored, infantry, and commando brigades.

In practice, each Iranian division has a somewhat different organization

Iran does have at least one elite Special Forces Division, which was formed in 1993–1994, and the 55th paratroop division.

According to one source, the 23rd Special Forces Division has 5,000 full-time regulars and is one of the most professional units in the Iranian Army.

The regular army also has a number of independent brigades and groups. These include some small armored units, one infantry brigade, one airborne and two to three Special Forces brigades, coastal defense units, a growing number of air-defense groups, five artillery brigades/regiments, four to six army aviation units, and a growing number of logistic and supply formations. The land forces have six major garrisons and 13 major casernes.

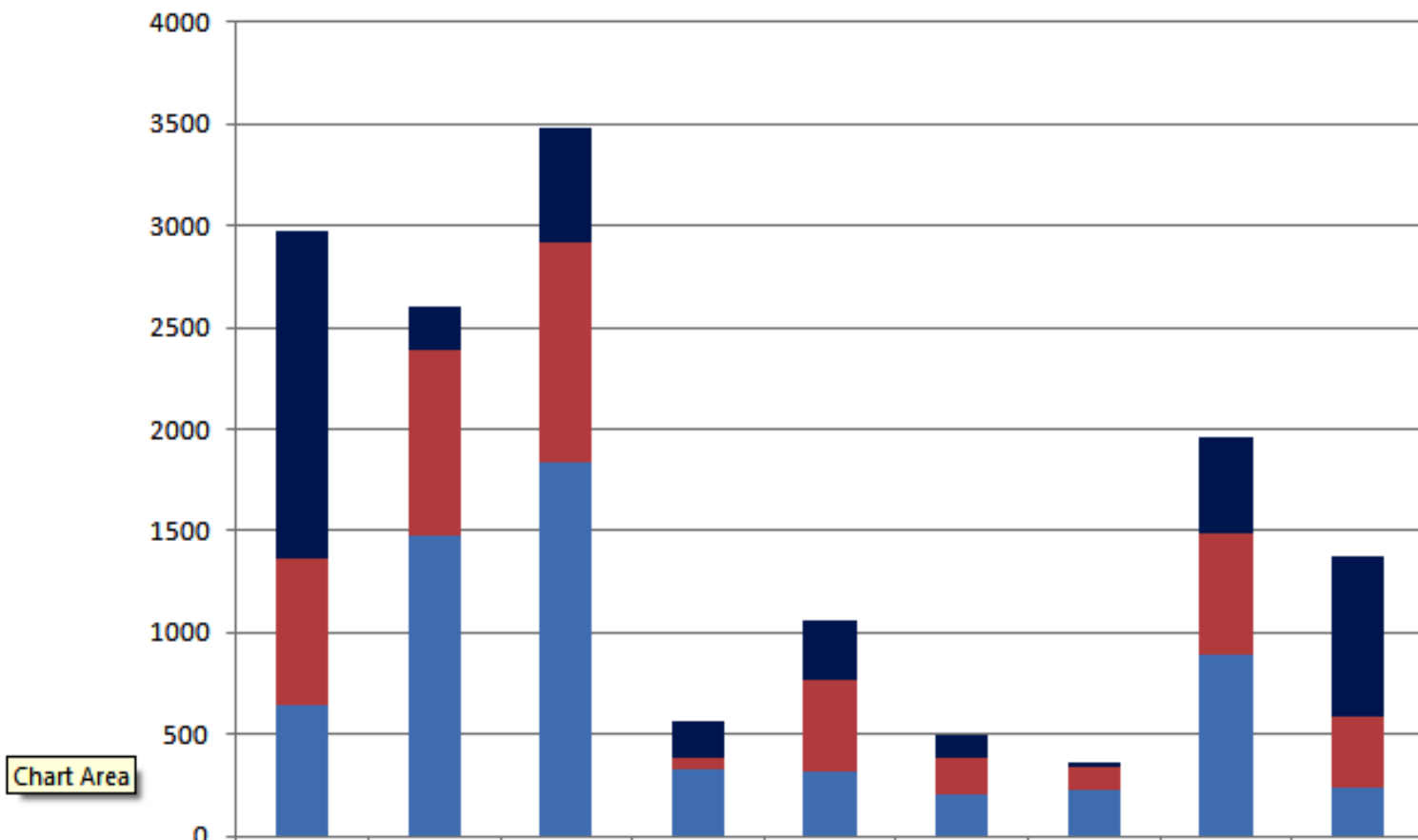
There is a military academy at Tehran, and a signal-training center in Shiraz. The airborne and Special Forces train at a facility in Shiraz, too.

No reliable data exist on the size and number of Iran's smaller independent formations.

There are reports that the lighter and smaller formations in the regular army include an Airmobile Forces group created since the Iran-Iraq War, and which includes the 29th Special Forces Division, which was formed in 1993–1994, and the 55th paratroop division.

