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American Strategy and Critical Challenges in U.S. "Energy Import Dependence"

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Request for comments:

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American Strategy and Critical Changes in U.S. “Energy Import Dependence”

Executive Summary

Changes in U.S. energy production, energy technology, and the way oil and gas reserves are estimated, are raising serious questions about the future U.S. dependence on energy imports, and how this affects U.S. strategy. While projections of US import dependence rare highly uncertain, and various sources differ sharply in detail, official U.S. projections show a steady decline in the level of future direct import dependence.

It is important to note, however, that U.S. strategic dependence on the stable flow of world energy exports at market prices is very different from total U.S. dependence on energy imports as measured in either the total level of energy used and produced in the U.S. in quads or direct imports of petroleum.

U.S. strategic dependence on direct energy imports is almost exclusively a matter of dependence on petroleum liquids and the ability to provide energy for the U.S. transportation sector and other users that cannot easily or cost effectively substitute other sources of energy. The U.S. can be a net exporter of other fuels – such as like coal and natural gas – and still be highly dependent on imports of crude oil.

Changing Estimates of Direct Energy Import Dependence

The 2015 EIA projections of U.S. imports reflect the possibility of a far lower dependence on imports, a greater possibility of a possible U.S. shift to crude exports, and a far wider range of uncertainty in every aspect of the future U.S. strategic dependence on direct imports of crude oil and liquid fuels.

The EIA summarizes these trends as follows:[1]

> U.S. crude oil production from tight formations leads the growth in total U.S. crude oil production in all the AEO2015 cases. In the Reference case, lower levels of domestic consumption of liquid fuels and higher levels of domestic production of crude oil push the net import share of crude oil and petroleum products supplied down from 33% in 2013 to 17% in 2040.
>
> In the High Oil Price and High Oil and Gas Resource cases, growth in tight oil production results in significantly higher levels of total U.S. crude oil production than in the Reference case. Crude oil production in the High Oil and Gas Resource case increases to 16.6 million barrels per day (bbl/d) in 2040, compared with a peak of 10.6 million bbl/d in 2020 in the Reference case. In the High Oil Price case, production reaches a high of 13.0 million bbl/d in 2026, then declines to 9.9 million bbl/d in 2040 as a result of earlier resource development. In the Low Oil Price case, U.S. crude oil production totals 7.1 million bbl/d in 2040.
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> The United States becomes a net petroleum exporter in 2021 in both the High Oil Price and High Oil and Gas Resource cases. With lower levels of domestic production and higher domestic consumption in the Low Oil Price case, the net import share of total liquid fuels supply increases to 36% of total domestic supply in 2040.

The end result is a situation where the U.S. still seems likely to remain dependent on crude oil imports, albeit at levels where the reference case is well under 30%, and could be as low as 17% in 2040 - roughly half the level of dependence estimated in 2013. At the same time, the U.S. is projected to be able to export gasoline and products by 2021.

At the same time, the EIA analysis of future direct dependence has become more complex and uncertain as the mix of technologies, market scenarios, and uncertainties affecting future supply have altered its estimates, but the key portions of its 2015 analysis of U.S. dependence on oil and liquids imports as follows: [2]

> In the Reference case, the existing U.S. competitive advantage in oil refining compared to the rest of the world continues over the projection period. This advantage results in growing gasoline and diesel exports through 2040 in the Reference case. The production of motor gasoline blending components, which totaled 7.9 million bbl/d in 2013, begins declining in 2015 and falls to 7.2 million bbl/d by the end of the projection period, while diesel fuel production rises from 4.2 million bbl/d in 2013 to 5.3 million bbl/d in 2040.
>
> *As a result of declining consumption of liquid fuels and increasing production of domestic crude oil, net imports of crude oil and petroleum products fall from 6.2 million bbl/d in 2013 (33% of total domestic consumption) to 3.3 million bbl/d in 2040 (17% of domestic consumption) in the Reference case*. Growth in gross exports of refined petroleum products, particularly of motor gasoline and diesel fuel, results in a significant increase in net petroleum product exports between 2013 and 2040.
>
> In both the High Oil and Gas Resource and High Oil Price cases, total U.S. crude oil production is higher than in the Reference case, mainly as a result of growth in tight oil production, which rises at a substantially faster rate in the near term in both cases than in the Reference case. In the High Oil and Gas Resource case, tight oil production grows in response to assumed higher estimated ultimate recovery (EUR) and technology improvements, closer well spacing, and development of new tight oil formations or additional layers within known tight oil formations. Total crude oil production reaches 16.6 million bbl/d in 2037 in the High Oil and Gas Resource case.
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> In the High Oil Price case, higher oil prices improve the economics of production from new wells in tight formations as well as from other domestic production sources, leading to a more rapid increase in production volumes than in the Reference case. Tight oil production increases through 2022, when it totals 7.4 million bbl/d. After 2022, tight oil production declines, as drilling moves into less productive areas. Total U.S. crude oil production reaches 13.0 million bbl/d by 2025 in the High Oil Price case before declining to 9.9 million bbl/d in 2040…
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> Recent declines in West Texas Intermediate oil prices (falling by 59% from June 2014 to January 2015) have triggered interest in the effect of lower prices on U.S. oil production. In the Low Oil Price case, domestic crude oil production is 9.8 million bbl/d in 2022, 0.7 million bbl/d lower than the 10.4 million bbl/d in the Reference case. In 2040, U.S. crude oil production is 7.1 million bbl/d, 2.3 million bbl/d lower than the 9.4 million bbl/d in the Reference case.
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> Most of the difference in total crude oil production levels between the Reference and Low Oil Price cases reflects changes in production from tight oil formations. However, all sources of U.S. oil production are adversely affected by low oil prices. As crude oil prices fall and remain at or below $76/ barrel (Brent) in the Low Oil Price case after 2014, poor investment returns lead to fewer wells being drilled in noncore areas of formations, which have smaller estimated ultimate recoveries (EURs) than wells drilled in core areas. As a result, they have a more limited impact on total production growth in the near term.
>
> …Production of petroleum products at U.S. refineries depends largely on the cost of crude oil, domestic demand, and the absorption of petroleum product exports in foreign markets. U.S. refinery production of gasoline blending components declines in the Reference and Low Oil Price cases but increases in the High Oil Price and High Oil and Gas Resource cases. The steepest decline in production of motor gasoline blending components is projected in the Reference case, with production of blending components declining from 7.9 million bbl/d in 2013 to 7.2 million bbl/d in 2040, in response to a drop in U.S. crude oil production, higher crude oil prices, and lower demand.
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> In the High Oil and Gas Resource case, production of blending components increases to 9.1 million

bbl/d in 2040, because abundant domestic supply of lighter crude oil results in lower feedstock costs for refiners, lower gasoline prices, increased exports, and relatively higher levels of gasoline consumption (including exports) and production. Diesel fuel output from U.S. refineries rises in the High Oil and Gas Resource case from 4.2 million bbl/d in 2013 to 6.6 million bbl/d in 2037, as a result of lower costs for refinery feedstocks. In the Low Oil Price case, lower domestic diesel fuel prices result in higher levels of domestic consumption, leading to a 4.7 million bbl/d increase in diesel fuel production in 2040. In the High Oil Price case, higher oil prices (which are assumed to occur worldwide) make diesel fuel from U.S. refineries more competitive. Total U.S. diesel fuel output increases to 6.1 million bbl/d in 2040. In the Reference case, U.S. diesel fuel output increases to 5.3 million bbl/d in 2040.

…As in the Reference case, the United States remains a net importer of liquid fuels through 2040 in the Low Oil Price case. In the High Oil and Gas Resource case, as a result of higher levels of both domestic crude oil production and petroleum product exports, the United States becomes a net exporter of liquid fuels by 2021.

Refiners and oil producers gain a competitive advantage from abundant domestic supply of light crude oil and higher GOM production of lower API crude oil streams, along with lower refinery fuel costs as a result of abundant domestic natural gas supply. *In the High Oil Price case, the United States becomes a net exporter of liquid fuels in 2020, as higher oil prices reduce U.S. consumption of petroleum products and spur additional U.S. crude oil production. U.S. net crude oil imports—which fall to 5.5 million bbl/d in 2022 as domestic crude oil production grows—rise to 8.9 million bbl/d in 2040 as domestic production flattens and begins to decline.*

By 2040, the level of net liquid fuels exports is significantly larger in the High Oil and Gas Resource case than in the High Oil Price case. In the High Oil Price case, higher world crude oil prices make overseas refineries less competitive compared to U.S. refineries. *As a result, net U.S. exports of petroleum products increase by more in the High Oil Price case than in the High Oil and Gas Resource case. However, the availability of more domestic crude oil resources in the High Oil and Gas Resource case results in a significantly greater drop in net crude oil imports and a larger overall swing in liquid fuels trade than in any of the other AEO2015 cases*

… U.S. net imports of liquid fuels as a share of total domestic consumption continue to decline in the AEO2015 Reference case, primarily as a result of increased domestic oil production. Net imports of liquid fuels as a share of total U.S. liquid fuel use reached 60% in 2005 before dipping below 50% in 2010 and falling to an estimated 33% in 2013 (Figure E5).

The net import share of domestic liquid fuels consumption declines to 14% in 2020 in the AEO2015 Reference case—compared with 26% in the AEO2014 Reference case—as a result of faster growth of domestic liquid fuels supply compared with growth in consumption. Domestic liquid fuels supply begins to decline after 2023 in the AEO2015 Reference case, and as a result, the net import share of domestic liquid fuels consumption rises from 14% in 2022 to 17% in 2040. However, domestic liquid fuels supply in the AEO2015 Reference case is 25% higher in 2040 than in the AEO2014 Reference case, while domestic consumption is only 3% higher. As a result, despite increasing after 2020, the percentage of U.S. liquid fuel supply from net imports in the AEO2015 Reference case remains just over half that in the AEO2014 Reference case through 2040.

Other forms of U.S. Strategic Dependence on Stable Global Energy Exports and Indirect US Energy Imports

U.S. dependence on direct imports of petroleum is only part of the story, and no longer is the most important part in strategic terms. U.S. strategic dependence on the flow of world oil exports involves a number of other variables – several of which are now more important than direct import dependence.

These variables include:

- The rising instability in the Middle East, North Africa, and other exporting areas since 2011. Civil war, insurgency, and violent Islamist extremism in or near key exporters, and a growing arms race between Iran and the Arab Gulf states.
- The lack of any credible strategic alternative to U.S. power projection into the Middle East and the Gulf, and a U.S. strategic partnership with the Arab Gulf states – coupled to the fact any other potential source of power projection would now have to come from China and Russia.
- The fact that U.S. energy prices are shaped by world oil and energy prices and any crisis affecting world oil and gas exports has a major direct impact on the U.S. economy.
- The steady increase in U.S. dependence on the overall health of the global economy.
- The fact that the U.S. is now critically dependent on the steady flow of manufactured goods and industrial imports, and these now come from countries whose economies and ability to export is critical dependent on the flow of Gulf and other oil and gas exports.

If these variables are taken fully into consideration, US strategic dependence on the stable flow of world petroleum exports will increase regardless of the level of US petroleum imports and the need for US strategic partnerships with key oil exporting states will be at least as critical in the future as the present.

U.S. Dependence on the Global Economy and Sensitivity to World Oil Prices

There is no simple way to quantify U.S. economic dependence on the global economy and secure flow of global energy exports. It is all too clear, however, that this dependence continues to increase. As the "great recession" showed all too clearly after 2007, the U.S. economy is critically dependent on the health of the global economy.

The U.S. must pay world prices for energy. Even in a partial recovery year like 2010 the global economy depended on the predictable flow of 45 million barrels a day of crude oil imports, 23.75 million barrels of refined products, and 1.6 trillion cubic feet of gas. Any major interruption in the flow of energy exports raises world market prices, and the U.S. economy must pay such prices regardless of where the interruption occurs.

There is also ample historical evidence as to just how quickly oil prices can change in a crisis, and past price rises would have been much sharper if the U.S. had not acted to reassure and support its Gulf allies, or what would have happened if the conflicts that began in 2011 had spread throughout the region and sustained or even increased peak oil prices.

The Vulnerability of World Oil Exports

There are other reasons why the U.S. defense strategic guidance issued in early 2012 gave the same strategic importance to the MENA region as rebalancing to Asia, why the U.S. has since built up is asymmetric warfare capabilities in the Gulf, why U.S. forces are involved in Iraq and Yemen, and why recent U.S. Navy seapower studies project an increase in U.S. naval deployments.

In spite of the increase in reserves and production in other regions, the MENA area still dominates the reserves of exportable oil and plays a critical role in reserves of gas. The same is true of current production, and it is clear that both reserves and production are concentrated in the Gulf region. BP estimates that:[3]

- Some 52% of world oil reserves are in the MENA region, with some 48% of that total in the Gulf.
- A little over 36% of world oil production took place in the MENA region in 2013, with some 32% in the Gulf.

- Roughly 48% of world natural gas reserves are in the MENA region, with more than 42% in the Gulf.
- A little over 21% of world natural gas production took place in the MENA region in 2013, with some 17% in the Gulf.

Like the EIA, the International Energy Agency (IEA) estimates that the growth in future world oil production through 2040 will be dominated by the Middle East, while the increases in prediction in other key areas like Brazil, Canada, and the U.S. will be far more limited or decline.[4] It notes in its summary of its *World Energy Outlook* for 2014 that, "The short-term picture of a well-supplied market should not obscure future risks as demand rises to 104 million barrels per day, and reliance grows on Iraq and the rest of the Middle East." It also projects that the Middle East will be a key supplier of LNG through 2040 [5]

As the EIA noted in a report issued in November 2014, [6]

> In 2013, total world petroleum and other liquids production was about 90.1 million barrels per day (bbl/d). EIA estimates that about 63% of this amount (56.5 million bbl/d) traveled via seaborne trade. Oil tankers accounted for 30% of the world's shipping by deadweight tonnage in 2013, according to data from the United Nations Conference on Trade and Development (UNCTAD).
>
> International energy markets depend on reliable transport routes. Blocking a chokepoint, even temporarily, can lead to substantial increases in total energy costs and world energy prices. Chokepoints also leave oil tankers vulnerable to theft from pirates, terrorist attacks, shipping accidents that can lead to disastrous oil spills, and political unrest in the form of wars or hostilities.
>
> … Located between Oman and Iran, the Strait of Hormuz connects the Persian Gulf with the Gulf of Oman and the Arabian Sea. The Strait of Hormuz is the world's most important oil chokepoint because of its daily oil flow of 17 million barrels per day in 2013. Flows through the Strait of Hormuz in 2013 were about 30% of all seaborne-traded oil.
>
> EIA estimates that more than 85% of the crude oil that moved through this chokepoint went to Asian markets, based on data from Lloyd's List Intelligence tanker tracking service. Japan, India, South Korea, and China are the largest destinations for oil moving through the Strait of Hormuz.
>
> Qatar exported about 3.7 trillion cubic feet (Tcf) per year of liquefied natural gas (LNG) through the Strait of Hormuz in 2013, according to BP's Statistical Review of World Energy 2014. This volume accounts for more than 30% of global LNG trade.

The US strategic role in the Middle East, and its partnership with the Arab Gulf states, remains a vital US strategic interest because the flow of energy exports through the Gulf, the Strait of Hormuz, the Gulf on Oman, and nearby waters in the Indian Ocean is so vulnerable, and because the turmoil and conflict elsewhere in the Middle East has meant there are so few pipeline alternatives.

While new pipelines will increase capacity marginally in the future, the strategic importance of this increase will be offset by the fact that the estimate increases in Gulf oil exports will exceed the new pipeline capacity and the pipeline ports on the Indian Ocean will be well with the range of potential Iranian attacks, [7]

The Importance of Indirect Imports to U.S. Trade and Economic Stability

At the same time, the US is already critically dependent on indirect imports of petroleum in the form of manufactured and industrial goods. The CIA *World Factbook* estimates that U.S. had a $16.72 trillion economy in 2014. The data on U.S. imports and exports lag a year, but total U.S. exports were $1.575 trillion in 2013, or roughly 9% of the U.S. GDP while U.S. imports were $2,273 trillion in 2013, or roughly 14% of the U.S. GDP.

In 2013, at a time when U.S. direct dependence on energy imports was far higher than is projected for the future, the CIA estimated that energy imports only accounted for 8.2% of total U.S. imports – or $186 billion. In contrast, 24.7% of total U.S. imports were industrial supplies ($622 billion), 30.4% were capital goods ($691 billion), and 31.8% ($723 billion) were consumer goods -- for total of 86.9% of all U.S. imports ($1,975 billion).

These percentages all highlight the importance the stable flow of global trade, since much of the U.S. manufacturing center and high technology activity is now dependent on the steady flow of imported elements and components. As a result, U.S. growth and health of the U.S. economy, and of American jobs, is critically dependent on the flow of imports of industrial supplies and capital goods.

All of these US imports are, however, critically dependent on the flow of Gulf and MENA petroleum exports to the states that provide such exports of industrial supplies, capital goods, and consumer good to the US. As a result, they become indirect imports of petroleum. China, Korea, Japan and other key exporters to the U.S. are critically dependent on Gulf energy exports. These nations that accounted for over 33% of all U.S. imports – – a percentage of U.S. trade roughly four times larger than direct U.S. import dependence on petroleum imports in 2013.

