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

By Anthony H. Cordesman

*April 21, 2015*

***Request for comments:***

Comments and suggested changes would be greatly appreciated. Please send any comments to Anthony H. Cordsman, Arleigh A. Burke Chair in Strategy, at acordesman@gmail.com.

**ANTHONY H. CORDESMAN**
Arleigh A. Burke Chair in Strategy
acordesman@gmail.com

# American Strategy and Critical Changes in US "Energy Import Dependence"

**Anthony H. Cordesman**
**April 21, 2015**

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

It is important to note, however, that US strategic dependence on the stable flow of world energy exports at market prices is very different from total US dependence on energy imports as measured in quads. US direct strategic dependence on imports is almost exclusively a matter of dependence on petroleum liquids and the ability to provide energy for the US transportation sector and other importers that cannot easily or cost effectively substitute other sources of energy. The US can be a net export of other fuels like coal and natural gas and still be highly dependent on imports of crude oil.

## US Total "Energy Independence" in BTUs

Since at least 2012, projections by the International Energy Agency (IEA), and the Energy Information Agency (EIA) of the US Department of Energy have reported that a combination of new technologies and more diverse sources of fossil and other fuels could give the US enough annual output *of all forms of energy* to be a net exporter of energy.

Since those 2012 estimates, projections of US energy output relative to demand have increased, and the projections that the EIA issued in April 2015 now project that total US energy import dependence based on national energy consumption in BTUs will drop from 30% in 2005 and roughly 10% in 2013, to approximately 5%-8% in most scenarios during 2020-2030. The US would be 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:[1]

> 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 EIA, like the IEA and other meaningful sources of such projections, indicates that such estimates are highly uncertain in the out years given the every meaningful parameter involved, and that future resources levels, technology, and price have substantial uncertainty in every credible scenario. 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.

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 US transportation fleet alone makes the US 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 US 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 2**,[2]

> 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.[3] 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. [4]

This conclusion is reinforced by the relatively static projection of the total share of petroleum and other liquids in EIA projections of total US energy use through 2014. 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. [5] The EIA summarizes these trends as follows: [6]

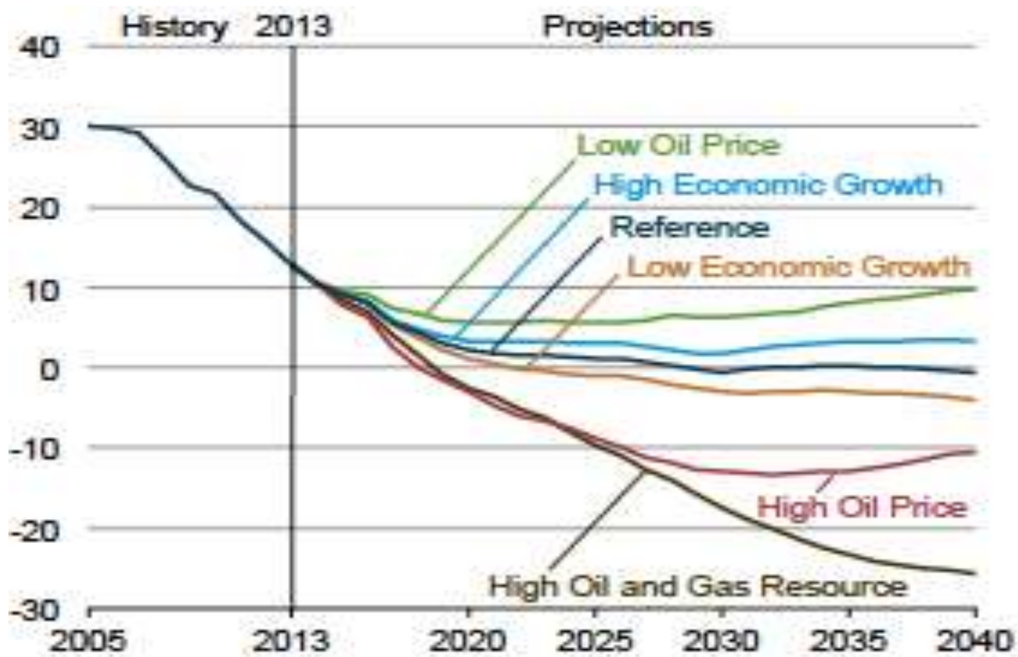
> Consumption of petroleum products across all sectors in 2040 is unchanged from 2013 levels, as motor gasoline consumption in the transportation sector declines as a result of a 70% increase in the average efficiency of on-road light-duty vehicles (LDVs), to 37 mpg in 2040, which more than offsets projected 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.