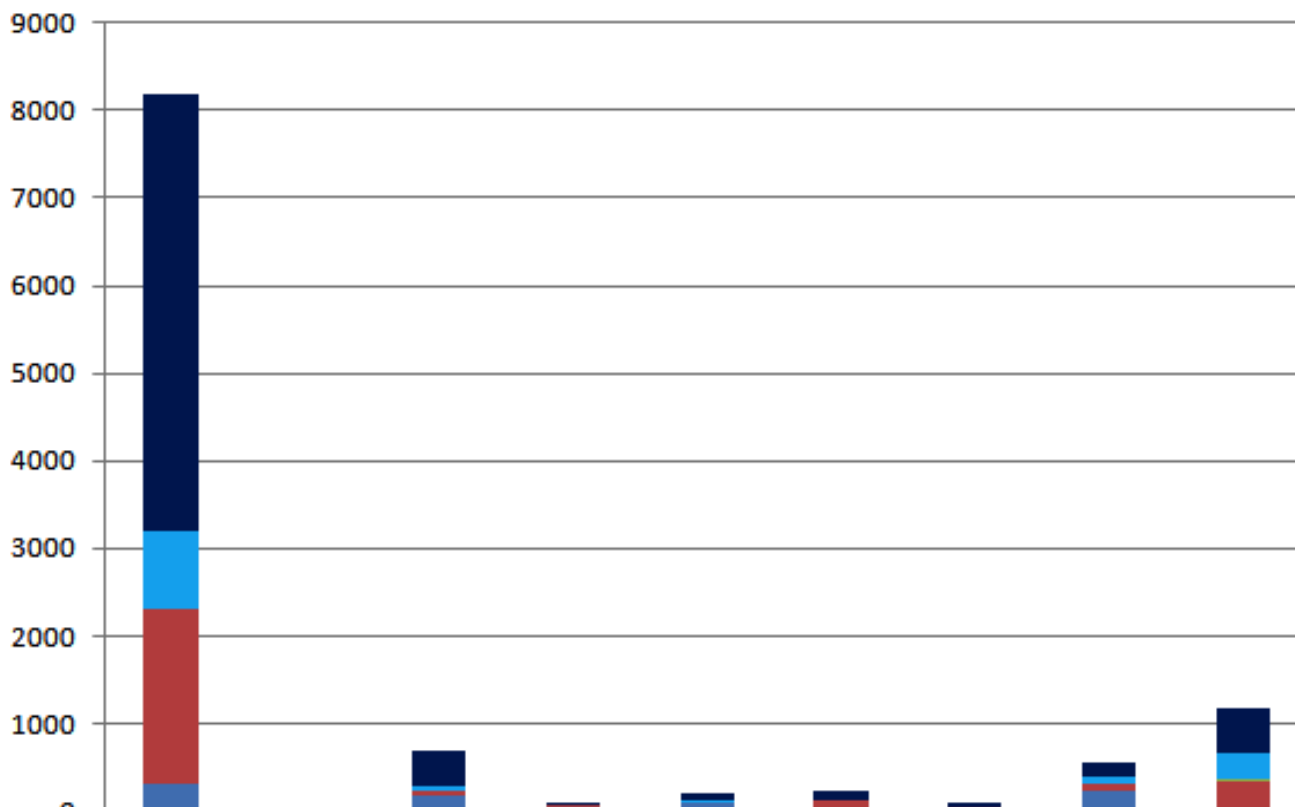
There are also reports that the regular army and IRGC commando forces are loosely integrated into a corps of up to 30,000 men with integrated helicopter lift and air assault capabilities. The airborne and special forces are trained at a facility in Shiraz..

# Comparative Armored Forces



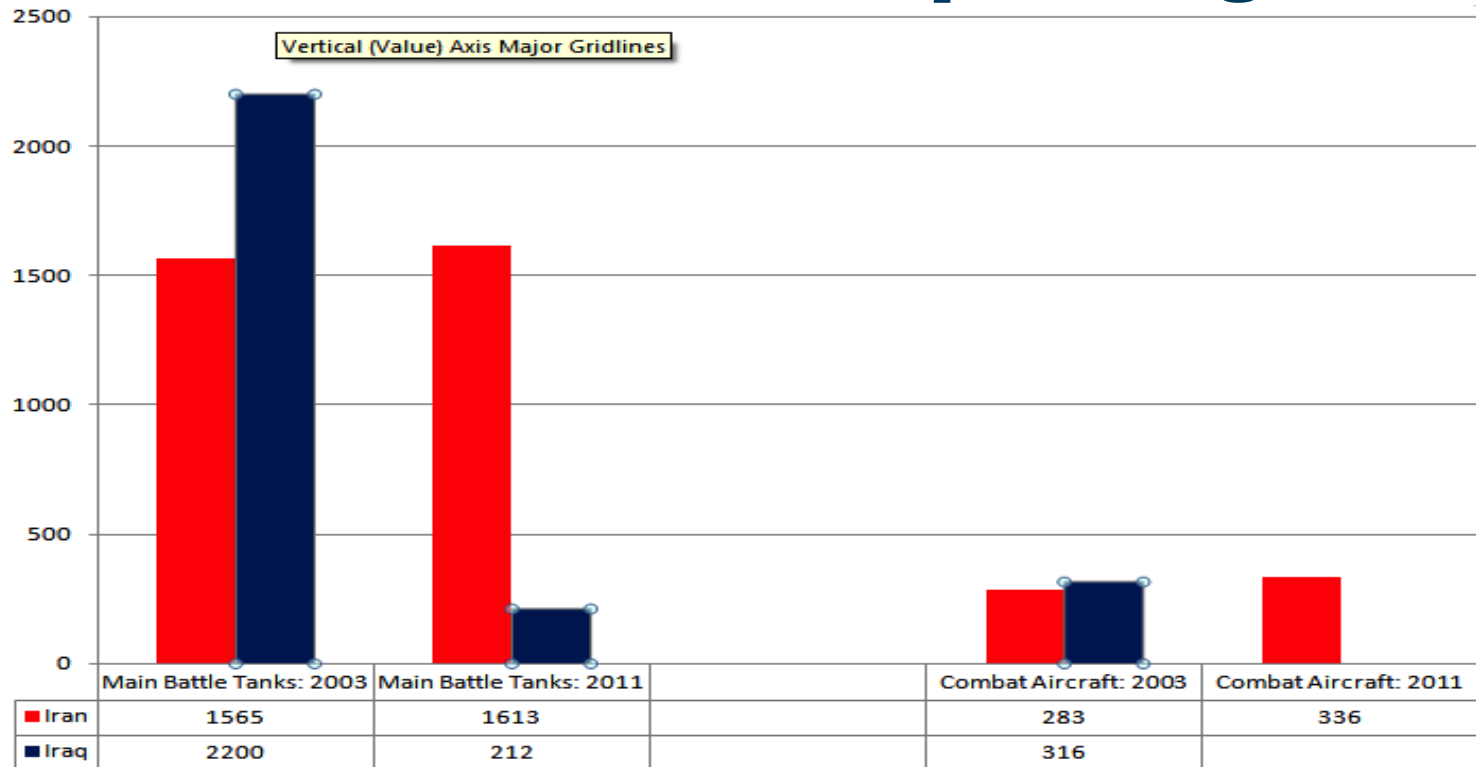
	Iran	Iraq	Saudi	Bahrain	Kuwait	Oman	Qatar	UAE	Yemen
■ Main Battle Tanks	1613	212	565	180	293	117	30	471	790
■ AIFV/Recce/Lt. Tanks	725	912	1080	55	450	174	108	595	348
■ APCs	640	1479	1840	325	321	206	226	892	240