These conclusions are supported by the data on foreign dependence on Gulf and MENA oil that International Energy Agency provided in its report on *Energy Supply Security 2014, Emergency Response of IEA Countries 2014*.[8] They are further reinforced by data that BP has issued on interregional trade movements. The BP *Statistical Review of Energy for 2014* reports that the "Middle East" – which consists almost totally of Gulf oil exports in BP reporting – exported a total of 19.4 million barrels a day of oil in 2013. Out of this total,[9]

- 2.0 MMBD went to the U.S. out of total imports of 9.8 MMBD.
- 2.1 MMB went to Europe out of total imports of 12.6 MMBD.
- 3.1 MMD went to China out of total imports of 6.9 MMBD.
- 2.5 MMD went to India out of total imports of 4.1 MMBD.
- 3.3 MMD went to India out of total imports of 4.5 MMBD.
- 1.1 MMD went to Singapore out of total imports of 3.0 MMBD.
- 4.6 MMD went to the rest of Asia out of total imports of 7.5 MMBD.

Taken together, these data indicate a level of continuing US strategic dependence on indirect imports that goes far beyond the uncertain future U.S. need for direct petroleum imports. The also indicate a critical need for the U.S. to reappraise how it assesses strategic dependence and its vital national security interests. Almost none of the official estimates of U.S. import dependence – past, current- or future – take indirect imports into consideration.

Assessing the Impact of A Major Conflict in the Gulf

The unclassified U.S. official assessments of the impact of major energy interruptions have not kept current with these shifts in direct and indirect strategic dependence, and the risks of a major war in the Gulf. They are badly out of date and need to focus on the broader impact of such a conflict on the global economy as well as on oil and gas supply and price effects.

The International Energy Agency (IEA) has conducted recent public studies of the impact of major energy interruptions in 2011 and 2014, although they did not examine the risk of a major war in the Gulf region, or the broader economic consequences of energy interruptions on world trade and the global economy. As a result, the IEA issued the following warnings:[10]

- Although the oil delivery system has changed dramatically since the oil shocks of the 1970s, there is still a high risk of a supply disruption which could have great economic consequences for IEA member countries.
- Capacity constraints, both in production and refining, have increased the potential of supply falling short of demand. Given this delicate balance of supply and demand, even a disruption of relatively small volume can have a significant impact on the market.
- Global demand growth exacerbates market tightness, further re-enforcing the need for investment in capacity expansion.
- Uncertain investment climates in some producer countries, often described as an aspect of "resource nationalism", may also hamper the development of future supply streams.
- Geopolitical tensions and terrorism create uncertainty as to the continuous availability of supply. This "risk premium" adds to the volatility of an already tense market, where available oil supplies are increasingly concentrated in fewer countries.
- Natural disasters, such as extreme weather conditions, can disrupt the supply/demand balance, cutting off supply or causing demand to spike.
- ...the unexpected event!

Work by the IEA also shows that past interruptions have been much smaller in scale and duration that what could happen in the future.

Some additional work has been done by U.S. think tanks and the US Congress, but it does not have official standing of work by the EIA, and such work has never fully examined the impact on indirect imports.[11] Accordingly, the public modeling efforts of by the Department of Energy badly need to be updated to examine the new threats posed by non-state actors and the growing potential impact of a major war in the Gulf. Like the overall nature of U.S. import dependence, such assessments need to focus on the impact on indirect imports and world trade, and on the nature of regional dependence on energy imports to sustaining exports to the U.S., particularly in the case of Asia.

Table of Contents

U.S. Total "Energy Independence" Measure in Quadrillion BTUs (Quads)

During the last half decade, the International Energy Agency (IEA), and the Energy Information Agency (EIA) of the U.S. Department of Energy, have issued estimates of future U.S. energy supply and demand that show that a combination of new technologies, and more diverse sources of fossil and other fuels, could give the U.S. enough annual output *of all forms of energy* to be a net exporter of energy.

Total U.S. Energy Supply and Demand for All Forms of Energy

The EIA issued forecasts in April 2015 that indicated total U.S. energy import dependence based on national energy consumption in quadrillions of BTUs (Quads) will drop from 30% in 2005, and roughly 10% in 2013, to some 5%-8% in most scenarios during 2020-2030. They also indicate that the U.S. could become a net exporter of energy at levels of 10-25% after 2025-2030 in the "high oil price" and "high oil and gas resource scenarios.

The EIA describes these results as follows, and they are shown in **Figure 1** below:[12]

> U.S. net energy imports decline and ultimately end, largely in response to increased oil and dry natural gas production Energy imports and exports come into balance in the United States in the AEO2015 Reference case, starting in 2028.
>
> In the High Oil Price and High Oil and Gas Resource cases, with higher U.S. crude oil and dry natural gas production and lower imports, the United States becomes a net exporter of energy in 2019. In contrast, in the Low Oil Price case, the United States remains a net energy importer through 2040 (Figure 1). Economic growth assumptions also affect the U.S. energy trade balance. In the Low Economic Growth case, U.S. energy imports are lower than in the Reference case, and the United States becomes a net energy exporter in 2022. In the High Economic Growth case, the United States remains a net energy importer through 2040.
>
> The share of total U.S. energy production from crude oil and lease condensate rises from 19% in 2013 to 25% in 2040 in the High Oil and Gas Resource case, as compared with no change in the Reference case. Dry natural gas production remains the largest contributor to total U.S. energy production through 2040 in all the AEO2015 cases, with a higher share in the High Oil and Gas Resource case (38%) than in the Reference case (34%) and all other cases.
>
> In 2013, dry natural gas accounted for 30% of total U.S. energy production. Coal's share of total U.S. energy production in the High Oil and Gas Resource case falls from 26% in 2013 to 15% in 2040. In the Reference case and most of the other AEO2015 cases, the coal share remains slightly above 20% of total U.S. energy production through 2040; in the Low Oil Price case, with lower oil and gas production levels, it remains essentially flat at 23% through 2040.

The U.S. as a Possible Net Exporter of Energy

The EIA, like the IEA and other meaningful sources of such projections, indicates that they are highly uncertain in the out years in terms of every meaningful parameter involved, and that future resources levels, technology, and price have substantial uncertainty in every credible scenario. In another report, the EIA summarizes the key factors and uncertainties driving the estimates in **Figure 1** as follows:[13]

> Projections in EIA's *Annual Energy Outlook 2015* (AEO2015), released April 14, show the potential to eliminate net U.S. energy imports sometime between 2020 and 2030. This reflects changes in both supply and demand, as continued growth in oil and natural gas production and the use of

> renewables combine with demand-side efficiencies to moderate demand growth. The United States has been a net importer of energy since the 1950s.
>
> The United States is currently an exporter of petroleum products and coal, but an importer of natural gas and crude oil. When the energy content of these fuels is combined, the United States in 2014 imported 23.3 quadrillion British thermal units (Btu) of energy and exported 12.2 quadrillion Btu. Projections in EIA's recently released AEO2015 show that, on an energy content basis, U.S. energy imports and exports could come into balance in coming years.
>
> The timing of the projected end to U.S. net energy imports depends on assumptions about oil prices, energy resources, and economic growth. In the AEO2015 Reference case, imports and exports are balanced starting in 2028. In other cases, such as the High Oil Price and High Oil and Gas Resource cases, the United States becomes a net exporter of energy in 2019. However, in the Low Oil Price case, the United States remains a net energy importer through 2040.
>
> In most of these cases, natural gas is the dominant U.S. energy export, while crude oil and liquid fuels continue to be imported. In all cases, the United States transitions from a net importer of natural gas to a net exporter in 2017. These natural gas exports are mostly sent by pipeline to Mexico or in the form of liquefied natural gas (LNG) to other countries.
>
> The United States continues to be a net importer of crude oil and liquid fuels in most cases, despite increases in exports of petroleum products. Net trade in coal and other energy commodities is relatively unchanged.
>
> These changes in energy trade are anticipated based on both increases in domestic production—especially crude oil and natural gas—and more moderate expectations of demand growth. Subsequent articles will provide more information on these supply and demand projections.

Strategic Dependence on imports of Liquid Fuels vs. Total Energy Consumption

What is critical from a strategic viewpoint, however, is that an export surplus in total energy output in BTUs – or very low total import levels – is not a valid measure of U.S. strategic dependence on energy imports or the stable flow of world energy exports at market prices. **Figure 2** shows the EIA estimate of U.S. dependence on energy imports by fuel type in the reference or most likely case.

While the dotted shows that the U.S. may become a net exporter of total energy because of growing exports of natural gas and coal, the U.S. is projected to remain dependent on imports of crude oil through 2040, and crude oil is critical to the functioning of the U.S. transportation sector and other areas of consumption where there is no currently cost-effective way to substitute other fuels and sources of energy.

Continue Dependence on Crude Oil Imports in the Reference Case

There is no practical way in the near- to mid-term to substitute other forms of energy for petroleum and other liquid fuels. The massive U.S. transportation fleet alone makes the U.S. dependent on petroleum regardless of the level of its natural gas production, coal projection and other fuels.

Barring a massive and sustained crisis in petroleum supply and radical change in the economics of energy that would alter the entire character of critical aspects of the U.S. economy, this dependence will endure through the end of current projections, which is 2040. This dependence is reflected in the lack of variation in EIA estimates of the future energy consumption in a transportation sector that remains heavily dependent on gasoline and diesel fuels, and is shown in **Figure 3**,[14] Energy consumption in the transportation sector declines in the AEO2015 Reference case from 27.0 quadrillion Btu (13.8 million bbl/d) in 2013 to 26.4 quadrillion Btu (13.5 million bbl/d) in 2040. Energy consumption falls most rapidly through 2030, primarily as a result of improvement in light-duty vehicle (LDV) fuel economy with the implementation of corporate average fuel economy

(CAFE) standards and greenhouse gas emissions (GHG) standards (Figure 10). This projection is a significant departure from the historical trend. Transportation energy consumption grew by an average of 1.3%/year from 1973 to 2007—when it peaked at 28.7 quadrillion Btu—as a result of increases in demand for personal travel and movement of goods that outstripped gains in fuel efficiency.

Transportation sector energy consumption varies across the alternative cases (Figure 11). Compared with the Reference case, energy consumption levels in 2040 are higher in the High Economic Growth case (by 3.0 quadrillion Btu), Low Oil Price case (by 1.4 quadrillion Btu), and High Oil and Gas Resource case (by 1.2 quadrillion Btu) and lower in the High Oil Price case (by 1.4 quadrillion Btu) and Low Economic Growth case (by 2.6 quadrillion Btu).

In the Reference case, energy consumption by LDVs—including passenger cars, light-duty trucks, and commercial light-duty trucks—falls from 15.7 quadrillion Btu in 2013 to 12.6 quadrillion Btu in 2040, as increases in fuel economy more than offset increases in LDV travel. Total vehicle miles traveled (VMT) for LDVs increase by 36% from 2013 (2,711 billion miles) to 2040 (3,675 billion miles), and the average VMT per licensed driver increase from about 12,200 miles in 2013 to 13,300 miles in 2040.

The fuel economy of new vehicles increases from 32.8 mpg in 2013 to 48.1 mpg in 2040, as more stringent CAFE and GHG emissions standards take effect. As a result, the average fuel economy of the LDV stock increases by 69%, from 21.9 mpg in 2013 to 37.0 mpg in 2040.

Passenger vehicles fueled exclusively by motor gasoline for all motive and accessory power, excluding any hybridization and flex-fuel capabilities, accounted for 83% of new sales in 2013. In the AEO2015 Reference case, gasoline-only vehicles, excluding hybridization or flex-fuel capabilities, still represent the largest share of new sales in 2040, at 46% of the total (see the first box below for comparison of relative economics of various technologies). However, alternative fuel vehicles and vehicles with hybrid technologies gain significant market shares, including gasoline vehicles equipped with micro hybrid systems (33%), E85 flex-fuel vehicles (10%), full hybrid electric vehicles (5%), diesel vehicles (4%), and plug-in hybrid vehicles and electric vehicles (2%). (EIA considers several types of hybrid electric vehicles—micro, mild, full, and plug-in…

In comparison with the Reference case, LDV energy consumption in 2040 is higher in the Low Oil Price case (14.3 quadrillion Btu), High Economic Growth case (13.2 quadrillion Btu), and High Oil and Gas Resource case (12.9 quadrillion Btu), as a result of projected higher VMT in all three cases and lower fuel economy in the Low Oil Price and High Oil and Gas Resource cases.

Conversely, LDV energy consumption in 2040 in the High Oil Price case (10.6 quadrillion Btu) and the Low Economic Growth case (11.3 quadrillion Btu) is lower than projected in the Reference case, as a result of lower VMT in both cases and higher fuel economy in the High Oil Price case. Energy use by all heavy-duty vehicles (HDVs)—including tractor trailers, buses, vocational vehicles, and heavy-duty pickups and vans—increases from 5.8 quadrillion Btu (2.8 million bbl/d) in 2013 to 7.3 quadrillion Btu (3.5 million bbl/d) in 2040, with higher VMT only partially offset by improved fuel economy. HDV travel grows by 48% in the Reference case—as a result of increases in industrial output—from 268 billion miles in 2013 to 397 billion miles in 2040, while average HDV fuel economy increases from 6.7 mpg in 2013 to 7.8 mpg in 2040 as a result of HDV fuel efficiency standards and GHG emissions standards.

Diesel remains the most widely used HDV fuel. The share of diesel falls from 92% of total HDV energy use in 2013—with the remainder 7% motor gasoline and 1% gaseous (propane, natural gas, liquefied natural gas)—to 87% diesel in 2040, with natural gas, either compressed or liquefied, accounting for 7% of HDV energy use in 2040 as the economics of natural gas fuels improve and the refueling infrastructure expands.

> The largest differences from the Reference case level of HDV energy consumption in 2040 are in the High and Low Economic Growth cases (9.4 quadrillion Btu and 6.3 quadrillion Btu, respectively), as a result of their higher and lower projections for travel demand, respectively. Notably, the use of natural gas is significantly higher in the High Oil Price case than in the Reference case, at nearly 30% of total HDV energy use in 2040.

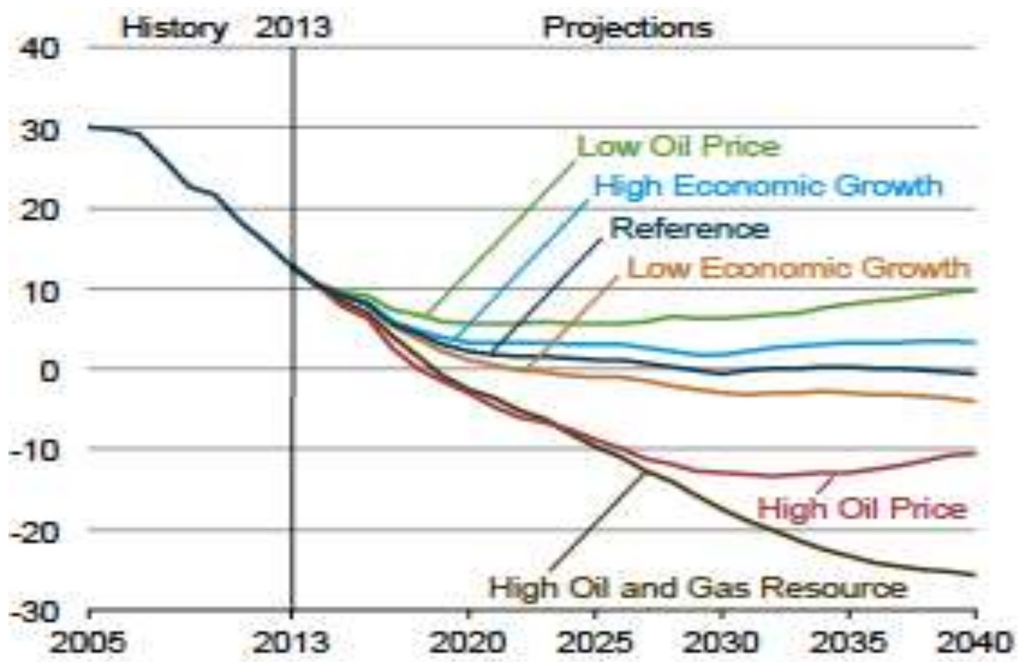
The EIA does explicitly examine the probable future energy savings and impact of hybrid and electric transportation vehicles and they remain competitive with fossil fueled vehicles.[15] Once again, no one can predict a technological breakthrough, but from a strategic viewpoint, it is hard to see how one could radically influence the projected strategic of dependence on fossil liquid fuels before 2025 at the earliest – given the sunk cost in the existing transport fleet and payback period for even a radical change in transportation technology.[16]

Continued Overall Dependence on Petroleum Liquids through 2040

This conclusion is reinforced by the relatively static projection of the total share of petroleum and other liquids in EIA projections of total U.S. energy use through 2014 shown in **Figure 4**. The percentage has dropped from 40% in 1990 to 36% in 2013, but is still predicted to be 33% in 2040 in the reference case.[17] The EIA summarizes these trends as follows:[18]