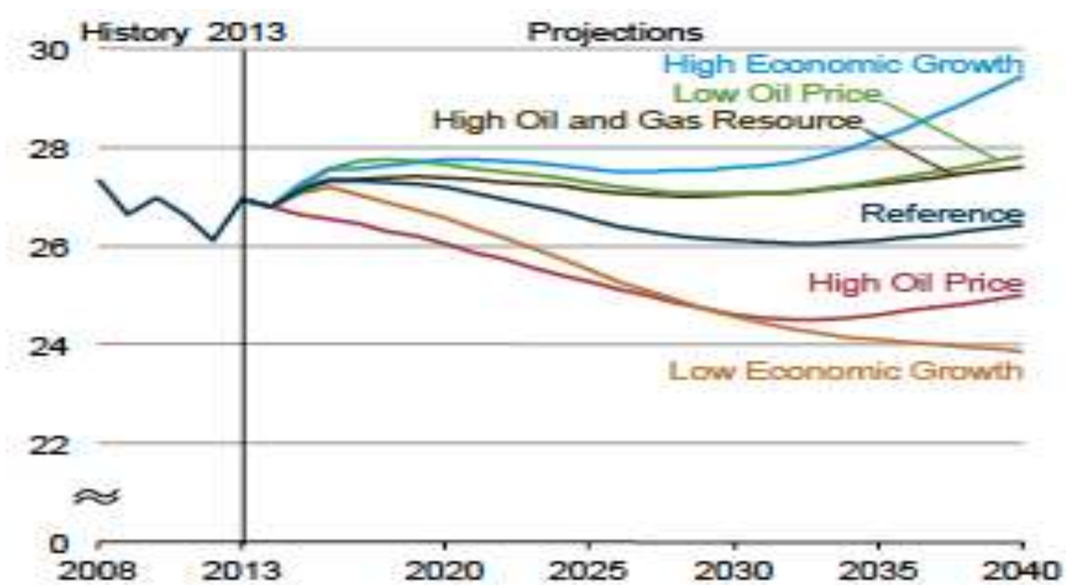
The gasoline share of total demand for transportation petroleum and other liquids declines by 10.6 percentage points, while distillate consumption increases by 7.2 percentage points. Increased use of compressed natural gas and LNG in vehicles also replaces about 3% of petroleum and other liquids consumption 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)**