# Comparative Gulf Artillery



	Iran	Iraq	Saudi	Bahrain	Kuwait	Oman	Qatar	UAE	Yemen
■ Mortar	5000		400	24	78	101	45	155	502
■ Multiple Rocket Launcher	876		60	0	27	0	4	92	294
■ Assault and Coastal	0		0	0	0	0	0	0	36
■ Towed Tube	2010		58	26	0	108	12	93	310
■ Self-Propelled Tube	310		170	33	95	24	28	221	25

# The Iran-Iraq Challenge



Category	2003			2011		
	Iraq	Iran	Force Ratio	Iraq	Iran	Force Ratio
Active Manpower	424,000	513,000	8:10	245,782	523,000	2:5
Reserve Manpower	650,000	350,000	19:10	0	350,000	NA
Main Battle Tanks	2,200	1,565	7:5	212	1,613	1:8
OAFVs	1,300	815	8:5	434	725	1:1.7
Reconnaissance APCs	2,400	590	4:1	1,479	640	23:10
Towed Artillery	1,900	2,085	9:10	0	2,010	NA
SP Artillery	150	310	1:2	0	310	NA
MRLs	200	889	1:5	0	876	NA
Combat Aircraft	316	283	11:10	0	336	NA
Attack Helicopters	100	85	6:5	0	50	NA
Major SAM Launchers	225	205	11:10	0	289	NA

Source: Adapted from IISS, The Military Balance 2011, various editions and Jane's Sentinel series

# *Iranian Missile Threats*

# Iranian Missile Threats

Iran's limitations in air power might lead it to use its long-range ballistic missile forces to attack targets in the Southern Gulf or Iraq in a limited war or contingency, but seems more likely to use them if it must respond to a preventive attack by Israel or led by the US. Iran has a significant number of such missiles, ranging from long-range rockets/short-range ballistic missiles to systems with the range to reach Israel and Europe.

Iran's missiles now, however, do not have nuclear warheads and have limited accuracy and uncertain reliability. They can be used with conventional or chemical warheads to attack city-seized targets as terror weapons, but cannot be used to hit key facilities in precision strikes and lack the lethality to do major damage. This situation would change radically if Iran could arm them with nuclear warheads, or with reliable conventional warheads warhead with terminal guidance systems.

- **Iran's missile threat:** Iran has a wide range of rockets and missiles. Some analysts feel that Iran could fire enough such systems to do significant damage to an urban area or large are energy target or military facility. It is not clear that Iran has this capacity, or what levels of real-world damage it could achieve without warheads with advanced terminal guidance systems.
- **Missile Attack Range and Density:** Much would depend in a conventional attack on Iran's ability to fire its missiles in "volleys" of different systems.
- **Iranian Missile Range:** Iran's longest-range missiles can now hit at city-sized targets at ranges up to 1,600 miles.
- **A Gulf Missile War:** Iran does, however, face steadily improving US, Southern Gulf, and Arabian missile defenses. A combination of such missile defenses and preventive air attacks on Iranian missile launches could sharply reduce the effectiveness of Iran's attacks.

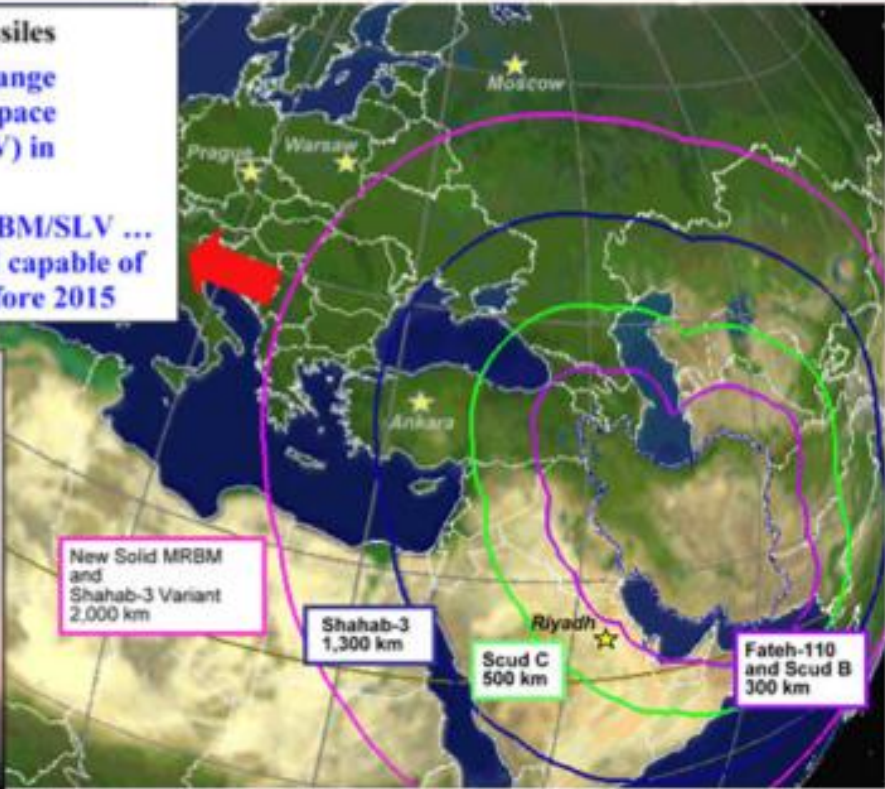
In general, the use of missiles without guided warheads or warhead with weapons of mass destruction seems more likely to be a "terror" weapon Iran would use only if it felt it could pressure other neighboring states into halting support for a US offensive or under extreme pressure. It is unlikely such systems would do critical damage to an energy facility but their use would be so provocative that it could lead to very high levels of counterescalation and damage to Iran.