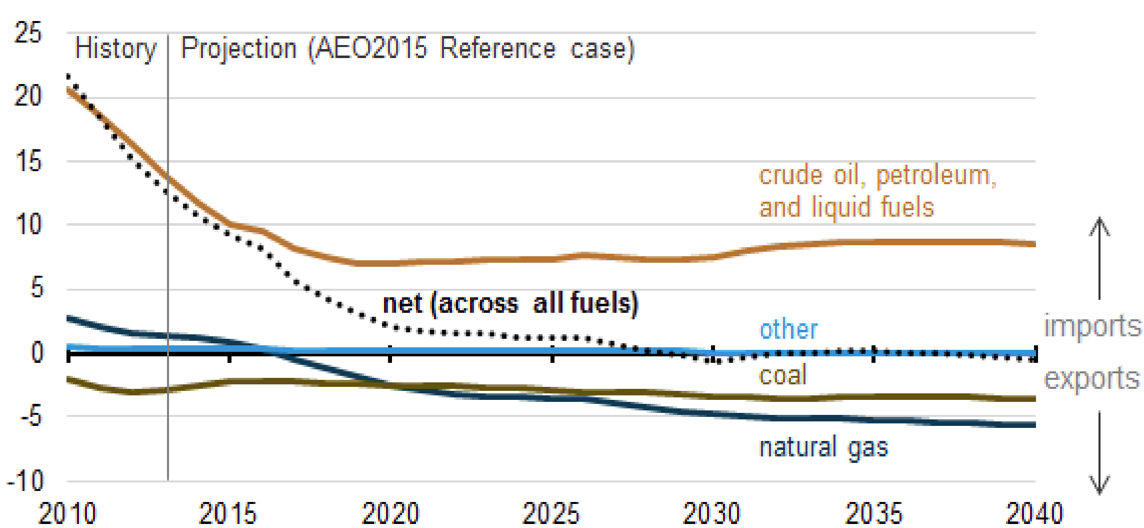
> Consumption of petroleum products across all sectors in 2040 is unchanged from 2013 levels, as motor gasoline consumption in the transportation sector declines as a result of a 70% increase in the average efficiency of on-road light-duty vehicles (LDVs), to 37 mpg in 2040, which more than offsets projected growth in vehicle, miles traveled (VMT).
>
> Total motor gasoline consumption in the transportation sector is about 3.4 quadrillion Btu (1.8 million barrels per day (bbl/d)) lower in 2040 than in 2013, and total petroleum consumption in the transportation sector is about 1.6 quadrillion Btu (0.9 million bbl/d) lower in 2040 than in 2013.
>
> U.S. consumption of petroleum and other liquids, which totaled 35.9 quadrillion Btu (19.0 million bbl/d) in 2013, increases to 37.1 quadrillion Btu (19.6 million bbl/d) in 2020, 2040. In the transportation sector, which continues to dominate demand for petroleum and other liquids, there is a shift from motor gasoline to distillate.
>
> The gasoline share of total demand for transportation petroleum and other liquids declines by 10.6 percentage points, while distillate consumption increases by 7.2 percentage points. Increased use of compressed natural gas and LNG in vehicles also replaces about 3% of petroleum and other liquids consumption in the transportation sector in 2040. Consumption of ethane and propane (the latter including propylene), which are used in chemical production, shows the largest increase of all petroleum products in the AEO2015 Reference case from 2013 to 2040. Industrial consumption of ethane and propane, extracted from wet gas in natural gas processing plants, grows by almost 1 quadrillion Btu (790 thousand bbl/d) as dry natural gas production increases.

Figure 1: U.S. net energy imports in six cases, 2005-40 (Quadrillion Btu)



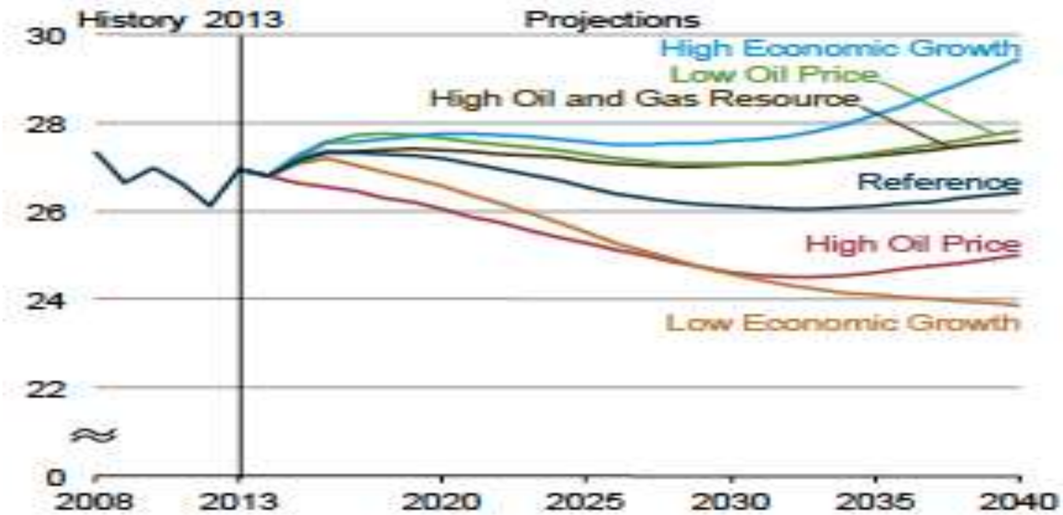
Source: U.S. Energy Information Administration,| *Annual Energy Outlook 2015*, p. ES-3, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

Figure 2: U.S. Net Energy Trade by Fuel Type 2010-2040 (Quadrillion BTU)



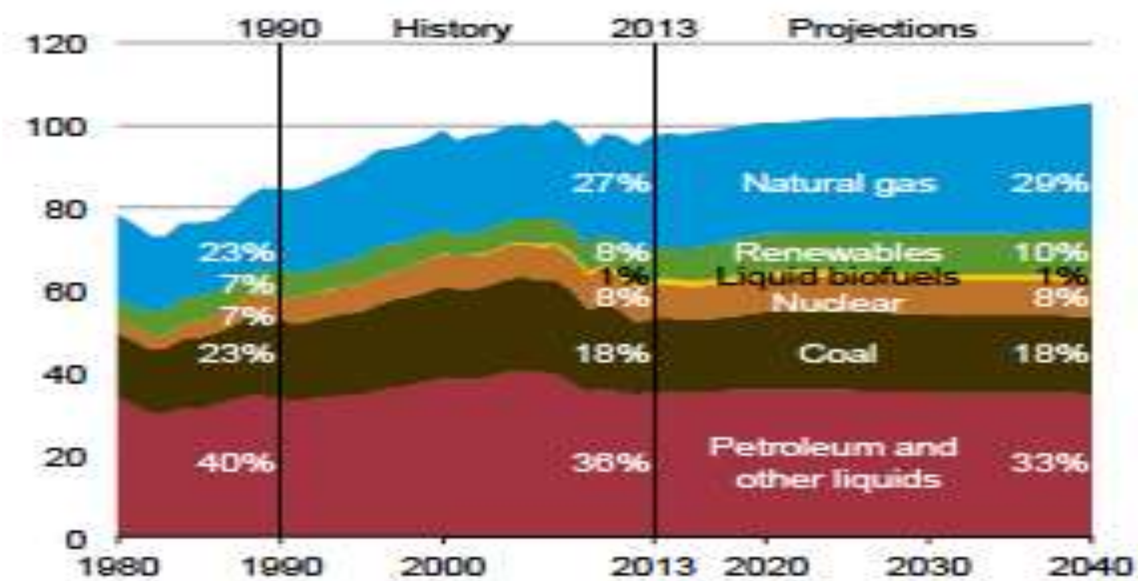
EIA, "U.S. energy imports and exports to come into balance for first time since 1950s," http://www.eia.gov/todayinenergy/detail.cfm?id=20812# .

Figure 3: Delivered energy consumption for transportation in six cases, 2008-40 (Quadrillion Btu)



Source: U.S. Energy Information Administration,| *Annual Energy Outlook 2015*, p. ES-6, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

Figure 4: Primary energy consumption by fuel in the Reference case, 1980-2040 (quadrillion Btu)



Source: U.S. Energy Information Administration,| *Annual Energy Outlook 2015*, p. 15, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

The Uncertain Impact of Increases in U.S. Domestic Oil Production

This continuing U.S. dependence on fossil fuels for its transportation sector does not mean that the U.S. is not becoming less dependent on crude oil and other liquids imports – and could mean that the U.S. could still become an exporter of gasoline and product. The Reference Case projection of continued crude oil imports shown in **Figure 2** is not the only case, and the U.S. does become a net exporter or crude oil in several of its other scenarios.

The projections in the *Annual Energy Outlook* for 2015 show that the U.S. is making significant increases in domestic production of various forms of oil, as well as both improving the efficiency of its gasoline and diesel powered vehicles and conservation in the use of such fuels. As **Figure 5** shows, these increases have been striking over the last half decade, and EIA reports that,[19]

> U.S. crude oil production (including lease condensate) increased during 2014 by 1.2 million barrels per day (bbl/d) to 8.7 million bbl/d, the largest volume increase since recordkeeping began in 1900. On a percentage basis, output in 2014 increased by 16.2%, the highest growth rate since 1940. Most of the increase during 2014 came from tight oil plays in North Dakota, Texas, and New Mexico where hydraulic fracturing and horizontal drilling were used to produce oil from shale formations.
>
> In percentage terms, the 2014 increase is the largest in more than six decades. Annual increases in crude oil production regularly surpassed 15% in the first half of the 20th century, but those changes were relatively less in absolute terms because production levels were much lower than they are now. Crude oil production in the United States has increased in each of the previous six years. This trend follows a period from 1985 to 2008 in which crude oil production fell in every year (except one).

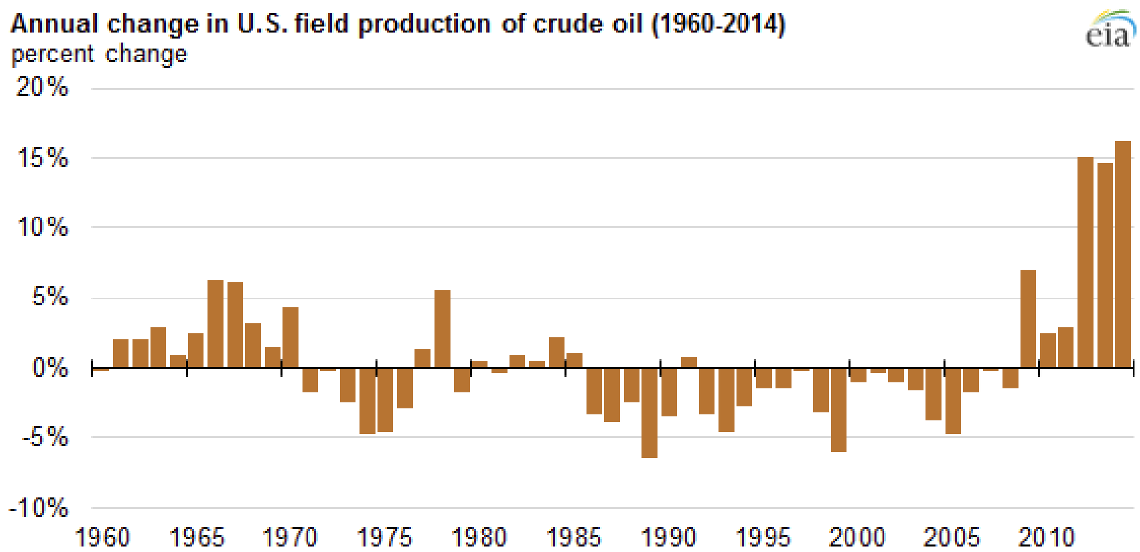
It is important to stress that the 2015 EIA projections do reflect a very wide range of potential increases in total U.S. crude oil production, and oil production from tight sands, that depend on the economy, technology, and world demand. It is also the case that virtually every different source produces a different range of future production and consumption and uses different scenarios to estimate uncertainty

The increases in U.S. production are still likely to significant, however, in most scenarios. This is also shown in **Figure 5**, and the EIA reports that,[20]

> U.S. crude oil production from tight formations leads the growth in total U.S. crude oil production in all the AEO2015 cases. In the Reference case, lower levels of domestic consumption of liquid fuels and higher levels of domestic production of crude oil push the net import share of crude oil and petroleum products supplied down from 33% in 2013 to 17% in 2040.
>
> In the High Oil Price and High Oil and Gas Resource cases, growth in tight oil production results in significantly higher levels of total U.S. crude oil production than in the Reference case. Crude oil production in the High Oil and Gas Resource case increases to 16.6 million barrels per day (bbl/d) in 2040, compared with a peak of 10.6 million bbl/d in 2020 in the Reference case.
>
> In the High Oil Price case, production reaches a high of 13.0 million bbl/d in 2026, then declines to 9.9 million bbl/d in 2040 as a result of earlier resource development. In the Low Oil Price case, U.S. crude oil production totals 7.1 million bbl/d in 2040. The United States becomes a net petroleum exporter in 2021 in both the High Oil Price and High Oil and Gas Resource cases. With lower levels of domestic production and higher domestic consumption in the Low Oil Price case, the net import share of total liquid fuels supply increases to 36% of total domestic supply in 2040.

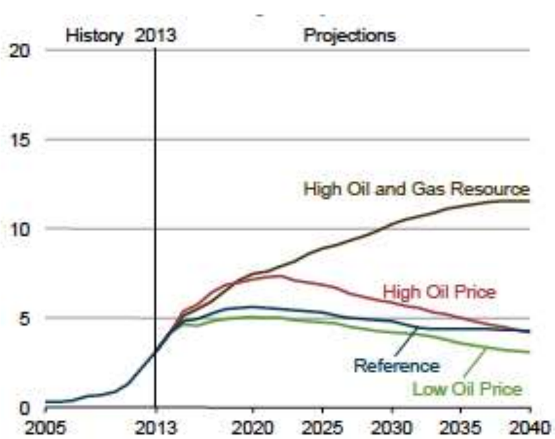
Figure 5: U.S. Crude Oil Production in MMBD: 2005-2040

U.S. Crude Oil Production 1960-2014.

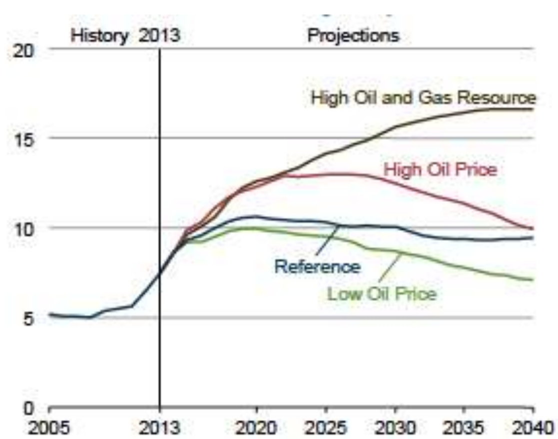


Possible Vectors of U.S. Production 2013-2040

U.S. tight oil production in four cases, 2005-40



U.S. total crude oil production in four cases, 2005-40



[26]West Texas Intermediate is a crude stream produced in Texas and southern Oklahoma that serves as a reference, or marker, for pricing a number of other crude streams and is traded in the domestic spot market at Cushing, Oklahoma.

Source: U.S. Energy Information Administration,| *Annual Energy Outlook 2015*, p. 18, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

Changes in Estimates of U.S. Strategic Dependence on Oil Imports

These increases in U.S. crude oil and other liquids production, and the resulting changes in overall economics of U.S. and global energy production and consumption have sharply affected U.S. government official estimates of direct U.S. import dependence in strategic terms.

The 2012, 2013, and 2014 EIA Estimates

The sheer pace of change is reflected in the shift in EIA estimates between 2012 and 2014:

- **Figure 6** shows the EIA estimate of U.S. dependence on energy imports in 2012 – a dependence that had dropped from a peak of around 60%, but that was still 40%.
- **Figure 7** shows the EIA estimate of future U.S. import dependence made in the 2013 edition of the Annual energy Outlook. For the first time, the EIA discussed the possibility of an end to U.S. crude oil imports, but projected that the U.S. would still be dependent on crude oil imports for 37% of its total supply in 2040 in the reference case, for 50% in its low oil price case, and 27% in its high oil price case.
- **Figure 8** shows the EIA projections of import dependence in 2014. In the course of one year, the EIA estimate of future U.S. import dependence in reference case dropped from 37% in 2040 in the 2013 estimate to 32% in the 2014 estimate.

The 2015 EIA Estimates

The 2015 EIA projections of U.S. imports and possible U.S. exports are shown in detail in **Figure 9** and **Figure 10.** They reflect the possibility of a far lower dependence on imports, a greater possibility of a possible U.S. shift to crude exports, and a far wider range of uncertainty in every aspect of the future U.S. strategic dependence on direct imports of crude oil and liquid fuels.