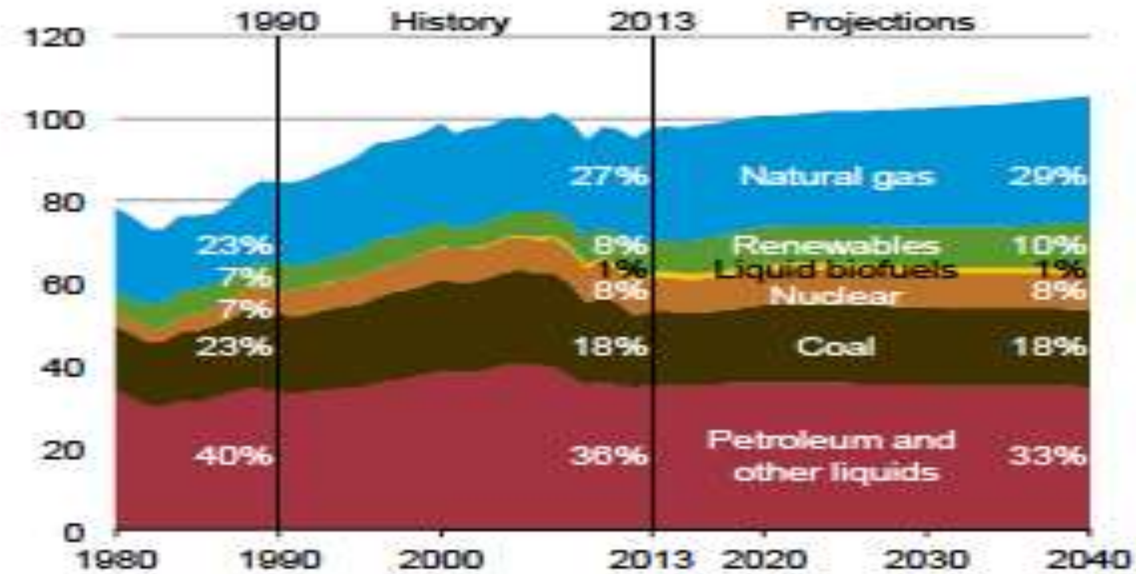

Source: U.S. Energy Information Administration,| *Annual Energy Outlook 2015*, p. ES-3, http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf.

**Figure 2: 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 3: 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 US Domestic Oil Production

This continuing US dependence on fossil fuels for its transportation sector does not mean that the US is not becoming less dependent on crude oil and other liquids imports – and could mean that the US could still become an exporter of gasoline and product.

The projections in the *Annual Energy Outlook* for 2015 show that the US 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.

It is important to stress that the 2015 EIA projections do reflect a very wide range of potential increases in total US 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 US production are still likely to significant, however, in most scenarios. This is shown in **Figure 4**, and the EIA reports that,[7]

> 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

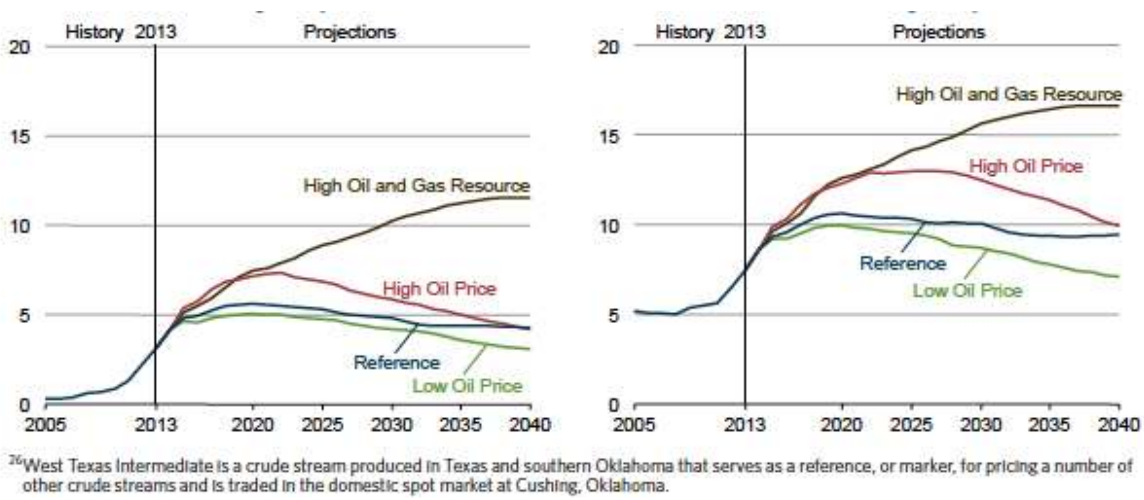
production in the High Oil and Gas Resource case increases to 16.6 million barrels per day (bbl/d) in 2040, compared with a peak of 10.6 million bbl/d in 2020 in the Reference case.

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 4: US Crude Oil Production in MMBD: 2005-2040**

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

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




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

## Radical Changes in the 2015 Estimates of US Strategic Dependence on Oil Imports

Increases in US crude oil and other liquids production, and the overall economics of US and global energy production and consumption have already affected direct US import dependence in strategic terms. **Figure 5** shows just how sharply estimates of direct important dependence on crude oil dropped between 2013 and 2014 as estimates of US domestic oil production increased and projections of cost and demand changed.

The 2015 EIA projections of US imports and possible US exports shown in **Figure 6**, however, reflect the possibility of a dramatically lower dependence on imports, a possible shift to exports, and a far wider range of uncertainty in every aspect of the future.