# Iranian Missile Threat

**Long-Range Ballistic Missiles**

- New Intermediate Range Ballistic Missile or Space Launch Vehicle (SLV) in development
- Likely to develop ICBM/SLV ... could have an ICBM capable of reaching the U.S. before 2015



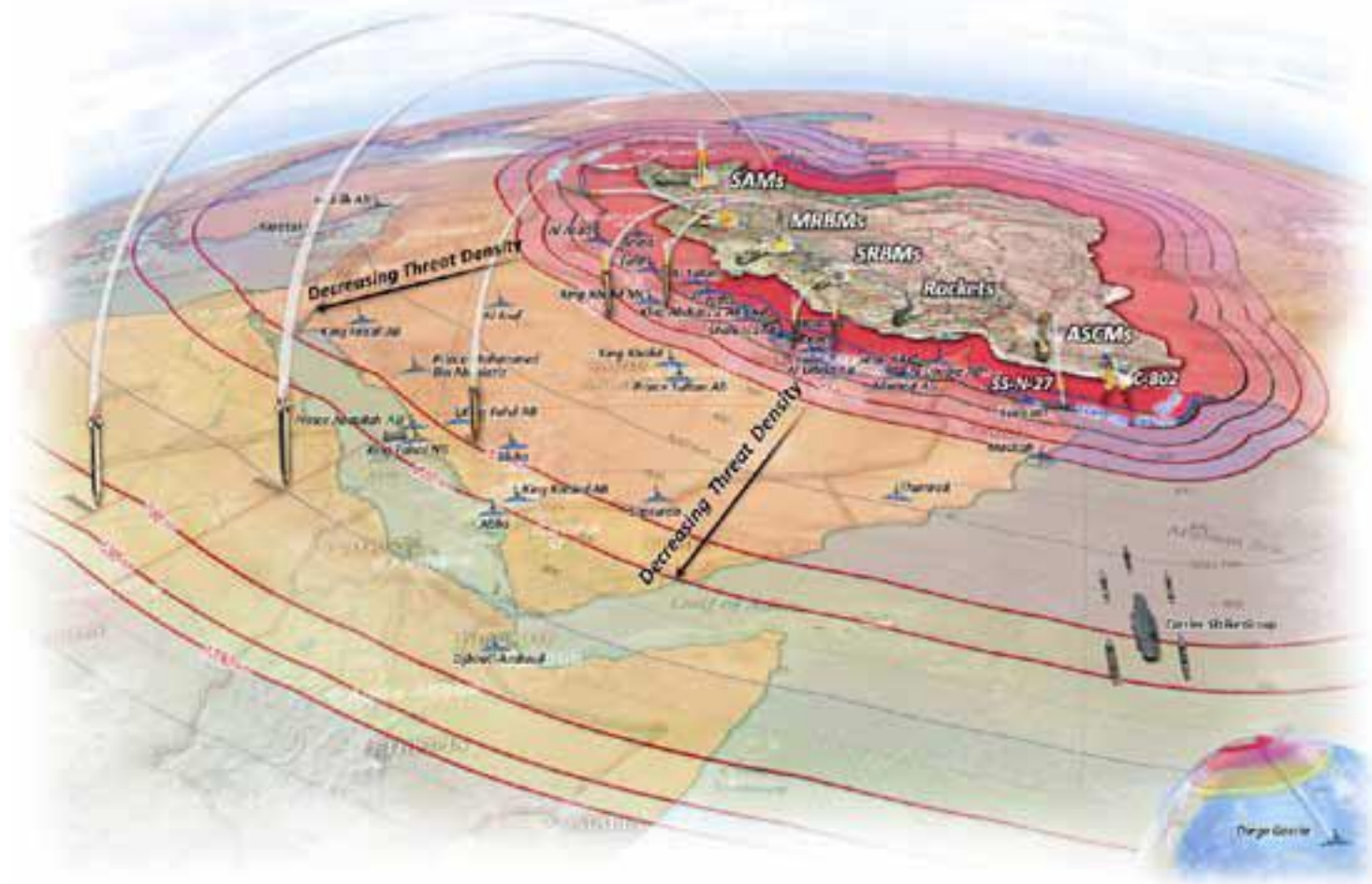
Shehab 3/3A

Range (km)	Payload (kg)
1,350	1,158
1,400	987
1,500	760
1,540	650
1,560	590.27
1,580	557.33
1,600	550
1,780	240
2,000	-

ms-1096738 / 061407

(Source: Missile Defense Program Overview for the European Union, Committee on Foreign Affairs, Subcommittee on Security and Defense. Dr. Patricia Sanders. Executive Director. Missile Defense Agency)

# Missile Attack Range and Density



# Iranian Missile Range

## THE RANGE OF IRAN'S SHAHAB-3



Source: Stratfor,

[http://www.google.com/imgres?imgurl=http://digitaljournal.com/img/1/2/2/8/5/5/i/5/7/1/o/iran\\_missile\\_map.jpg&imgrefurl=http://digitaljournal.com/image/57146&h=364&w=400&sz=56&tbnid=131nAmeBGGgErdwGM:&tbnh=90&tbnw=99&zoom=1&docid=fi86K5v8K5dAM&sa=X&ei=A947T\\_D9Ncbr0gHIvMjRCw&ved=0CDUQ9QEwAw&dur=235](http://www.google.com/imgres?imgurl=http://digitaljournal.com/img/1/2/2/8/5/5/i/5/7/1/o/iran_missile_map.jpg&imgrefurl=http://digitaljournal.com/image/57146&h=364&w=400&sz=56&tbnid=131nAmeBGGgErdwGM:&tbnh=90&tbnw=99&zoom=1&docid=fi86K5v8K5dAM&sa=X&ei=A947T_D9Ncbr0gHIvMjRCw&ved=0CDUQ9QEwAw&dur=235)

# A Gulf Missile War



*Preventive Strikes and Iranian  
Missile Threats*

# Preventive Strikes

The previous analysis focuses on the kind of clashes and confrontations that might grow out of the steadily escalating pressure from sanctions and other tensions in the Gulf region. There is, however, a far more serious set of scenarios that could grow out of Israeli or US preventive strikes, and that might involve Iran's long-range missile forces. These do not seem probable near term contingencies, particularly for the US. They are, however, possible contingencies and the ones most likely to lead Iran to move towards a high level of escalation in spite of the risk of a devastating US and Southern Gulf response.