The EIA summarizes these trends as follows:[21]

> U.S. crude oil production from tight formations leads the growth in total U.S. crude oil production in all the AEO2015 cases. In the Reference case, lower levels of domestic consumption of liquid fuels and higher levels of domestic production of crude oil push the net import share of crude oil and petroleum products supplied down from 33% in 2013 to 17% in 2040.
>
> In the High Oil Price and High Oil and Gas Resource cases, growth in tight oil production results in significantly higher levels of total U.S. crude oil production than in the Reference case. Crude oil production in the High Oil and Gas Resource case increases to 16.6 million barrels per day (bbl/d) in 2040, compared with a peak of 10.6 million bbl/d in 2020 in the Reference case. In the High Oil Price case, production reaches a high of 13.0 million bbl/d in 2026, then declines to 9.9 million bbl/d in 2040 as a result of earlier resource development. In the Low Oil Price case, U.S. crude oil production totals 7.1 million bbl/d in 2040.
>
> The United States becomes a net petroleum exporter in 2021 in both the High Oil Price and High Oil and Gas Resource cases. With lower levels of domestic production and higher domestic consumption in the Low Oil Price case, the net import share of total liquid fuels supply increases to 36% of total domestic supply in 2040.

New Levels of Complexity and Uncertainty

The end result is a situation where the U.S. still seems likely to remain dependent on crude oil imports, albeit at levels where the reference case is well under 30%, and could be as low as 17% in 2040 - roughly half the level of dependence estimated in 2013. At the same time, the U.S. is projected to be able to export gasoline and products by 2021.

The EIA analysis of future direct dependence has become more complex and uncertain as the mix of technologies, market scenarios, and uncertainties affecting future supply have altered its estimates, but the key portions of its 2015 analysis of U.S. dependence on oil and liquids imports as follows: [22]

> In the Reference case, the existing U.S. competitive advantage in oil refining compared to the rest of the world continues over the projection period. This advantage results in growing gasoline and diesel exports through 2040 in the Reference case. The production of motor gasoline blending components, which totaled 7.9 million bbl/d in 2013, begins declining in 2015 and falls to 7.2 million bbl/d by the end of the projection period, while diesel fuel production rises from 4.2 million bbl/d in 2013 to 5.3 million bbl/d in 2040.
>
> *As a result of declining consumption of liquid fuels and increasing production of domestic crude oil, net imports of crude oil and petroleum products fall from 6.2 million bbl/d in 2013 (33% of total domestic consumption) to 3.3 million bbl/d in 2040 (17% of domestic consumption) in the Reference case*. Growth in gross exports of refined petroleum products, particularly of motor gasoline and diesel fuel, results in a significant increase in net petroleum product exports between 2013 and 2040.
>
> In both the High Oil and Gas Resource and High Oil Price cases, total U.S. crude oil production is higher than in the Reference case, mainly as a result of growth in tight oil production, which rises at a substantially faster rate in the near term in both cases than in the Reference case. In the High Oil and Gas Resource case, tight oil production grows in response to assumed higher estimated ultimate recovery (EUR) and technology improvements, closer well spacing, and development of new tight oil formations or additional layers within known tight oil formations. Total crude oil production reaches 16.6 million bbl/d in 2037 in the High Oil and Gas Resource case.
>
> In the High Oil Price case, higher oil prices improve the economics of production from new wells in tight formations as well as from other domestic production sources, leading to a more rapid increase in production volumes than in the Reference case. Tight oil production increases through 2022, when it totals 7.4 million bbl/d. After 2022, tight oil production declines, as drilling moves into less productive areas. Total U.S. crude oil production reaches 13.0 million bbl/d by 2025 in the High Oil Price case before declining to 9.9 million bbl/d in 2040…
>
> Recent declines in West Texas Intermediate oil prices (falling by 59% from June 2014 to January 2015) have triggered interest in the effect of lower prices on U.S. oil production. In the Low Oil Price case, domestic crude oil production is 9.8 million bbl/d in 2022, 0.7 million bbl/d lower than the 10.4 million bbl/d in the Reference case. In 2040, U.S. crude oil production is 7.1 million bbl/d, 2.3 million bbl/d lower than the 9.4 million bbl/d in the Reference case.
>
> Most of the difference in total crude oil production levels between the Reference and Low Oil Price cases reflects changes in production from tight oil formations. However, all sources of U.S. oil production are adversely affected by low oil prices. As crude oil prices fall and remain at or below $76/ barrel (Brent) in the Low Oil Price case after 2014, poor investment returns lead to fewer wells being drilled in noncore areas of formations, which have smaller estimated ultimate recoveries (EURs) than wells drilled in core areas. As a result, they have a more limited impact on total production growth in the near term.
>
> …Production of petroleum products at U.S. refineries depends largely on the cost of crude oil, domestic demand, and the absorption of petroleum product exports in foreign markets. U.S. refinery production of gasoline blending components declines in the Reference and Low Oil Price cases but increases in the High Oil Price and High Oil and Gas Resource cases. The steepest decline in production of motor gasoline blending components is projected in the Reference case, with production of blending components declining from 7.9 million bbl/d in 2013 to 7.2 million bbl/d in 2040, in response to a drop in U.S. crude oil production, higher crude oil prices, and lower demand.
>
> In the High Oil and Gas Resource case, production of blending components increases to 9.1 million bbl/d in 2040, because abundant domestic supply of lighter crude oil results in lower feedstock costs for refiners, lower gasoline prices, increased exports, and relatively higher levels of gasoline consumption (including exports) and production. Diesel fuel output from U.S. refineries rises in the

High Oil and Gas Resource case from 4.2 million bbl/d in 2013 to 6.6 million bbl/d in 2037, as a result of lower costs for refinery feedstocks. In the Low Oil Price case, lower domestic diesel fuel prices result in higher levels of domestic consumption, leading to a 4.7 million bbl/d increase in diesel fuel production in 2040. In the High Oil Price case, higher oil prices (which are assumed to occur worldwide) make diesel fuel from U.S. refineries more competitive. Total U.S. diesel fuel output increases to 6.1 million bbl/d in 2040. In the Reference case, U.S. diesel fuel output increases to 5.3 million bbl/d in 2040.

…As in the Reference case, the United States remains a net importer of liquid fuels through 2040 in the Low Oil Price case. In the High Oil and Gas Resource case, as a result of higher levels of both domestic crude oil production and petroleum product exports, the United States becomes a net exporter of liquid fuels by 2021.

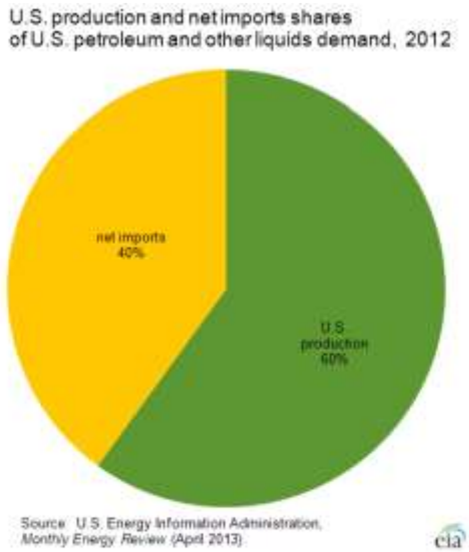
Refiners and oil producers gain a competitive advantage from abundant domestic supply of light crude oil and higher GOM production of lower API crude oil streams, along with lower refinery fuel costs as a result of abundant domestic natural gas supply. *In the High Oil Price case, the United States becomes a net exporter of liquid fuels in 2020, as higher oil prices reduce U.S. consumption of petroleum products and spur additional U.S. crude oil production. U.S. net crude oil imports—which fall to 5.5 million bbl/d in 2022 as domestic crude oil production grows—rise to 8.9 million bbl/d in 2040 as domestic production flattens and begins to decline.*

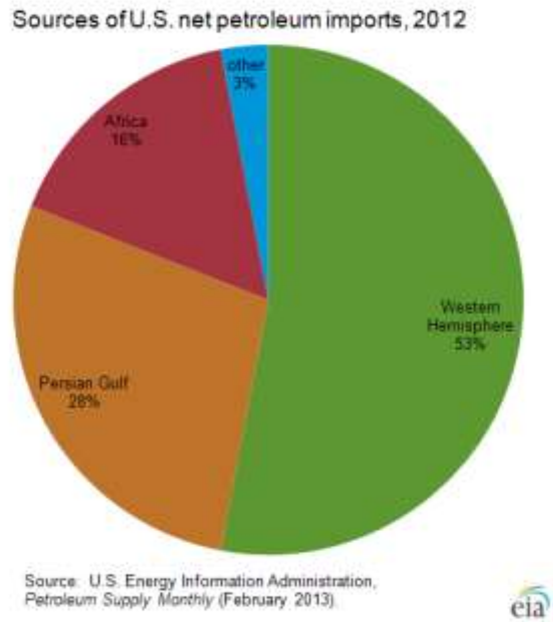
By 2040, the level of net liquid fuels exports is significantly larger in the High Oil and Gas Resource case than in the High Oil Price case. In the High Oil Price case, higher world crude oil prices make overseas refineries less competitive compared to U.S. refineries. *As a result, net U.S. exports of petroleum products increase by more in the High Oil Price case than in the High Oil and Gas Resource case. However, the availability of more domestic crude oil resources in the High Oil and Gas Resource case results in a significantly greater drop in net crude oil imports and a larger overall swing in liquid fuels trade than in any of the other AEO2015 cases*

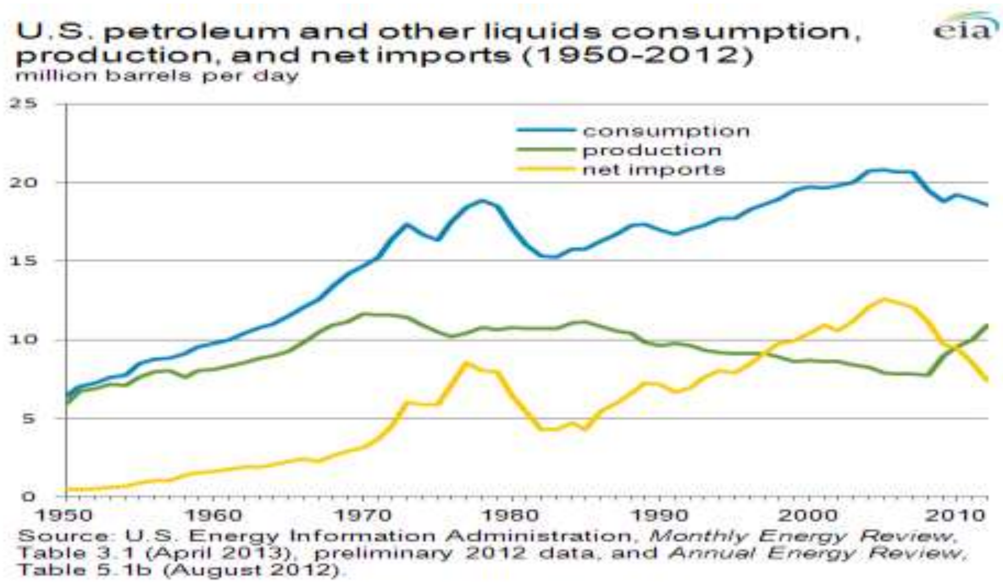
... U.S. net imports of liquid fuels as a share of total domestic consumption continue to decline in the AEO2015 Reference case, primarily as a result of increased domestic oil production. Net imports of liquid fuels as a share of total U.S. liquid fuel use reached 60% in 2005 before dipping below 50% in 2010 and falling to an estimated 33% in 2013 (Figure E5).

The net import share of domestic liquid fuels consumption declines to 14% in 2020 in the AEO2015 Reference case—compared with 26% in the AEO2014 Reference case—as a result of faster growth of domestic liquid fuels supply compared with growth in consumption. Domestic liquid fuels supply begins to decline after 2023 in the AEO2015 Reference case, and as a result, the net import share of domestic liquid fuels consumption rises from 14% in 2022 to 17% in 2040. However, domestic liquid fuels supply in the AEO2015 Reference case is 25% higher in 2040 than in the AEO2014 Reference case, while domestic consumption is only 3% higher. As a result, despite increasing after 2020, the percentage of U.S. liquid fuel supply from net imports in the AEO2015 Reference case remains just over half that in the AEO2014 Reference case through 2040.

Figure 6: U.S. Petroleum Import Dependence: 1950-2012



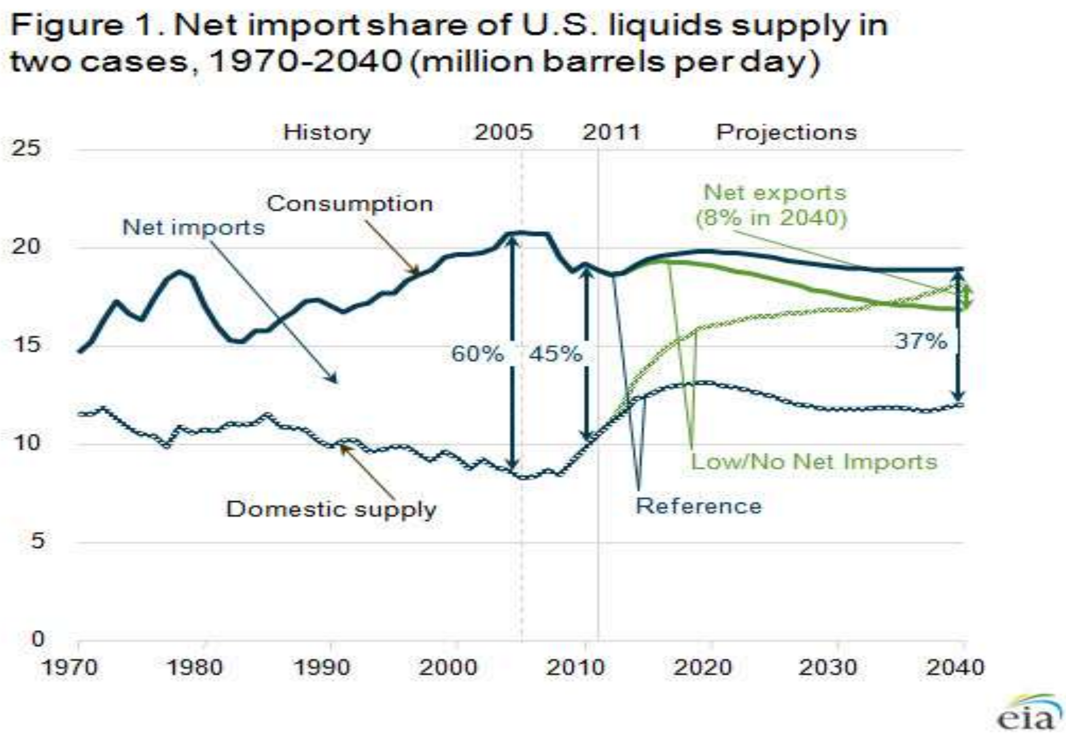




The United States imported 11.0 MMbd of crude oil and refined petroleum products in 2012, and exported 3.2 MMbd of crude oil and petroleum products, so net imports (imports minus exports) equaled 7.4 MMbd. The United States imported 2.1 MMbd of petroleum products such as gasoline, diesel fuel, heating oil, jet fuel, and other products while exporting 3.1 MMbd of products, making the United States a net exporter of petroleum products. Over 50% of U.S. crude oil and petroleum products imports came from the Western Hemisphere (North, South, and Central America, and the Caribbean, including U.S. territories) during 2012. About 29% came from the Persian Gulf countries of Bahrain, Iraq, Kuwait, Qatar, Saudi Arabia, and United Arab Emirates. Our largest sources of net crude oil and petroleum product imports were Canada and Saudi Arabia.

Source: EIA, *How dependent are we on foreign oil?*, May 10, 2013, http://www.eia.gov/energy_in_brief/article/foreign_oil_dependence.cfm

Figure 7: EIA Projections of U.S. Petroleum Import Dependence in 2013



In the Reference case Blue), U.S. net imports of petroleum and other liquids decline through 2019, while still providing approximately one-third of total U.S. supply. The net import share of U.S. petroleum and other liquids consumption continues to decline in the Reference case, falling to 34 percent in 2019 before increasing to 37 percent in 2040.

In the Low/No Net Imports case, the United States ends its reliance on net imports of liquid fuels in the mid-2030s, with net exports rising to 8 percent of total U.S. liquid fuel production in 2040. In contrast, in the High Net Imports case, net petroleum import dependence is above 44 percent in 2040, which is higher than the Reference case level of 37 percent but still well below the 2005 level of 60 percent.

In the High Oil and Gas Resource case, changes due to the supply assumptions alone cause net import dependence to decline to 7 percent in 2040, with U.S. crude oil production rising to 10.2 million barrels per day in 2040, or 4.1 million barrels per day above the Reference case level. Tight oil production accounts for more than 77 percent (or 3.2 million barrels per day) of the difference in production between the two cases. Production of natural gas plant liquids in the United States also exceeds the Reference case level.