The end result is a complex situation where the US seems most likely to remain dependent on crude oil imports, but is projected to be able to export gasoline and product and could become as net exporter by 2021. The trends involved are graphed in **Figure 6,** and the EIA summarizes resulting levels of US strategic dependence on oil and liquids imports as follows: [8]

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 (Figure 21 and Figure 22).

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.

In both the High Oil and Gas Resource and High Oil Price cases, growing production of 27°–35° American Petroleum Institute (API) medium sour crude oil from the offshore Gulf of Mexico (GOM) helps balance the crude slate when combined with the increasing production of light, sweet crude from tight oil formations.

In all cases, GOM crude oil production increases through 2019, as offshore deepwater projects have relatively long development cycles that have already begun. GOM production declines through at least 2025 in all cases and fluctuates thereafter as a result of the timing of large, discrete discoveries that are brought into production. Overall GOM production through 2040 is highest in the High Oil and Gas Resource case, followed closely by the High Oil Price case and finally by the Reference case and Low Oil Price case.

In the High Oil Price case, producers take greater advantage of CO2-enhanced oil recovery (CO2-EOR) technologies. CO2-EOR production increases at a steady pace over the projection period in the Reference case and increases more dramatically in the High Oil Price case, where higher prices make additional CO2-EOR projects economically viable. In the High Oil and Gas Resource and Low Oil Price cases, with lower crude oil prices, fewer CO2-EOR projects are economical than in the Reference case.

Production of natural gas plant liquids (NGPL), including ethane, propane, butane, isobutane, and natural gasoline, increases from 2013 to 2023 in all the AEO2015 cases. After 2023, only the High Oil and Gas Resource case shows increasing NGPL production through the entire projection period. However, the High Oil Price case also shows significant NGPL production growth through 2026. Most of the early growth in NGPL production is associated with the continued development of liquids-rich areas in the Marcellus, Utica, and Eagle Ford formations.

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.

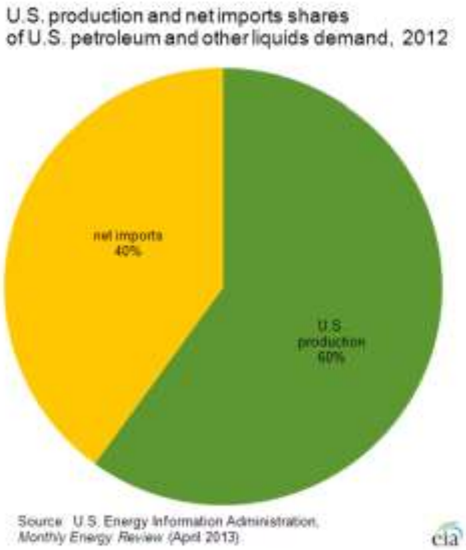
In the High Oil and Gas Resource case, production of blending components increases to 9.1 million bbl/d in 2040, because abundant domestic supply of lighter crude oil results in lower feedstock costs for refiners, lower gasoline prices, increased exports, and relatively higher levels of gasoline consumption (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.

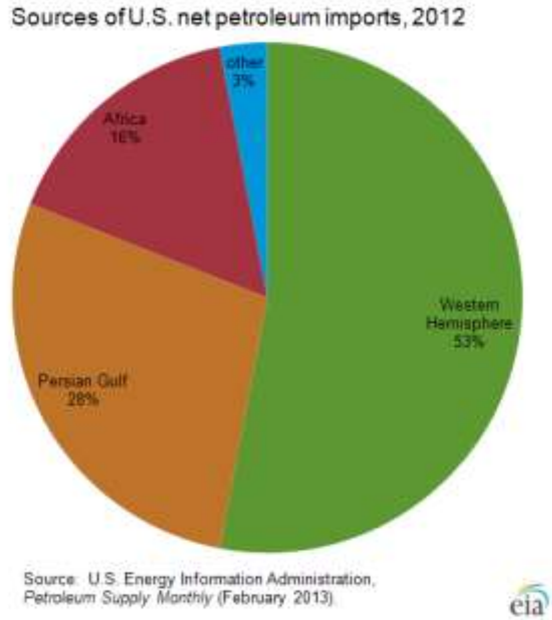
*As in the Reference case, the United States remains a net importer of liquid fuels through 2040 in the Low Oil Price case. In the High Oil and Gas Resource case, as a result of higher levels of both domestic crude oil production and petroleum product exports, the United States becomes a net exporter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