It is not possible to analyze the options involved in any detail in a summary brief, but it is possible to illustrate the seriousness of the kind of attacks and conflicts that might result:

- **Israeli Preventive Strikes:” An Escalation Ladder:** Israel faces serious limits on the level of strikes it could conduct, and the size of the Iranian target base it could cover. It could, however, potentially set Iran's program back by a year or more by focusing on key facilities. The main problems it would face include overflight of Arab territory, refueling and supporting enabling aircraft in hostile air space, range-payload problems in penetrating deeply into Iran and the risk of losing aircraft to fuel problems if they had to make combat maneuvers, and the ability to do lasting damage to Iranian hard target like Frodo and Natanz.
- **US Preventive Strikes:” An Escalation Ladder:** The US would not face anything like the same problems if it used forward base strike attack aircraft, cruise missiles, and stealth bombers. It could penetrate deeply, cover the full range of Iranian targets, conduct damage assessment and then restrike. This could produce much more lasting damage and could include key Iranian missile, air defense, and other military forces and facilities. If it had the support fits Southern Gulf allies it could also maintain overwatch and strike at suspect Iranian activity and keep closing the entrance to Iran's underground and shelter facilities, effectively making them traps for the facilities inside. This could produce a lasting halt to Iran's nuclear programs.
- **Possible Iranian Responses to US and Israeli Strikes:** There are serious risks involved in both Israeli and US preventive strikes. Iran has a wide range of ways to respond and might lash out in ways where it would escalate to “closing the Gulf” and producing a major energy crisis.
- **Key Iranian Nuclear Targets:** Iran has a limited number of priority suspect targets and ones that could directly contribute to its ability to produce a nuclear weapon. Only two – Frodo and Natanz – are hardened. Only one reactor – Bushehr – might produce serious radiological effect if attacks. These, however, are known, unclassified sites. The target list known to Israeli or US intelligence and given priority in any preventive strike might be very different. The distance indicator on this map is important. It shows that Israel might face range-payload problems in covering the full range of targets unless it risked refueling over hostile airspace.

- **Possible Range of Nuclear Targets:** Iran does have a much, much longer list of known nuclear facilities that may be usable for a weapons effort or weapons-related research. There are similar lists for missile, chemical, and biological facilities. Israel could not possibly strike the full range of these targets, although its intelligence almost certainly allows it to formulate a much shorter list.
- The US could attack the full range of targets, but would probably need access to Southern Gulf bases and facilities for a rapid, full-scale attack and to sustain an overwatch operation.
  - **Natanz Centrifuge Facility: Vehicle Entrance Ramp (before burial)**
  - **Natanz Centrifuge Facility: Vehicle Entrance Ramp (after burial)**
  - **Natanz: Effective Concealment:** These three images of Natanz illustrate the efforts to conceal Iran's main centrifuge facility and what a hardened underground target looks like.
  - **Frodo Fuel Enrichment Plant – In Process**
  - **Frodo Fuel Enrichment Plant- Finishing:** These two images of Fordo illustrate similar efforts to conceal a centrifuge facility in a mountainside.
  - **Bushehr City and Reactor Area**
  - **Bushehr Reactor: These two image illustrate the vulnerability of the Bushehr reactor, but also its proximity to populated areas.**

It should be stressed that the preventive attacks illustrated here cannot be assessed fully without access to classified intelligence, targeting, and operations data. Moreover, much depends on how Israel, the US, and Iran's neighbors assess the risks over time. In broad terms, Iran seems to be relatively conservative as a risk taker, and might well be "detractable." Much depends, however, on how Iran approaches both negotiations and improvements in its nuclear and delivery system capabilities in the future, and on how the Iranian regime evolves as a risk taker.

# Israeli Preventive Strikes:” An Escalation Ladder

- Single set of strikes against limited number (4 to 8?) of main forward facilities. “Close” entrance of Natanz and Frodo. Do Not strike Bushehr reactor.
- Single set of strikes against limited number (4 to 8?) of main forward facilities. Attempt major damage to Natanz and Frodo. Do strike Bushehr reactor.
- Single or multiple strikes against broad range of known and suspect facilities including centrifuge produce and research reactor; hit all main sites. Do strike Bushehr reactor (?)
- Tailor strikes to stimulate maximum Iranian hostile attack: “Trigger force” to push US and Gulf states to respond.
- Restrike after Iran attempts to recover; escalation to other key infrastructure or military target to deter further Iranian efforts.
- Preventive/preemptive nuclear strike on Iranian force after test or deployment; threat to attack Iranian population centers if Iran responds.