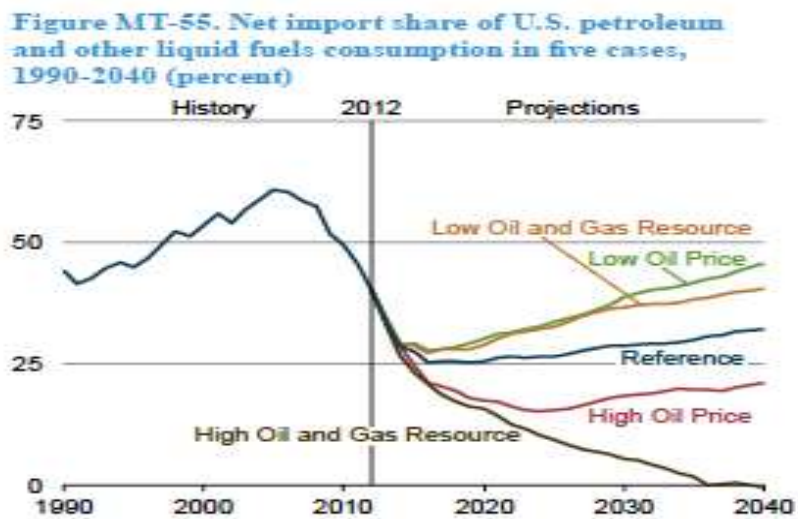
… The U.S. could become a net exporter of liquid fuels under certain conditions. An article in the Issues in focus section considers four cases that examine the impacts of various assumptions about U.S. dependence on imported liquids. Two cases (Low Oil and Gas Resource and High Oil and Gas Resource) vary only the supply assumptions, and two cases (Low/No Net Imports and High Net Imports) vary both the supply and demand assumptions.
The different assumptions in the four cases generate wide variation from the liquid fuels import dependence values in the *AEO2013* Reference case. In the Low/No Net Imports case, the United States ends its reliance on net imports of liquid fuels in the mid-2030s, with net exports rising to 8 percent of total U.S. liquid fuel production in 2040. In contrast, in the High Net Imports case, net petroleum import dependence is above 44 percent in 2040, which is higher than the Reference case level of 37 percent but still well below the 2005 level of 60 percent.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013 Early Release Overview*, May 2, 2013, http://www.eia.gov/forecasts/aeo/chapter_executive_summary.cfm#tightoil and *Annual Energy Outlook 2013*, pp. 2-3, 37-38, 82-83.

Figure 8: EIA Projections of U.S. Petroleum Import Dependence in 2014 vs. 2013

2013 Estimate of Import Dependence

2014 Estimate of Import Dependence



In the Reference case, the share of net crude oil and petroleum product imports as a percentage of total U.S. product consumed declines from 41% in 2012 to 25% in 2016, remains close to that level for several years, and then rises to 32% in 2040 (Figure ES-2). In the High Oil and Gas Resource case, domestically produced crude oil displaces more expensive imported crude at domestic refineries, and U.S. finished petroleum products become more competitive worldwide. The share of total U.S. product consumed represented by net crude oil and petroleum product imports in the High Oil and Gas Resource case declines to 15% in 2020 and continues to fall through 2040. The United States becomes a net exporter of crude oil and petroleum products at the end of the projection period

Among the most uncertain aspects of this analysis are the potential effects of alternative resource and technology assumptions on the global market for liquid fuels, which is highly integrated. Regardless of how much the United States reduces its reliance on imported liquids, consumer prices will not be insulated from global oil prices set in global markets for crude oil and petroleum products. Strategic choices made by leading oil-exporting countries could result in U.S. price and quantity changes that differ significantly from those presented in this outlook.

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2013,* pp. 2-3, 37-38, 82-83; *Annual Energy Outlook 2014,* http://www.eia.gov/forecasts/aeo/pdf/0383%282014%29.pdf, ES-3, MT-28 to MT 30.

Figure 9: U.S. Direct Dependence on Energy Imports: EIA 2015 Projection of Crude Oil Imports relative to Overall U.S. Energy Demand and Natural Gas Imports

Figure 23. U.S. net crude oil imports in four cases, 2005-40 (million barrels per day)

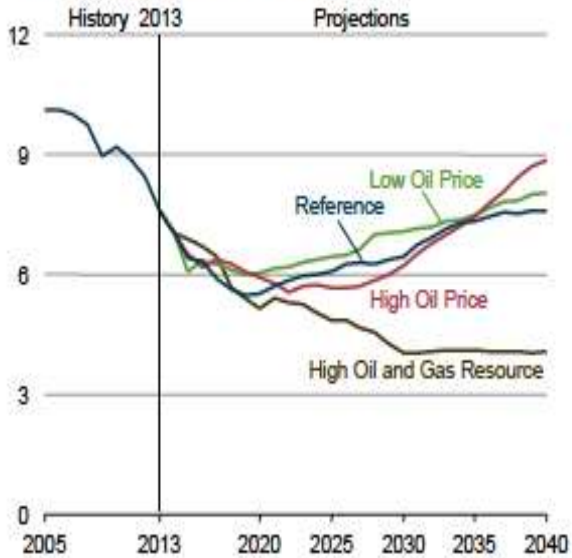


Figure ES3. U.S. net energy imports in six cases, 2005-40 (quadrillion Btu)

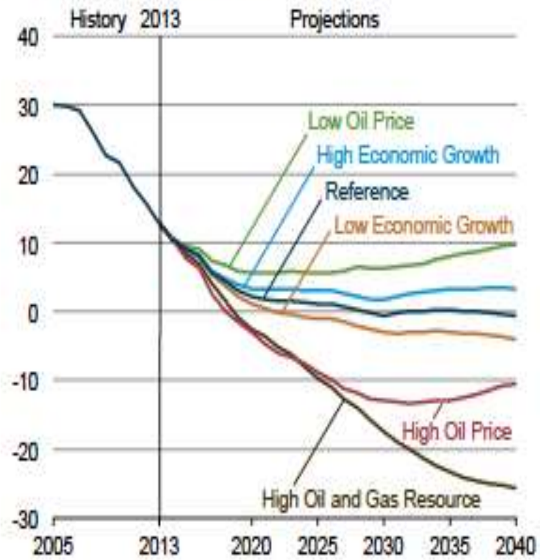


Figure ES4. Net crude oil and petroleum product imports as a percentage of U.S. product supplied in four cases, 2005-40 (percent)

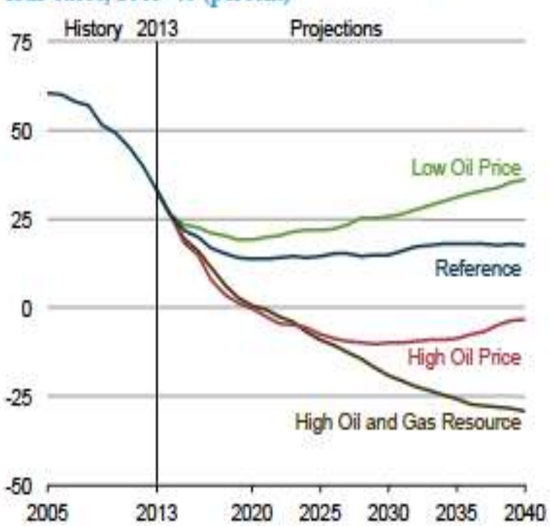


Figure ES5. U.S. total net natural gas imports in four cases, 2005-40 (trillion cubic feet)

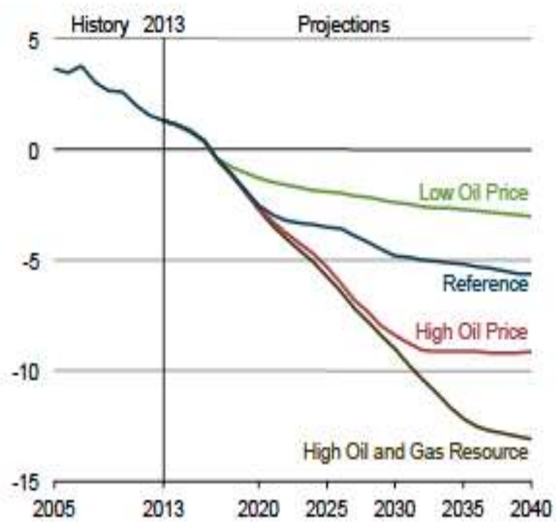
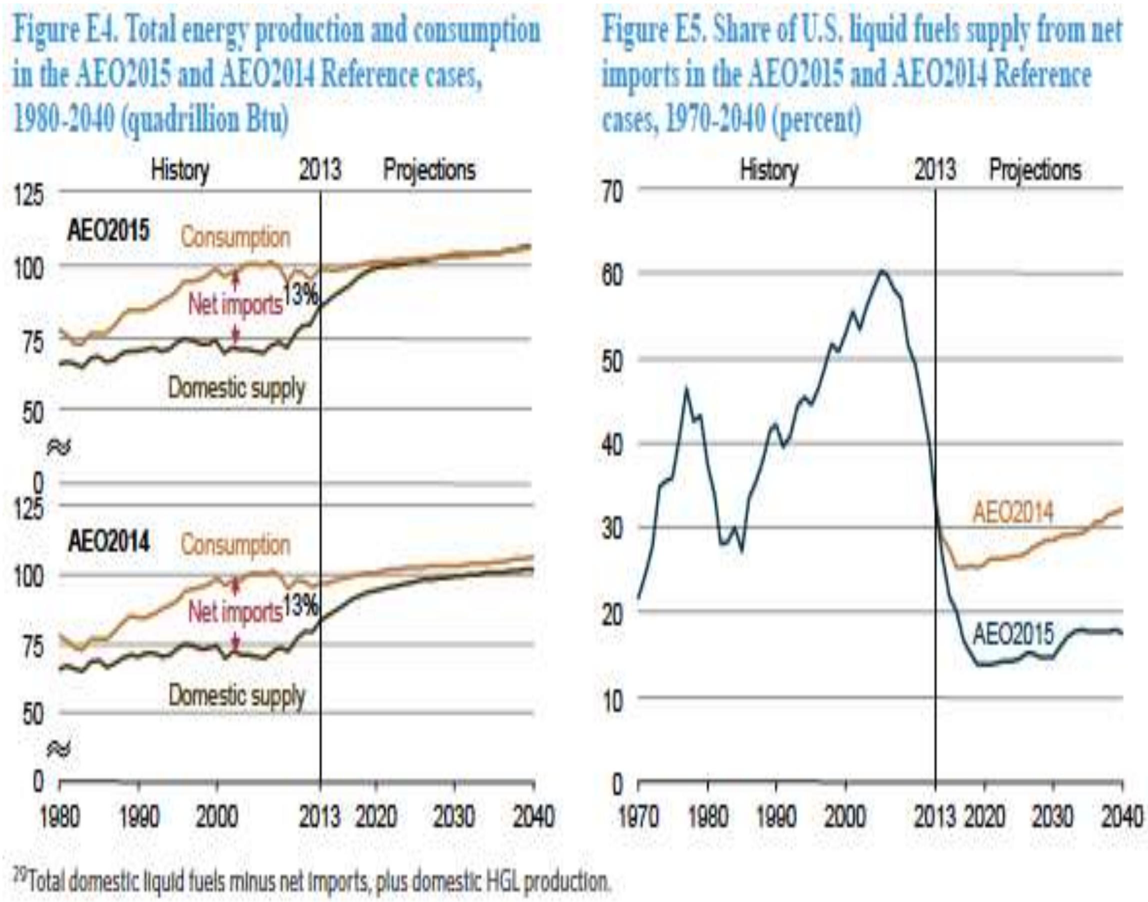


Figure 10: EIA Comparison of 2014 and 2015 EIA Reference Case Projections



U.S. crude oil production in the AEO2015 Reference case increases from 7.4 million bbl/d in 2013 to 9.4 million bbl/d in 2040— 26% higher than in the AEO2014 Reference case, despite lower prices. Production in AEO2015 reaches 10.6 million bbl/d in 2020, compared with a high of 9.6 million bbl/d in 2019 in AEO2014. Higher production volumes result mainly from increased onshore oil production, predominantly from tight (very low permeability) formations. Lower 48 onshore tight oil production reaches 5.6 million bbl/d in 2020 in the AEO2015 Reference case before declining to 4.3 million bbl/d in 2040, 34% higher than in AEO2014.

The pace of oil-directed drilling in the near term is faster in AEO2015 than in AEO2014, as producers continue to locate and target the *sweet spots* of plays currently under development. Lower 48 offshore crude oil supply grows from 1.4 million bbl/d in 2013 to 2.2 million bbl/d in 2019 in the AEO2015 Reference case, before fluctuating in accordance with the development of projects in the deepwater and ultra-deepwater portions of the Gulf of Mexico. In 2040, Lower 48 offshore production totals 2.2 million bbl/d in AEO2015, 9% more than in the AEO2014 Reference case.

Source: U.S. Energy Information Administration,| Annual Energy Outlook 2015, p. 18, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

Other forms of U.S. Strategic Dependence on Stable Global Energy Exports and Indirect US Energy Imports

U.S. dependence on direct imports of petroleum is only part of the story, and no longer is the most important part in strategic terms. U.S. strategic dependence on the flow of world oil exports involves a number of other variables – several of which are now more important than direct import dependence.

These variables include:

- The rising instability in the Middle East, North Africa, and other exporting areas since 2011. Civil war, insurgency, and violent Islamist extremism in or near key exporters, and a growing arms race between Iran and the Arab Gulf states.
- The lack of any credible strategic alternative to U.S. power projection into the Middle East and the Gulf, and a U.S. strategic partnership with the Arab Gulf states – coupled to the fact any other potential source of power projection would now have to come from China and Russia.
- The fact that U.S. energy prices are shaped by world oil and energy prices and any crisis affecting world oil and gas exports has a major direct impact on the U.S. economy.
- The steady increase in U.S. dependence on the overall health of the global economy.
- The fact that the U.S. is now critically dependent on the steady flow of manufactured goods and industrial imports, and these now come from countries whose economies and ability to export is critical dependent on the flow of Gulf and other oil and gas exports.

If these variables are taken fully into consideration, US strategic dependence on the stable flow of world petroleum exports will increase regardless of the level of US petroleum imports and the need for US strategic partnerships with key oil exporting states will be at least as critical in the future as the present.

U.S. Dependence on the Global Economy and Sensitivity to World Oil Prices

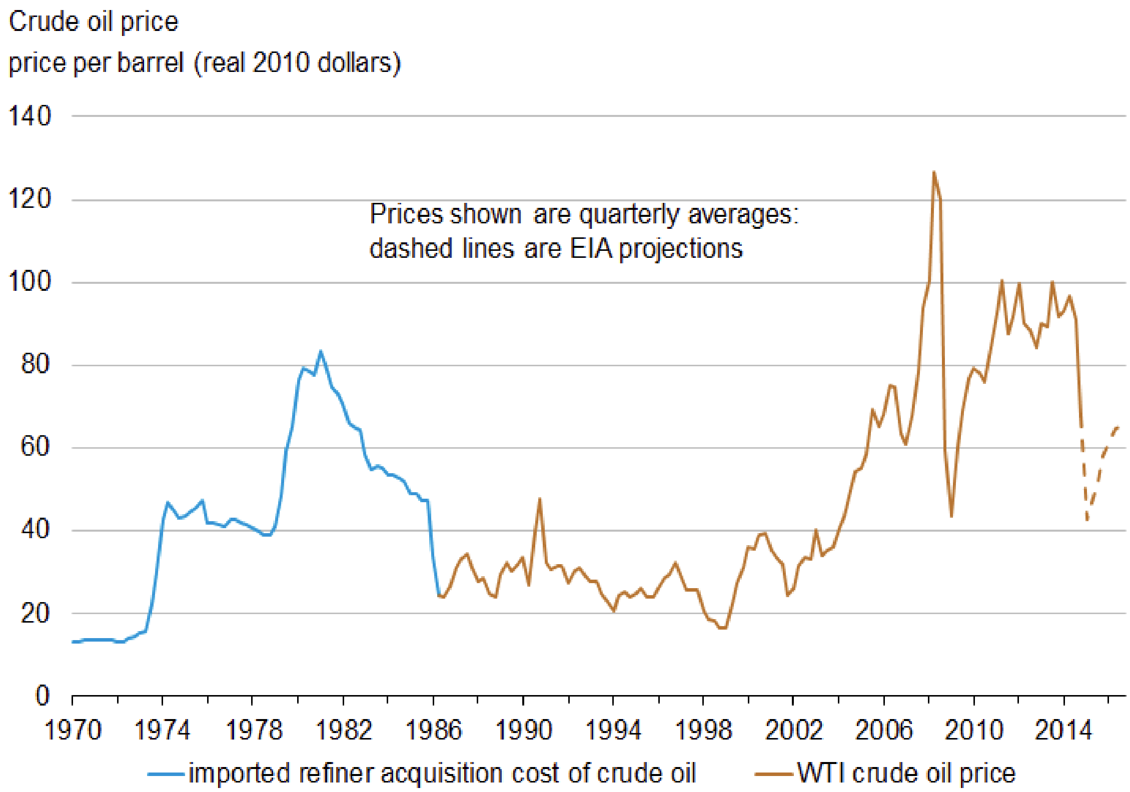
There is no simple way to quantify U.S. economic dependence on the global economy and secure flow of global energy exports. It is all too clear, however, that this dependence continues to increase. As the "great recession" showed all too clearly after 2007, the U.S. economy is critically dependent on the health of the global economy.