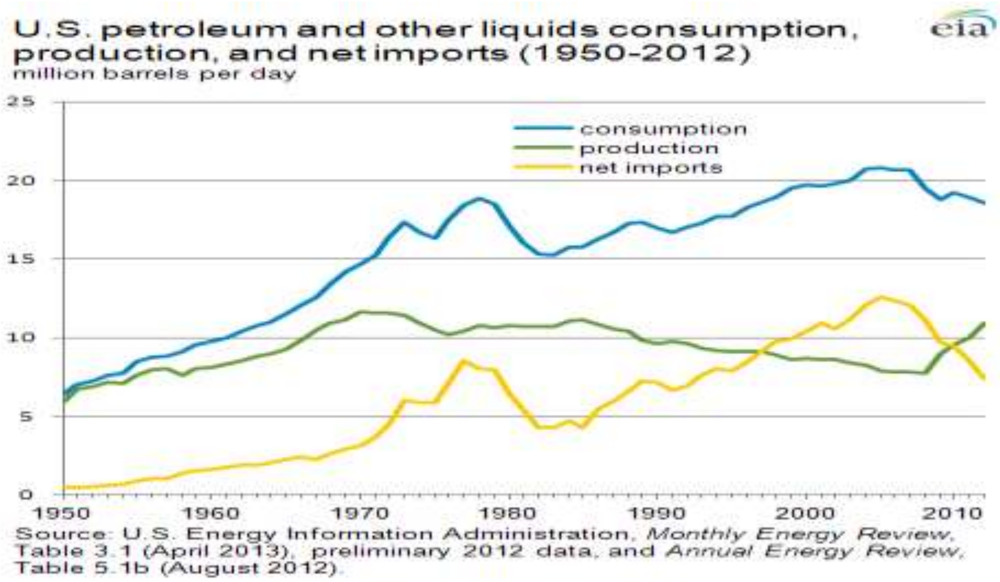
Refiners and oil producers gain a competitive advantage from abundant domestic supply of light crude oil and higher GOM production of lower API crude oil streams, along with lower refinery fuel costs as a result of abundant domestic natural gas supply. *In the High Oil Price case, the United States becomes 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 (Figure 23 and Figure 24).*