# Possible Iranian Responses to US and Israeli Strikes

**Withdraw from the NPT and increase its long-term resolve to develop a nuclear deterrent program.**

- Create an all-out nuclear weapons program with its surviving equipment and technology base, using Israel’s strike and aggression as an excuse to openly pursue a nuclear program.**
- Shift to genetically engineered biological weapons if such a program does not already exist.**
- Immediate retaliation using its ballistic missiles on Israel. Multiple launches of Shahab-3 including the possibility of CBR warheads against Tel Aviv, Israeli military and civilian centers, and Israeli suspected nuclear weapons sites.**
- Accuse the US of “green lighting” the Israeli strike, and being the real cause of the attacks.**
- Launch political attacks on Arab regimes friendly to the US on the grounds they did nothing to prevent an attack on Israel’s greatest enemy.**
- Use allied or “proxy” groups such as Hezbollah or Hamas to attack Israel proper with suicide bombings, covert CBR attacks, and rocket attacks from southern Lebanon.**
- Launch asymmetric attacks against American interests and allies in the Arabian Gulf.**
- Target US and Western shipping in the Gulf, and possibly attempt to interrupt the flow of oil through the Strait of Hormuz.**
- Attack US forces, ships, or facilities in the Gulf or anywhere in the world as a way of showing that Iran could attacks the “great Satan” and Israel ‘s closest ally.**
- Strike at Israeli or Jewish targets anywhere in the world using Iranian agents or anti-Israeli-proxies.**
- Try to use the UN and/or World Court to attack Israel for aggression and war crimes.**
- Transfer high technology small air-to-surface and guided anti-armor weapons to Hamas, Hezbollah, or other extreme anti-Israeli groups. Provide them with more lethal rockets, UCAVs, and chemical weapons.**
- Seek to use its leverage with Iraq, Syria, and Hezbollah to create an actual “Shi’ite crescent” to create a more intense range of threats to Israel.**
- Try to use the transfer of funds and arms, the MOIS/Vevak, and other covert means to influence the new regimes coming out of unrests in the Arab world to be far more aggressively anti-Israel.**

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300 miles  
500 km

TURKMENISTAN

TURKEY

Bonab



Lashkar A'bad

CASPIAN SEA

Ramsar

# Key Iranian Nuclear Targets

Sites circled in red  
unknown pre-mid 2002



Tehran

Parchin

IRAQ



Arak

Fordo



Natanz

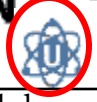


Isfahan

IRAN



Saghand



Ardekan

AFGHANISTAN

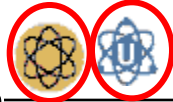
- MW** Megawatts
- Uranium processing facility
- Uranium mines
- Heavy-water facility
- Research reactors / research facilities
- Uranium enrichment facility
- Light-water reactor (under construction)



Bushehr

KUWAIT

The Gulf



Gachin

PAKISTAN

SAUDI ARABIA

BAHRAIN

QATAR

Gulf of Oman

MIDDLE EAST

## **Nuclear Conversion:**

1. Jabr Ibn Hayan Multipurpose Laboratories
2. Rudan Conversion Facility
3. Uranium Conversion Facility (UCF)

## **Nuclear Education and Training:**

1. Amir Kabir University of Technology
2. Imam Hussein University (IHU)
3. Institute for Studies in Theoretical Physics and Mathematics (IPM)
4. Malek Ashtar University (MAU)
5. Sharif University of Technology (SUT)
6. University of Tehran (UT)

## **Nuclear Enrichment:**

1. 7<sup>th</sup> of Tir Industries
2. Defense Industries Organization (DIO)
3. Farayand Technique
4. Fordow Fuel Enrichment Plant
5. Fuel Enrichment Plant (FEP)
6. Kalaye Electric Company
7. Kaveh Cutting Tools Company
8. Lashkar Ab'ad
9. Natanz Enrichment Complex
10. Pars Trash
11. Pilot Fuel Enrichment Plant (PFEP)
12. Tehran Nuclear research Center (TNRC)

## **Nuclear Fuel Fabrication:**

1. Fuel Fabrication Laboratory (FFL)
2. Fuel Manufacturing Plant (FMP)
3. Zirconium Production Plant (ZPP)

## **Nuclear Heavy Water Production:**

1. Heavy Water Production Plant (HWPP)

## **Nuclear Mining and Milling:**

1. Ardakan Yellowcake Production Plant
2. Bandar Abbas Uranium Production Plant (BUP)
3. Saghand

## **Nuclear Power Reactors:**

1. Bushehr Nuclear Power Plant (BNPP)
2. Darkhovin Nuclear Power Plant

## **Nuclear – Regulatory:**

1. Atomic Energy Organization of Iran (AEOI)

## **Nuclear Reprocessing:**

1. Tehran Nuclear Research Center (TNRC)

## **Nuclear Research Reactors:**

1. IR-40
2. Miniature Neutron Source Reactor (MNSR)
3. Tehran Research Reactor (TRR)

## **Nuclear Research and Development:**

1. Bonab Atomic Energy Research Center
2. Graphite Sub-Critical Reactor (ENTC GSCR)
3. Heavy Water Zero Power Reactor (ENTC-HWZPR)
4. Isfahan Nuclear Fuel Research and Production Center (NFRPC)
5. Isfahan Nuclear Technology Center (NTC)
6. Karaj Agricultural and Medical Research Center
7. Light Water Sub-Critical Reactor (ENTC-LWSCR)
8. Plasma Physics Research Center (TNRC)
9. Yazd Radiation Processing Center (YRPC)

## **Nuclear Waste Management:**

1. Anarak Waste Storage Facility
2. Isfahan Nuclear Waste Storage Facility
3. Karaj Waste Storage Facility
4. Qom Waste Disposal Site

## **Nuclear Weaponization:**

1. Institute of Applied Physics (IAP)
2. Kimia Maadan Company (KM)
3. Parchin Military Complex
4. Physics Research Center (PHRC)
5. Tehran Nuclear Research Center (TNRC)