The U.S. must pay world prices for energy. Even in a partial recovery year like 2010 the global economy depended on the predictable flow of 45 million barrels a day of crude oil imports, 23.75 million barrels of refined products, and 1.6 trillion cubic feet of gas. Any major interruption in the flow of energy exports raises world market prices, and the U.S. economy must pay such prices regardless of where the interruption occurs.

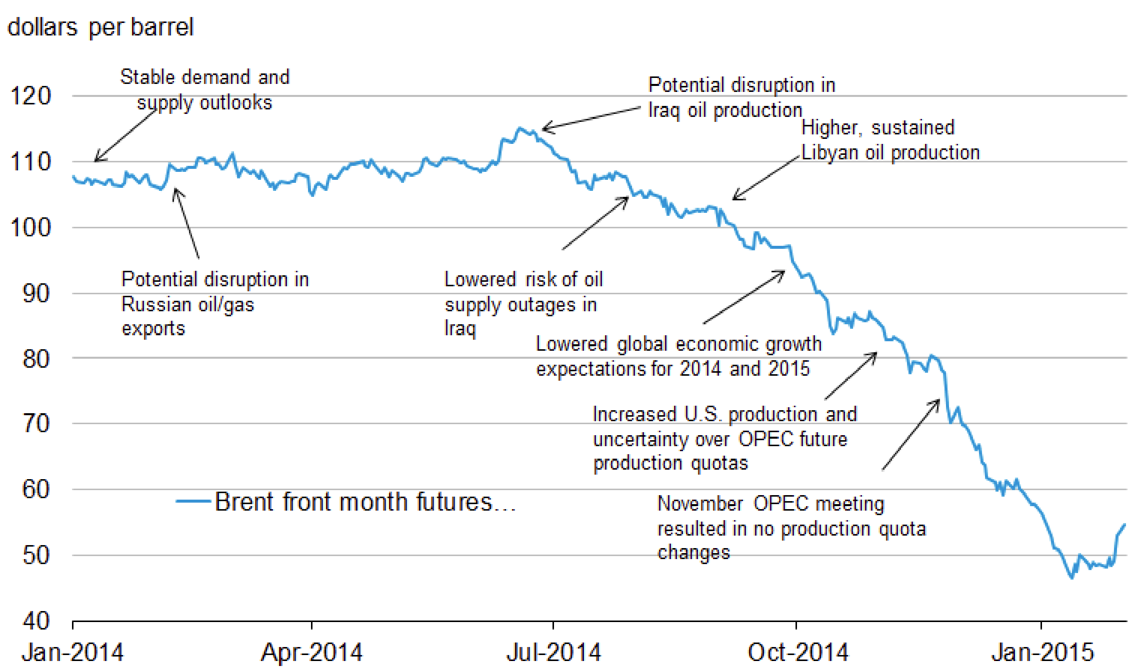
There is also ample historical evidence as to just how quickly oil prices can change in a crisis. **Figure 11** provides a histogram of oil price shifts, and the combined volatility of prices and the impact of past conflicts like the Iran-Iraq War, and Iraq's invasion of Kuwait.

There is little doubt that the price rises would have been much sharper if the U.S. had not acted to reassure and support its Gulf allies, or what would have happened if the conflicts that began in 2011 had spread throughout the region and sustained or even increased peak oil prices. At the same time, it is clear from the lower graph in **Figure 11** that the U.S. has benefited from helping its Arab partners to maintain some level of strategic stability in the MENA and Gulf regions.

Figure 11: Oil Price Volatility: 1970-2015



Sources: U.S. Energy Information Administration, Thomson Reuters



Source: EIA, Bloomberg

Adapted from the Statement of Adam Sieminski, Administrator, EIA/DOE, before the Committee on Energy and Commerce, U.S. House of Representatives, March 3, 2015.

The Vulnerability of World Oil Exports

There are other reasons why the U.S. defense strategic guidance issued in early 2012 gave the same strategic importance to the MENA region as rebalancing to Asia, why the U.S. has since built up is asymmetric warfare capabilities in the Gulf, why U.S. forces are involved in Iraq and Yemen, and why recent U.S. Navy seapower studies project an increase in U.S. naval deployments.

The importance of MENA Oil and Gas Reserves is shown in **Figure 12**. In spite of the increase in reserves and production in other regions, the MENA area still dominates the reserves of exportable oil and plays a critical role in reserves of gas. The same is true of current production, and it is clear that both reserves and production are concentrated in the Gulf region. BP estimates that:[23]

- Some 52% of world oil reserves are in the MENA region, with some 48% of that total in the Gulf.
- A little over 36% of world oil production took place in the MENA region in 2013, with some 32% in the Gulf.
- Roughly 48% of world natural gas reserves are in the MENA region, with more than 42% in the Gulf.
- A little over 21% of world natural gas production took place in the MENA region in 2013, with some 17% in the Gulf.

Like the EIA, the International Energy Agency (IEA) estimates that the growth in future world oil production through 2040 will be dominated by the Middle East, while the increases in prediction in other key areas like Brazil, Canada, and the U.S. will be far more limited or decline.[24] It notes in its summary of its *World Energy Outlook* for 2014 that, "The short-term picture of a well-supplied market should not obscure future risks as demand rises to 104 million barrels per day, and reliance grows on Iraq and the rest of the Middle East." It also projects that the Middle East will be a key supplier of LNG through 2040 [25]

The importance of Gulf exports, and their strategic vulnerability is shown in **Figure 13**. As the EIA noted in a report issued in November 2014, [26]

> In 2013, total world petroleum and other liquids production was about 90.1 million barrels per day (bbl/d). EIA estimates that about 63% of this amount (56.5 million bbl/d) traveled via seaborne trade. Oil tankers accounted for 30% of the world's shipping by deadweight tonnage in 2013, according to data from the United Nations Conference on Trade and Development (UNCTAD).
>
> International energy markets depend on reliable transport routes. Blocking a chokepoint, even temporarily, can lead to substantial increases in total energy costs and world energy prices. Chokepoints also leave oil tankers vulnerable to theft from pirates, terrorist attacks, shipping accidents that can lead to disastrous oil spills, and political unrest in the form of wars or hostilities.
>
> … Located between Oman and Iran, the Strait of Hormuz connects the Persian Gulf with the Gulf of Oman and the Arabian Sea. The Strait of Hormuz is the world's most important oil chokepoint because of its daily oil flow of 17 million barrels per day in 2013. Flows through the Strait of Hormuz in 2013 were about 30% of all seaborne-traded oil.
>
> EIA estimates that more than 85% of the crude oil that moved through this chokepoint went to Asian markets, based on data from Lloyd's List Intelligence tanker tracking service. Japan, India, South Korea, and China are the largest destinations for oil moving through the Strait of Hormuz.

> Qatar exported about 3.7 trillion cubic feet (Tcf) per year of liquefied natural gas (LNG) through the Strait of Hormuz in 2013, according to BP's Statistical Review of World Energy 2014. This volume accounts for more than 30% of global LNG trade.

The US strategic role in the Middle East, and its partnership with the Arab Gulf states, remains a vital US strategic interest because the flow of energy exports through the Gulf, the Strait of Hormuz, the Gulf on Oman, and nearby waters in the Indian Ocean is so vulnerable, and because the turmoil and conflict elsewhere in the Middle East has meant there are so few pipeline alternatives.

While new pipelines will increase capacity marginally in the future, the strategic importance of this increase will be offset by the fact that the estimate increases in Gulf oil exports will exceed the new pipeline capacity and the pipeline ports on the Indian Ocean will be well with the range of potential Iranian attacks, [27]

> At its narrowest point, the Strait of Hormuz is 21 miles wide, but the width of the shipping lane in either direction is only two miles wide, separated by a two-mile buffer zone. The Strait of Hormuz 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.
>
> Most potential options to bypass Hormuz are currently not operational. Only Saudi Arabia and the United Arab Emirates (UAE) presently have pipelines able to ship crude oil outside of the Persian Gulf and have additional pipeline capacity to circumvent the Strait of Hormuz. At the end of 2013, the total available unused pipeline capacity from the two countries combined was approximately 4.3 million bbl/d.
>
> Saudi Arabia has the 746-mile Petroline, also known as the East-West Pipeline, which runs across Saudi Arabia from its Abqaiq complex to the Red Sea. The Petroline system consists of two pipelines with a total nameplate (installed) capacity of about 4.8 million bbl/d. The 56- inch pipeline has a nameplate capacity of 3 million bbl/d, and its current throughput is about 2 million bbl/d. The 48-inch pipeline had been operating in recent years as a natural gas pipeline, but Saudi Arabia converted it back to an oil pipeline. The switch increased Saudi Arabia's spare oil pipeline capacity to bypass the Strait of Hormuz from 1 million bbl/d to 2.8 million bbl/d, but this is only achievable if the system operates at its full nameplate capacity. Saudi Arabia also operates the Abqaiq-Yanbu natural gas liquids pipeline, which has a capacity of 290,000 bbl/d. However, this pipeline is currently running at capacity and cannot move any additional oil.
>
> The UAE operates the Abu Dhabi Crude Oil Pipeline (1.5 million bbl/d) that runs from Habshan, a collection point for Abu Dhabi's onshore oil fields, to the port of Fujairah on the Gulf of Oman, allowing crude oil shipments to circumvent the Strait of Hormuz. The pipeline can transport more than half of UAE's total net oil exports. The government plans to increase this capacity in the near future to 1.8 million bbl/d.

The strategic importance and vulnerability of Gulf oil exports has been compounded by the growing instability in Yemen and the risk that Iran’s navy and air force may come to play a growing role in the Red Sea and Indian Ocean. An April 2015 report by EIA, following the collapse of the Yemeni government, reports that, [28]

> While Yemen is not a major oil-producing country, its coast borders the Bab el-Mandeb Strait, a narrow chokepoint between the Horn of Africa and the Middle East. This strait is a strategic route for Persian Gulf oil, natural gas, and petroleum product shipments to Europe and North America, as well as European and North African oil exports to Asia. Although the strait is 18 miles wide at its narrowest point, tankers passing through must use two 2-mile-wide shipping channels.
>
> Trade in crude oil and petroleum products transiting the Bab el-Mandeb has increased steadily in recent years, growing from 2.7 million barrels per day (bbl/d) in 2010 to almost 4.7 million bbl/d in 2014. From 2013 to 2014, trade grew by more than 20%, with an increase of more than 200,000 bbl/d in crude oil exports from Iraq to Europe contributing to higher northbound traffic.

Record-level exports of crude oil and petroleum products (particularly distillate fuel oil) from Russia to Asia contributed the most to higher southbound traffic through the strait, somewhat offset by declines in exports of petroleum products from Europe and exports of crude oil from Libya. About 30% of Bab el-Mandeb's southbound traffic also passed through the Suez Canal or the Suez-Mediterranean (Sumed) pipeline.

Increased instability around the Bab el-Mandeb could keep tankers in the Persian Gulf from reaching the Suez Canal or the Sumed Pipeline, diverting them around the southern tip of Africa, adding to transit time and cost. In addition, European and North African southbound oil flows could no longer take the most direct route to Asian markets through the Suez Canal and then on to the Bab el-Mandeb. As the security situation in Yemen has continued to deteriorate, the United States has heightened maritime security in the area, and has announced its intention to work with Gulf Cooperation Council partners to ensure the continued flow of commerce though the strait.

Figure 12: BP Estimate of the Impact of the MENA Region on World Oil and Gas Reserves – Part One

Oil Reserves

	At end 1993	At end 2003	At end 2012	At end 2013			
	Thousand Million Barrels	Thousand Million Barrels	Thousand Million Barrels	Thousand Million Barrels	Thousand Million Barrels	Share of Total	R/P Ratio
Iran	92.9	133.3	157.0	21.6	157.0	9.3%	*
Iraq	100.0	115.0	150.0	20.2	150.0	8.9%	*
Kuwait	96.5	99.0	101.5	14.0	101.5	6.0%	89.0
Oman	5.0	5.6	5.5	0.7	5.5	0.3%	16.0
Qatar	3.1	27.0	25.2	2.6	25.1	1.5%	34.4
Saudi Arabia	261.4	262.7	265.9	36.5	265.9	15.8%	63.2
Syria	3.0	2.4	2.5	0.3	2.5	0.1%	*
United Arab Emirates	98.1	97.8	97.8	13.0	97.8	5.8%	73.5
Yemen	2.0	2.8	3.0	0.4	3.0	0.2%	51.2
Other Middle East	0.1	0.1	0.3	+	0.3	x	3.4
Total Middle East	**662.1**	**745.7**	**808.7**	**109.3**	**808.6**	**47.9%**	**78.1**
Algeria	9.2	11.8	12.2	1.5	12.2	0.7%	21.2
Egypt	3.4	3.5	4.2	0.5	3.9	0.2%	15.0
Libya	22.8	39.1	48.5	6.3	48.5	2.9%	*
Tunisia	0.4	0.6	0.4	0.1	0.4	x	18.7
Total North Africa	**35.8**	**55.0**	**65.3**	**8.4**	**65.0**	**3.8%**	*****
Total MENA	**697.9**	**800.7**	**874.0**	**117.7**	**873.6**	**51.7%**	*****
Total World	**1041.4**	**1334.1**	**1687.3**	**238.2**	**1687.9**	**100.0%**	**53.3**

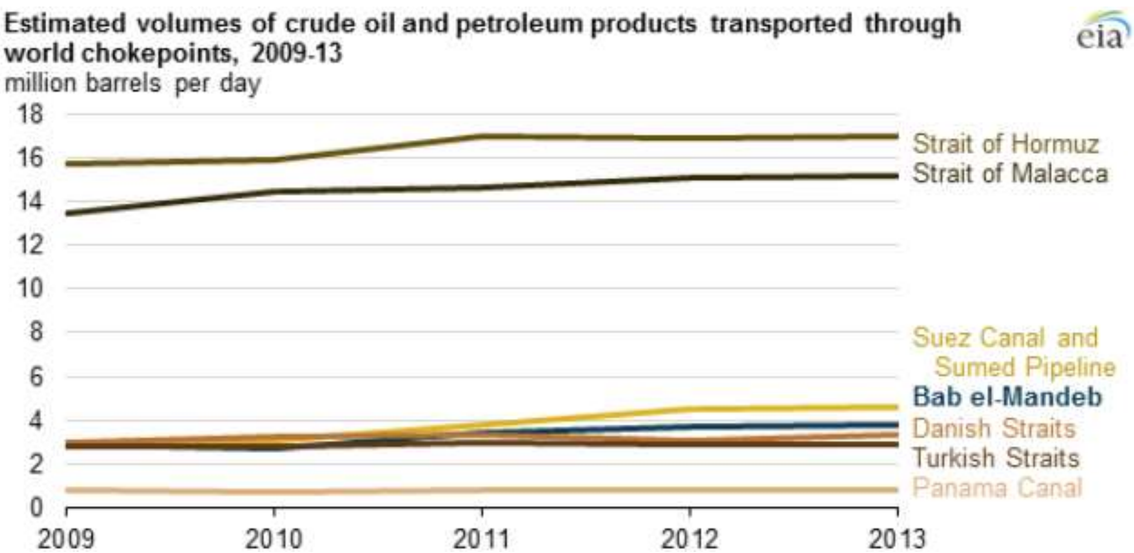
Figure 12: BP Estimate of the Impact of the MENA Region on World Oil and Gas Reserves – Part Two

Gas Reserves

	At end 1993	At end 2003	At end 2012	At end 2013			
	Trillion cubic meters	Trillion cubic meters	Trillion cubic meters	Trillion cubic meters	Trillion cubic meters	Share of Total	R/P Ratio
Bahrain	0.2	0.1	0.2	6.7	0.2	0.1%	12.1
Iran	20.7	27.6	33.6	1192.9	33.8	18.2%	*
Iraq	3.1	3.2	3.6	126.7	3.6	1.9%	*
Kuwait	1.5	1.6	1.8	63.0	1.8	1.0%	*
Oman	0.2	1.0	0.9	33.5	0.9	0.5%	30.7
Qatar	7.1	25.3	24.9	871.5	24.7	13.3%	*
Saudi Arabia	5.2	6.8	8.2	290.8	8.2	4.4%	79.9
Syria	0.2	0.3	0.3	10.1	0.3	0.2%	63.9
United Arab Emirates	5.8	6.0	6.1	215.1	6.1	3.3%	*
Yemen	0.4	0.5	0.5	16.9	0.5	0.3%	46.3
Other Middle East	+	0.1	0.2	8.1	0.2	0.1%	35.3
Total Middle East	**44.4**	**72.5**	**80.3**	**2835.3**	**80.3**	**43.3%**	*****
Algeria	3.7	4.5	4.5	159.1	4.5	2.4%	57.3
Egypt	0.6	1.7	2.0	65.2	1.8	1.0%	32.9
Libya	1.3	1.5	1.5	54.7	1.5	0.8%	*
Total North Africa	**5.6**	**7.7**	**8.0**	**279.0**	**7.8**	**4.2%**	*****
Total MENA	**50.0**	**80.2**	**88.3**	**3114.3**	**88.1**	**47.5%**	*****
Total World	**118.4**	**155.7**	**185.3**	**6557.8**	**185.7**	**100.0%**	**55.1**

Source: *BP Statistical Review of World Energy*, June 2014, pp. 6 and 20, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf.