## Figure 5: Past EIA Projections of US Petroleum Import Dependence: – Part One: 2013 Case



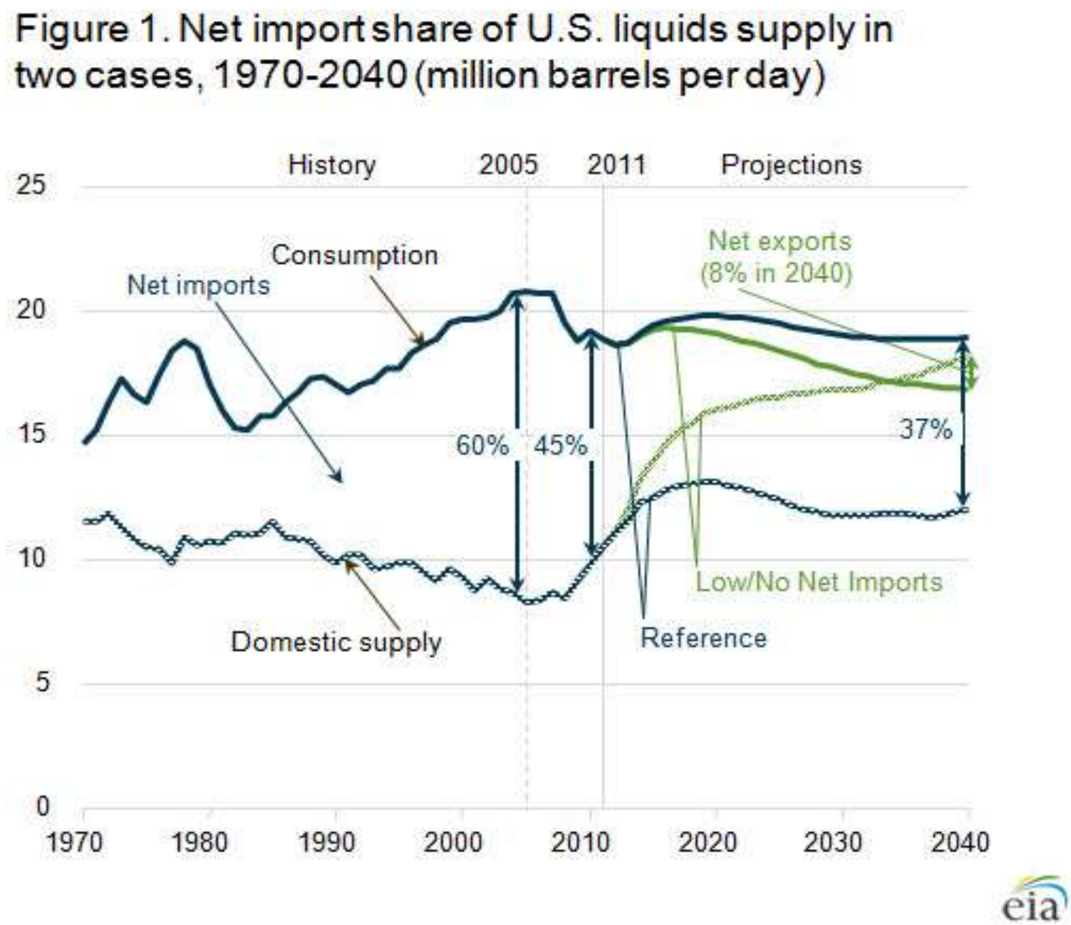




The United States imported 11.0 MMbd of crude oil and refined petroleum products in 2012, and exported 3.2 MMbd of crude oil and petroleum products, so net imports (imports minus exports) equaled 7.4 MMbd. The United States imported 2.1 MMbd of petroleum products such as gasoline, diesel fuel, heating 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 5: Past EIA Projections of US Petroleum Import Dependence: – Part Two: 2014 Case**




In the Reference case shown in Figure 5, U.S. net imports of petroleum and other liquids decline through 2019, while still providing approximately one-third of total U.S. supply. According to the EIA Annual Energy Outlook 2013:

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.

Source: US Energy Information Administration, *Annual Energy Outlook 2013 Early Release Overview*, May 2, 2013, http://www.eia.gov/forecasts/aeo/chapter_executive_summary.cfm#tightoil .

## Figure 6: US Direct Dependence on Energy Imports: Part One - EIA 2015 Projection

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

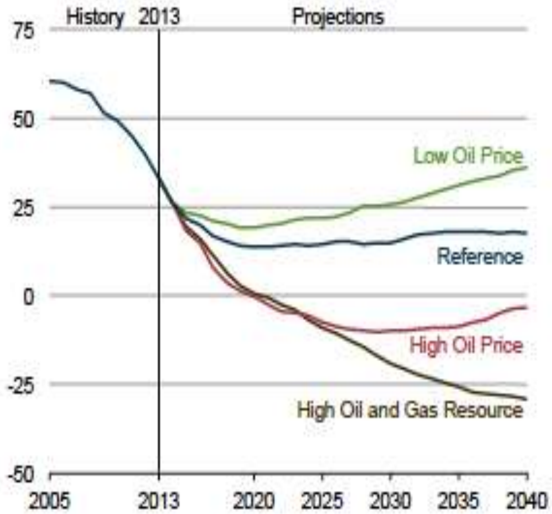



Figure ES5. U.S. total net natural gas imports in four cases, 2005-40 (trillion cubic feet)

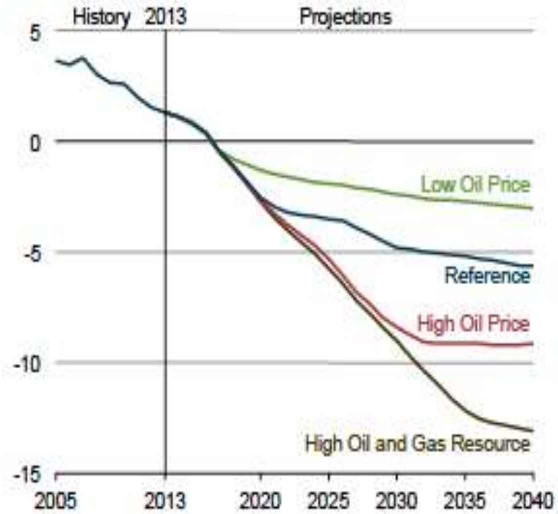



Figure 23. U.S. net crude oil imports in four cases, 2005-40 (million barrels per day)