# Natanz Centrifuge Facility: Vehicle Entrance Ramp (before burial)

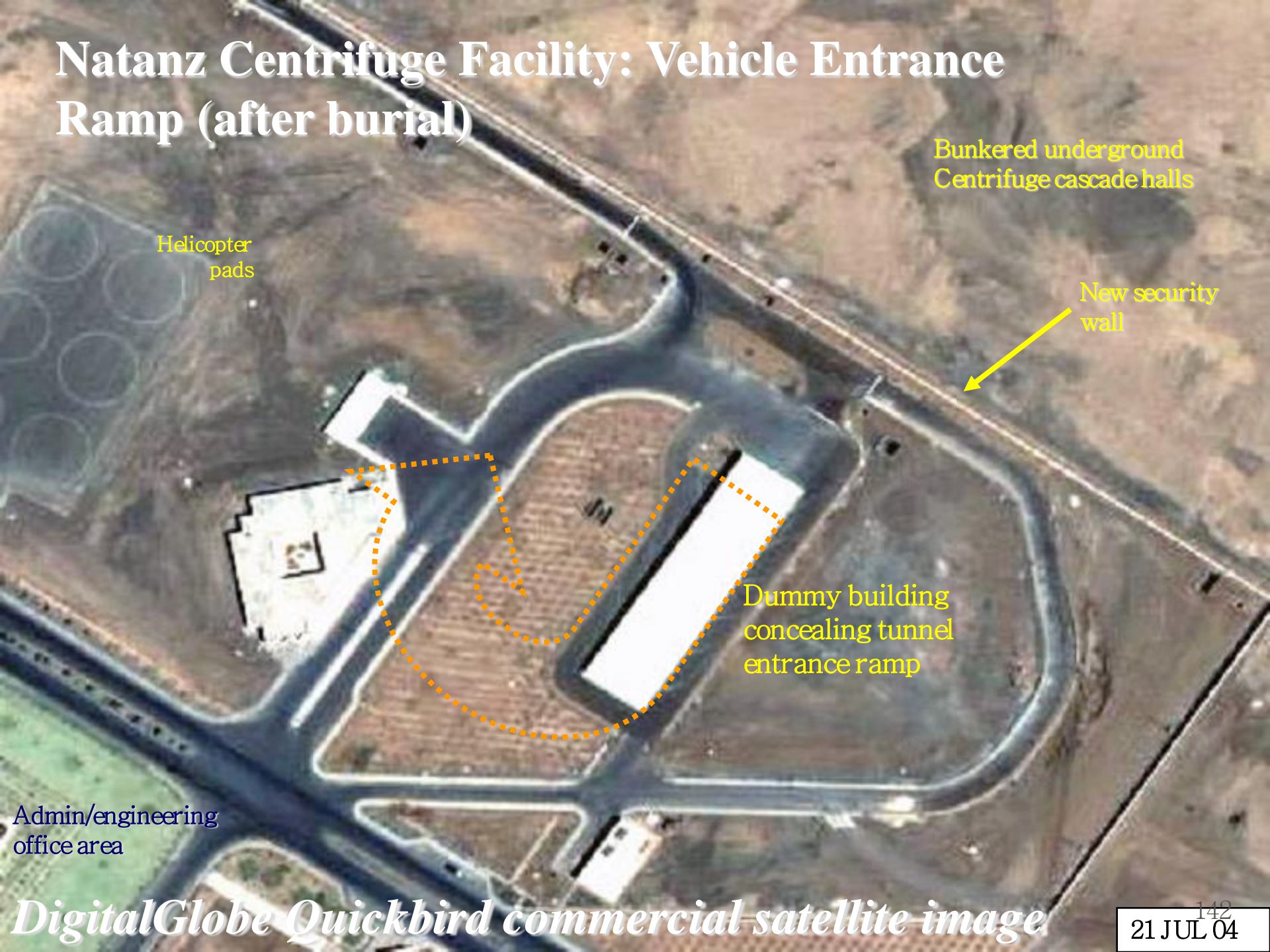
Bunkered underground production halls

Admin/engineering office area

*DigitalGlobe Quickbird commercial satellite image*

141  
20 SEP 02

# Natanz Centrifuge Facility: Vehicle Entrance Ramp (after burial)



Helicopter pads

Bunkered underground Centrifuge cascade halls

New security wall

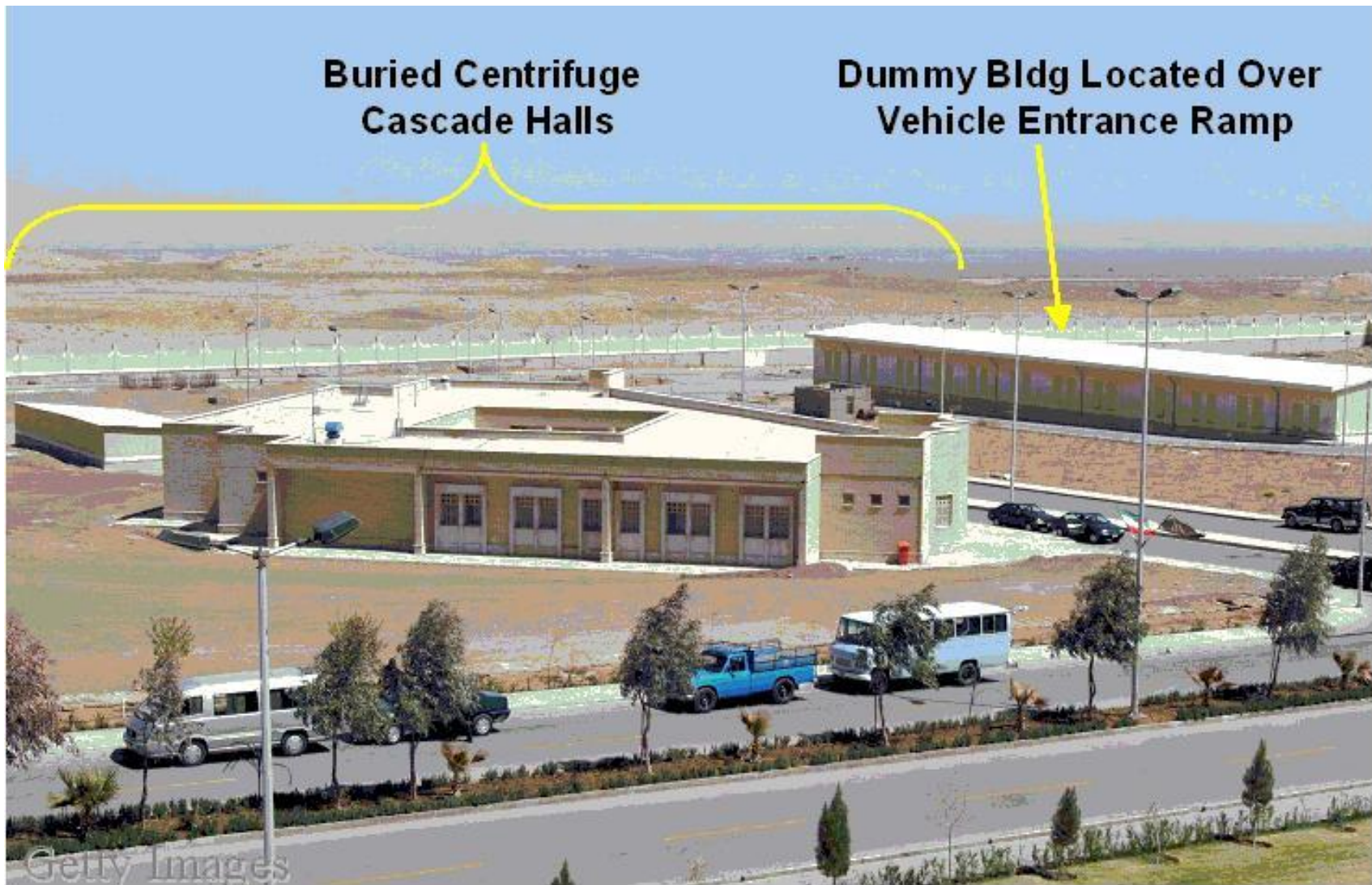
Dummy building concealing tunnel entrance ramp