Figure 13: U.S. Strategic Interests and Key Global Energy Export Chokepoints (In MMBD)

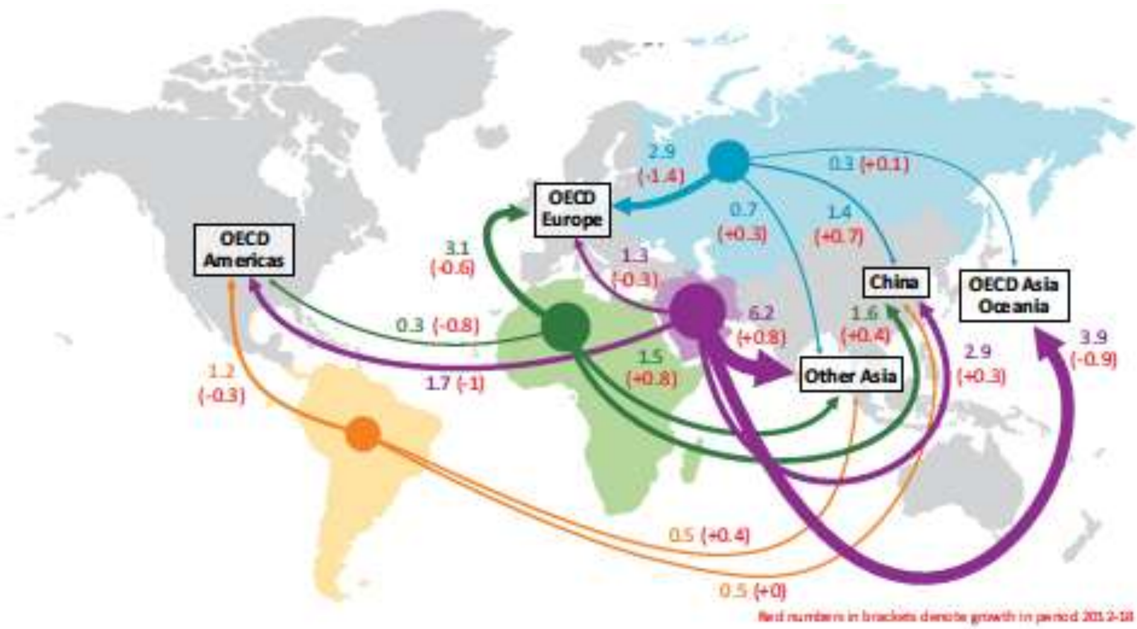


Location	2009	2010	2011	2012	2013
Strait of Hormuz	15.7	15.9	17.0	16.9	17.0
Strait of Malacca	13.5	14.5	14.6	15.1	15.2
Suez Canal and SUMED Pipeline	3.0	3.1	3.8	4.5	4.6
Bab el-Mandab	2.9	2.7	3.4	3.7	3.8
Danish Straits	3.0	3.2	3.3	3.1	3.3
Turkish Straits	2.8	2.8	3.0	2.9	2.9
Panama Canal	0.8	0.7	0.8	0.8	0.8
World maritime oil trade	**53.9**	**55.5**	**55.6**	**56.7**	**56.5**
World total oil supply	**84.9**	**87.5**	**87.8**	**89.7**	**90.1**

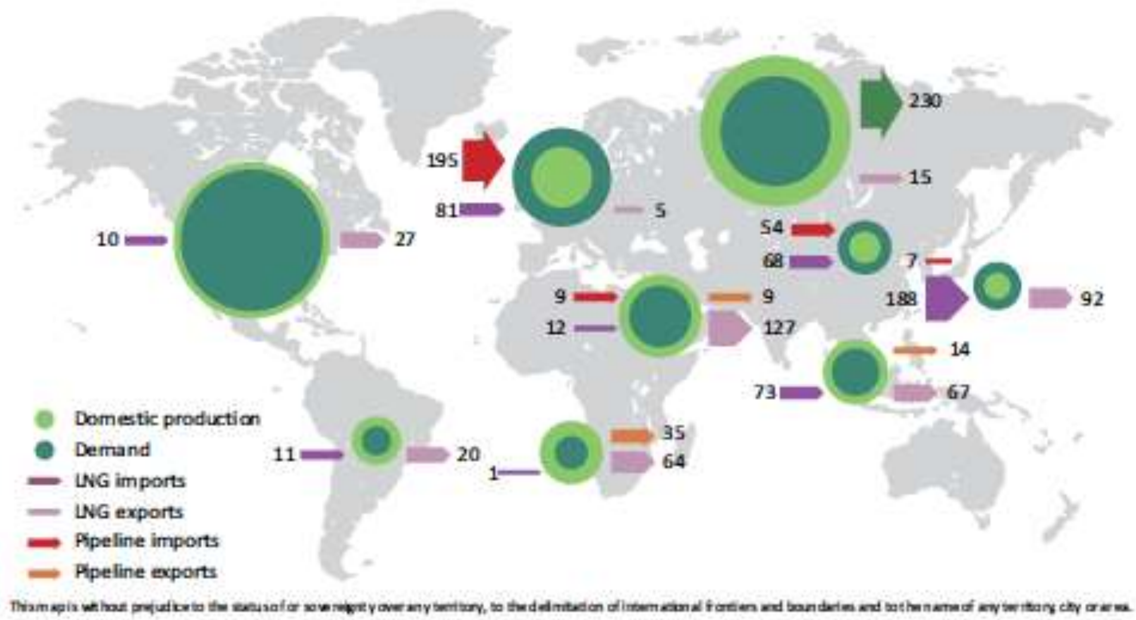
Source: Adapted from EIA, world Transit Energy Chokepoints, November 10, 2014, p. 2, http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf, and "Oil trade off Yemen coast grew by 20% to 4.7 million barrels per day in 2014," *Today in Energy*, April 23, 2015, http://www.eia.gov/todayinenergy/detail.cfm?id=20932

Figure 14: IEA Estimate of Increase in Oil and Gas Exports by Major Route and Consumer: 2012-2014

Oil Exports in MMBD in 2018 and Growth over 2012 by Key Route



Gas Exports in BCM in 2018 and Growth over 2012 by Key Route



Energy Supply Security 2014, Emergency Response of IEA Countries 2014, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html, pp. 18, 61.

The Importance of Indirect Imports to U.S. Trade and Economic Stability

At the same time, the US is already critically dependent on indirect imports of petroleum in the form of manufactured and industrial goods. The CIA *World Factbook* estimates that U.S. had a $16.72 trillion economy in 2014. The data on U.S. imports and exports lag a year, but total U.S. exports were $1.575 trillion in 2013, or roughly 9% of the U.S. GDP while U.S. imports were $2,273 trillion in 2013, or roughly 14% of the U.S. GDP.

In 2013, at a time when U.S. direct dependence on energy imports was far higher than is projected for the future, the CIA estimated that energy imports only accounted for 8.2% of total U.S. imports – or $186 billion. In contrast, 24.7% of total U.S. imports were industrial supplies ($622 billion), 30.4% were capital goods ($691 billion), and 31.8% ($723 billion) were consumer goods -- for total of 86.9% of all U.S. imports ($1,975 billion).

These percentages all highlight the importance the stable flow of global trade, since much of the U.S. manufacturing center and high technology activity is now dependent on the steady flow of imported elements and components. As a result, U.S. growth and health of the U.S. economy, and of American jobs, is critically dependent on the flow of imports of industrial supplies and capital goods.

All of these US imports are, however, critically dependent on the flow of Gulf and MENA petroleum exports to the states that provide such exports of industrial supplies, capital goods, and consumer good to the US. As a result, they become indirect imports of petroleum.

- **Figure 15** shows just how much the near-terms shifts in crude oil production favor North America while China – as key exporter to the U.S. continues to increase its oil demand.
- **Figure 16** shows that China, Korea, Japan and other key exporters to the U.S. are critically dependent on Gulf energy exports. These nations that accounted for over 33% of all U.S. imports – – a percentage of U.S. trade roughly four times larger than direct U.S. dependence.
- **Figure 17** provides an IEA estimate of the major increases in Asian oil imports that the IEA projects for the period from 2010 to 2035**.**

The data in these **Figures** show that U.S. indirect dependence on the overall flow of energy exports to key exporters to the U.S. has long been at least as important as direct U.S. dependence in on energy imports. They are supported by the data on foreign dependence on Gulf and MENA oil that International Energy Agency provided in its report on *Energy Supply Security 2014, Emergency Response of IEA Countries 2014*.[29]

They are further reinforced by data that BP has issued on interregional trade movements. The BP *Statistical Review of Energy for 2014* reports that the "Middle East" – which consists almost totally of Gulf oil exports in BP reporting – exported a total of 19.4 million barrels a day of oil in 2013. Out of this total,[30]

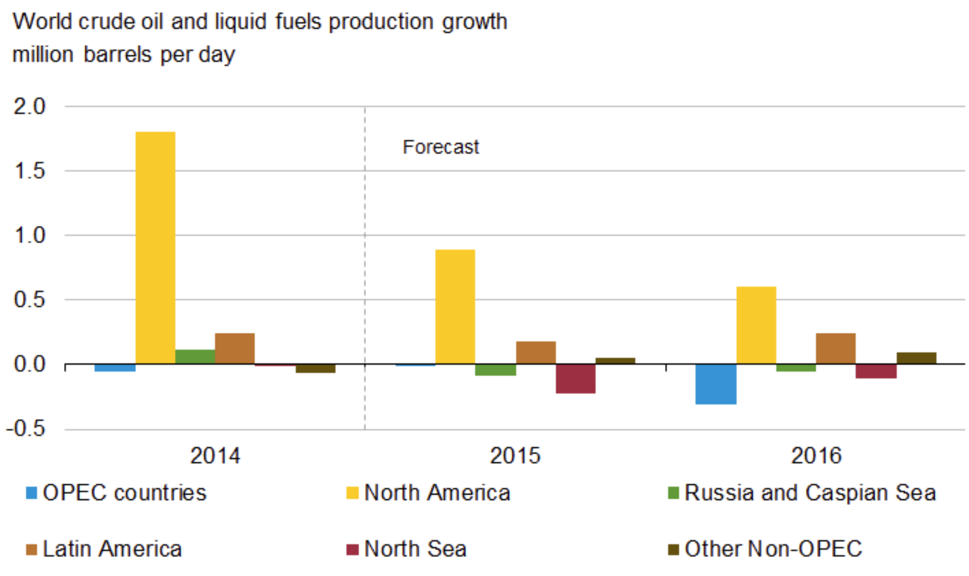
- 2.0 MMBD went to the U.S. out of total imports of 9.8 MMBD.
- 2.1 MMB went to Europe out of total imports of 12.6 MMBD.
- 3.1 MMD went to China out of total imports of 6.9 MMBD.
- 2.5 MMD went to India out of total imports of 4.1 MMBD.
- 3.3 MMD went to India out of total imports of 4.5 MMBD.

- 1.1 MMD went to Singapore out of total imports of 3.0 MMBD.
- 4.6 MMD went to the rest of Asia out of total imports of 7.5 MMBD.

Taken together, these data indicate a level of continuing US strategic dependence on indirect imports that goes far beyond the uncertain future U.S. need for direct petroleum imports. The also indicate a critical need for the U.S. to reappraise how it assesses strategic dependence and its vital national security interests. Almost none of the official estimates of U.S. import dependence – past, current- or future – take indirect imports into consideration.

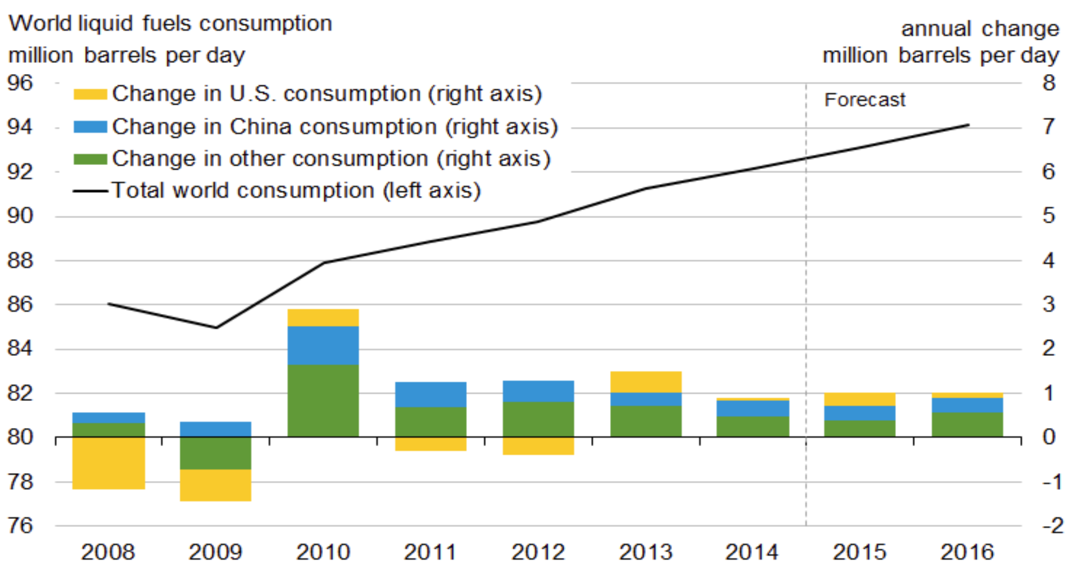
Figure 15: Shifts in World Oil Production Relative to U.S. and Chinese Oil Consumption

World Crude Oil and Liquids Production in MMBD



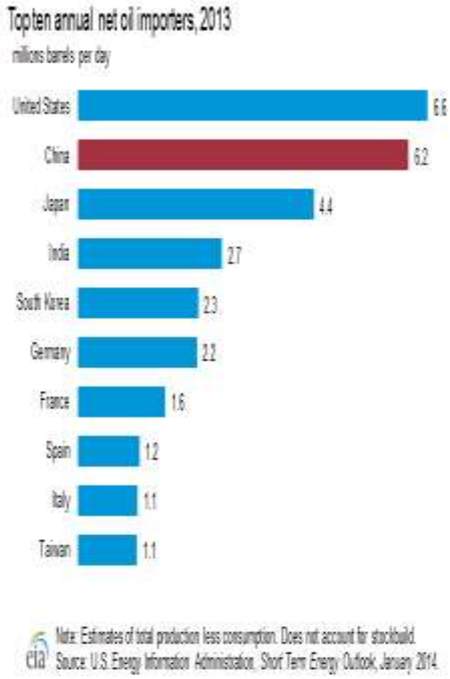
Source: EIA, Short-Term Energy Outlook, February 2015

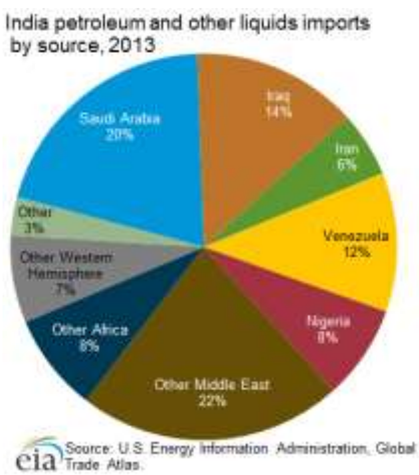
U.S. versus Chinese and Global Increase in Liquid Fuels Consumption

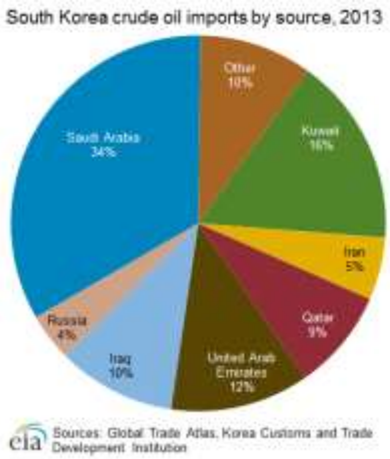


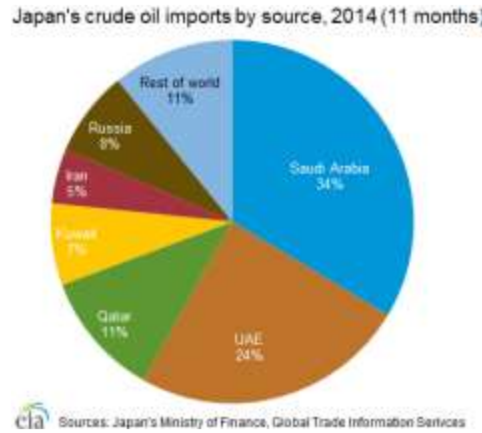
Source: EIA, Short-Term Energy Outlook, February 2015