Admin/engineering office area

*DigitalGlobe Quickbird commercial satellite image*

142  
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# Natanz: Effective Concealment



# Fordoo Fuel Enrichment Plant – In Process

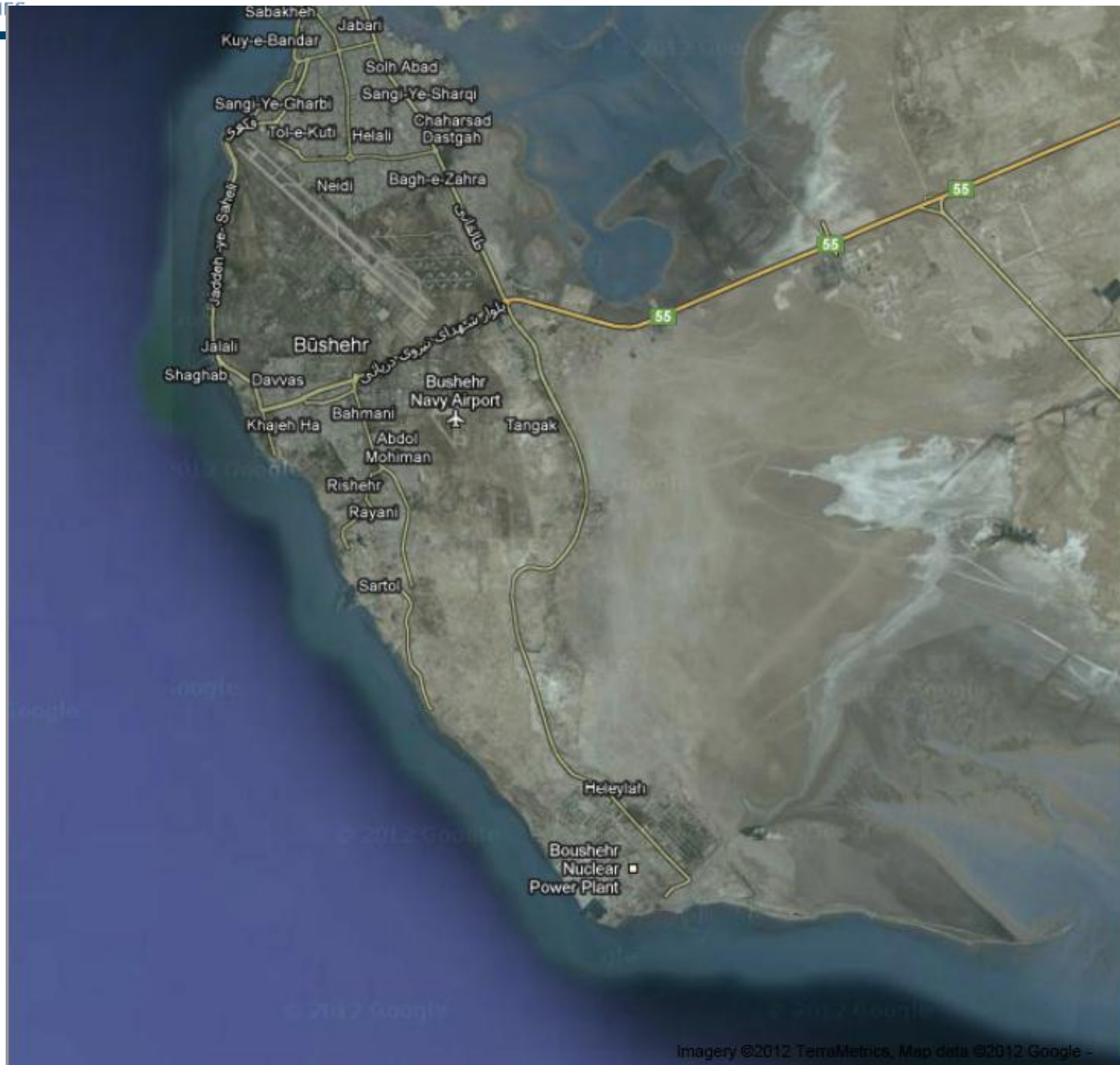




# Fordow Fuel Enrichment Plant- Finishing



# Bushehr City and Reactor Area



# Bushehr Reactor