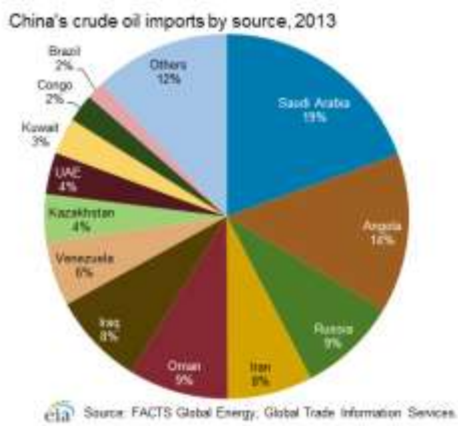
Figure 16: Asian Strategic Dependence on Gulf Energy Exports





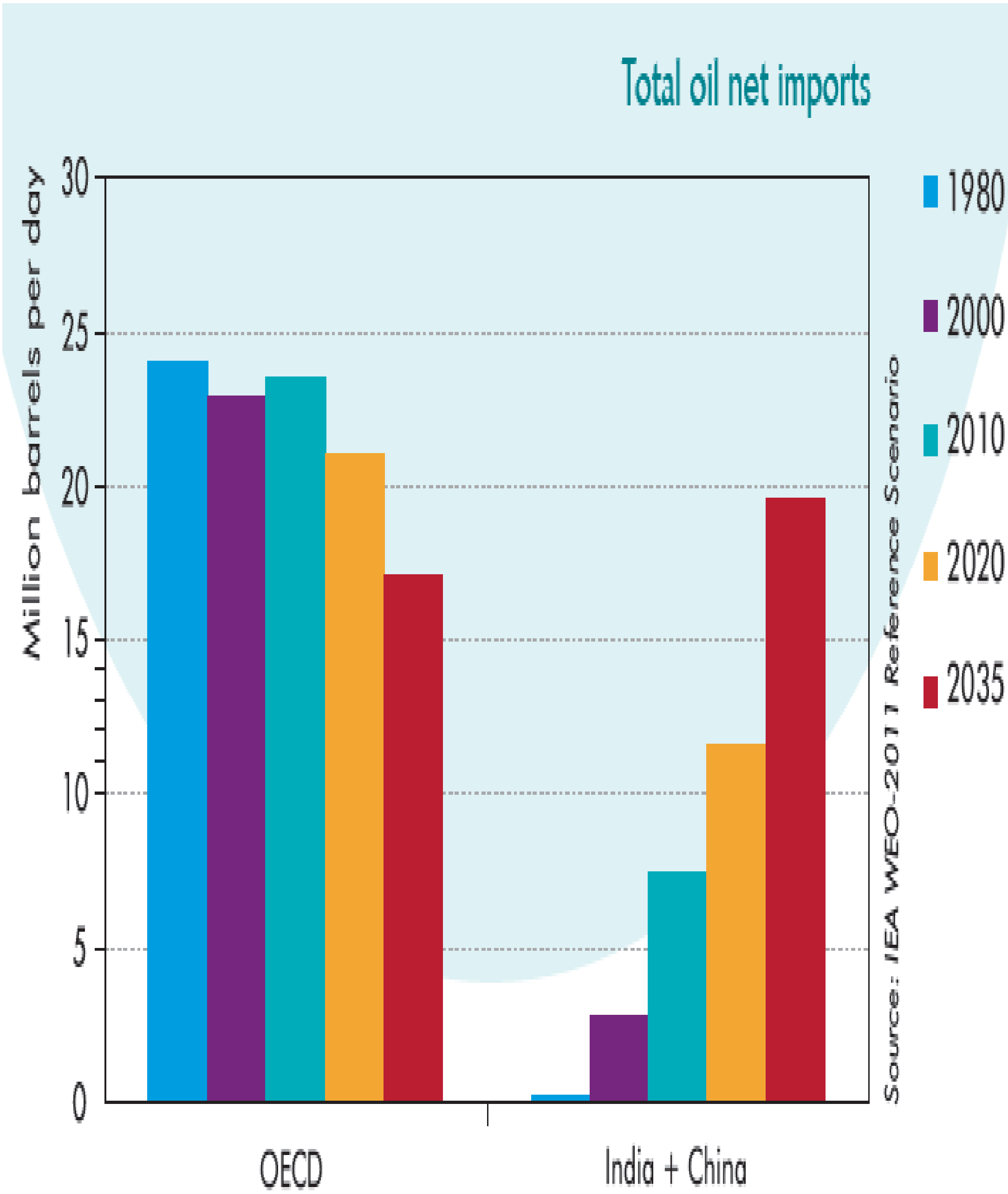






Source: Energy Information Agency (EIA), U.S. Department of Energy, http://www.eia.gov/countries/analysisbriefs/Japan/images/crude_oil_imports.png; http://www.eia.gov/countries/cab.cfm?fips=ks; http://www.eia.gov/countries/analysisbriefs/China/images/top_ten_oil_importers.png; http://www.eia.gov/countries/cab.cfm?fips=in;

Figure 17: IEA Estimate of OECD and Asian Demand for Oil Imports: 1980-2035



Source: IEA, *Response System for Oil Supply Disruptions, 2012*, http://www.iea.org/publications/freepublications/publication/EPPD_Brochure_English_2012_02.pdf, p. 13; and *Energy Supply Security 2014, Emergency Response of IEA Countries 2014*, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html, p. 17.

Assessing the Strategic Impact of A Major Conflict in the Gulf

The unclassified U.S. official assessments of the impact of major energy interruptions have not kept current with these shifts in direct and indirect strategic dependence, and the risks of a major war in the Gulf. They are badly out of date and need to focus on the broader impact of such a conflict on the global economy as well as on oil and gas supply and price effects.

The International Energy Agency (IEA) has conducted recent public studies of the impact of major energy interruptions in 2011 and 2014, although they did not examine the risk of a major war in the Gulf region, or the broader economic consequences of energy interruptions on world trade and the global economy. As a result, the IEA issued the following warnings:[xxxi]

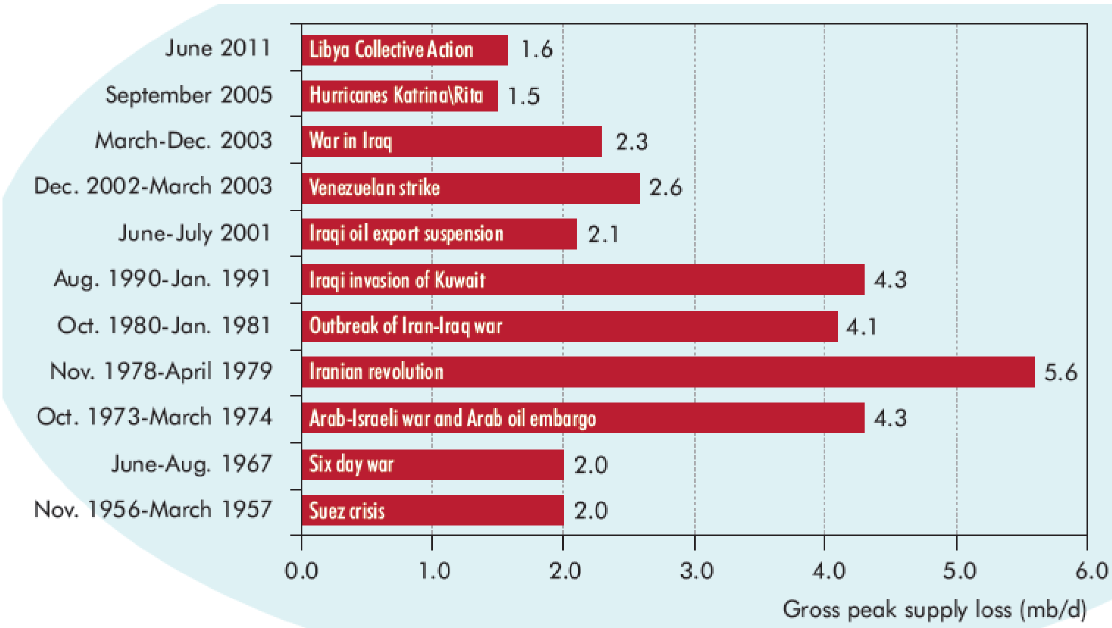
- Although the oil delivery system has changed dramatically since the oil shocks of the 1970s, there is still a high risk of a supply disruption which could have great economic consequences for IEA member countries.
- Capacity constraints, both in production and refining, have increased the potential of supply falling short of demand. Given this delicate balance of supply and demand, even a disruption of relatively small volume can have a significant impact on the market.
- Global demand growth exacerbates market tightness, further re-enforcing the need for investment in capacity expansion.
- Uncertain investment climates in some producer countries, often described as an aspect of "resource nationalism", may also hamper the development of future supply streams.
- Geopolitical tensions and terrorism create uncertainty as to the continuous availability of supply. This "risk premium" adds to the volatility of an already tense market, where available oil supplies are increasingly concentrated in fewer countries.
- Natural disasters, such as extreme weather conditions, can disrupt the supply/demand balance, cutting off supply or causing demand to spike.
- ...the unexpected event!

This work by the IEA also shows that past interruptions have been much smaller in scale and duration that what could happen in the future. **Figure 18** shows an IEA estimate of the maximum size of past interruptions. At the same time, **Figure 17** has already provided an IEA estimate of the massive increases in Asian demand for oil and risk this poses to the U.S. in terms of indirect imports.

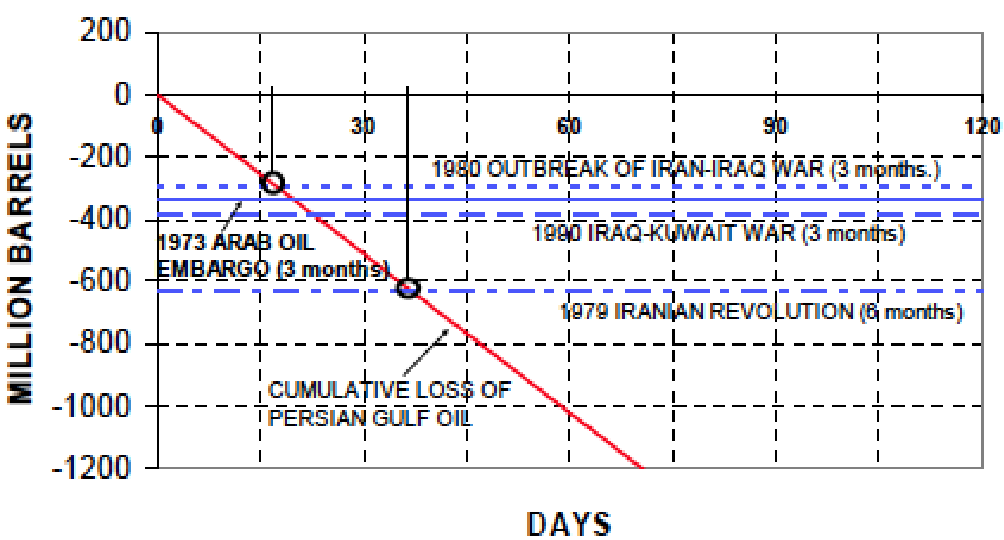
Some additional work has been done by U.S. think tanks and the US Congress, but it does not have official standing and has never examined the impact on indirect imports.[xxxii] Accordingly, the public modeling efforts of by the Department of Energy badly need to be updated to examine the new threats posed by non-state actors and the growing potential impact of a major war in the Gulf. Like the overall nature of U.S. import dependence, such assessments need to focus on the impact on indirect imports and world trade, and on the nature of regional dependence on energy imports to sustaining exports to the U.S., particularly in the case of Asia.

Figure 18: IEA and JEC Estimates of the Maximum Size of Past Major World Oil Disruptions

IEA Estimate of Peak Supply Loss and Duration



JEC Estimate of Strait of Hormuz Closure and Past Oil Supply Disruptions



Source: IEA, Response System for OIL SUPPLY Disruptions, 2012, http://www.iea.org/publications/freepublications/publication/EPPD_Brochure_English_2012_02.pdf, p. 11; and *Energy Supply Security 2014, Emergency Response of IEA Countries 2014*, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html, p. 20.; Jim Saxton, "The Strait of Hormuz and the Threat of an Oil Shock," Joint Economic Committee, United States Congress, July 2007, http://www.jec.senate.gov/republicans/public/?a=Files.Serve&File_id=6c23d7fa-5988-4f13-9457-84955b31d706.

[1] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 14, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, ES-4.

[2] U.S. Energy Information Administration, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, pp. 18-19.

[3] *BP Statistical Review of World Energy*, June 2014, pp. 6, 8, 20, and 22, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf.

[4]World Energy Outlook 2014 by Dr. Fatih Birol, Chief Economist of the International Energy Agency (IEA), http://www.slideshare.net/internationalenergyagency/world-energy-outlook-2014-london-november?ref=http://www.worldenergyoutlook.org/

[5]World Energy Outlook 2014 by Dr. Fatih Birol, Chief Economist of the International Energy Agency (IEA), http://www.slideshare.net/internationalenergyagency/world-energy-outlook-2014-london-november?ref=http://www.worldenergyoutlook.org/

[6] Source: EIA, world Transit Energy Chokepoints, November 10, 2014, p. 2, http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf

[7] Source: EIA, world Transit Energy Chokepoints, November 10, 2014, p. 2, http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf.

[8]IEA, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html.

[9] *BP Statistical Review of World Energy*, June 2014, p.18, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf.

[10] International Energy Association, Response System for Oil Supply Disruptions, 2012, http://www.iea.org/publications/freepublications/publication/EPPD_Brochure_English_2012_02.pdf.

[11] For example, see William Komiss and LaVar Huntzinger, *The Economic Implications of Disruptions to Maritime Oil Chokepoints*, CNA, CRM D0024669.A1/Final, March 2011, https://www.cna.org/sites/default/files/research/The%20Economic%20Implications%20of%20Disruptions%20to%20Maritime%20Oil%20Chokepoints%20D0024669%20A1.pdf. For a Congressional report, see

Jim Saxton, "The Strait of Hormuz and the Threat of an Oil Shock," Joint Economic Committee, United States Congress, July 2007, http://www.jec.senate.gov/republicans/public/?a=Files.Serve&File_id=6c23d7fa-5988-4f13-9457-84955b31d706.

[12] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. ES-3, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[13] U.S. Energy Information Administration, "U.S. energy imports and exports to come into balance for first time since 1950s," http://www.eia.gov/todayinenergy/detail.cfm?id=20812#

[14] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 11, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[15] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. ES-6, 9-10 http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[16] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 11, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[17] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 14, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[18] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 14, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf

[19] U.S. Energy Information Administration, "U.S. oil production growth in 2014 was largest in more than 100 years," *Today in Energy*, March 30, 2015, http://www.eia.gov/todayinenergy/detail.cfm?id=20572

[20] U.S. Energy Information Administration, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, pp. ES-4

[21] U.S. Energy Information Administration, *Annual Energy Outlook 2015*, p. 14, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, ES-4.

[22] U.S. Energy Information Administration, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, pp. 18-19.

[23] *BP Statistical Review of World Energy*, June 2014, pp. 6, 8, 20, and 22, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf.

[24]World Energy Outlook 2014 by Dr. Fatih Birol, Chief Economist of the International Energy Agency (IEA), http://www.slideshare.net/internationalenergyagency/world-energy-outlook-2014-london-november?ref=http://www.worldenergyoutlook.org/

[25]World Energy Outlook 2014 by Dr. Fatih Birol, Chief Economist of the International Energy Agency (IEA), http://www.slideshare.net/internationalenergyagency/world-energy-outlook-2014-london-november?ref=http://www.worldenergyoutlook.org/

[26] Source: EIA, world Transit Energy Chokepoints, November 10, 2014, p. 2, http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf

[27] Source: EIA, world Transit Energy Chokepoints, November 10, 2014, p. 2, http://www.eia.gov/countries/analysisbriefs/World_Oil_Transit_Chokepoints/wotc.pdf.

[28] EIA, "Oil trade off Yemen coast grew by 20% to 4.7 million barrels per day in 2014," *Today in Energy*, April 23, 2015.

[29]IEA, https://www.iea.org/publications/freepublications/publication/energy-supply-security-the-emergency-response-of-iea-countries-2014.html.

[30] *BP Statistical Review of World Energy*, June 2014, p.18, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf.

[xxxi] International Energy Association, Response System for Oil Supply Disruptions, 2012, http://www.iea.org/publications/freepublications/publication/EPPD_Brochure_English_2012_02.pdf.

[xxxii] For example, see William Komiss and LaVar Huntzinger, *The Economic Implications of Disruptions to Maritime Oil Chokepoints*, CNA, CRM D0024669.A1/Final, March 2011, https://www.cna.org/sites/default/files/research/The%20Economic%20Implications%20of%20Disruptions%20to%20Maritime%20Oil%20Chokepoints%20D0024669%20A1.pdf. For a Congressional report, see

Jim Saxton, "The Strait of Hormuz and the Threat of an Oil Shock," Joint Economic Committee, United States Congress, July 2007, http://www.jec.senate.gov/republicans/public/?a=Files.Serve&File_id=6c23d7fa-5988-4f13-9457-84955b31d706.