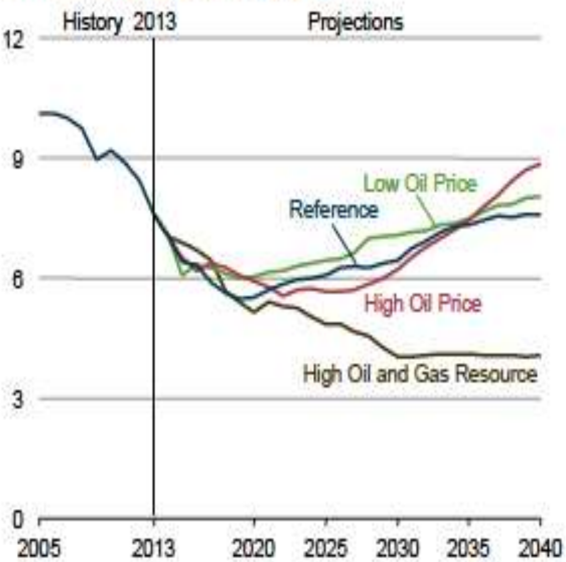
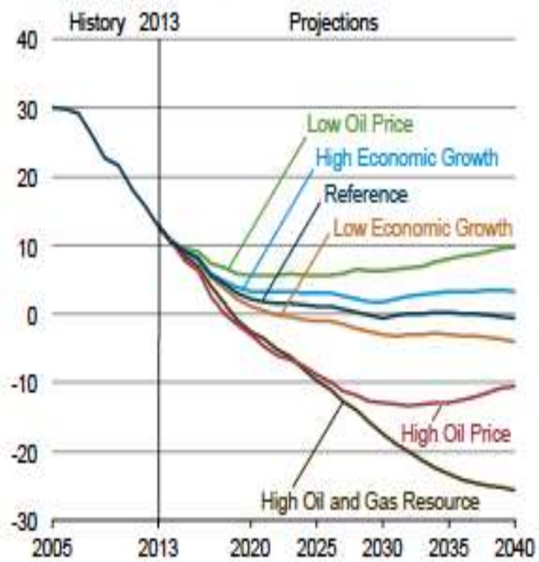



Figure ES3. U.S. net energy imports in six cases, 2005-40 (quadrillion Btu)



## Figure 6: US Direct Dependence on Energy Imports:

## Part Two: Comparison of 2014 and 2015 EIA Reference Case Projections

Figure E4. Total energy production and consumption in the AEO2015 and AEO2014 Reference cases, 1980-2040 (quadrillion Btu)

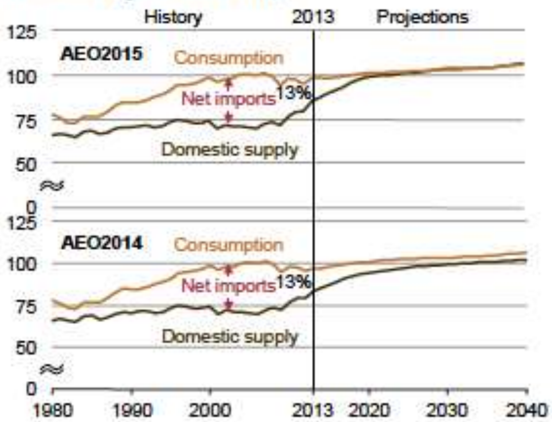



Figure E5. Share of U.S. liquid fuels supply from net imports in the AEO2015 and AEO2014 Reference cases, 1970-2040 (percent)


[29]Total domestic liquid fuels minus net imports, plus domestic HGL production.

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.

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.

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

## US Strategic Dependence on Indirect Energy Imports

Given the traditional basis for estimating US strategic dependence on energy imports, the EIA analysis makes a strong case for reassessing US strategic dependence in broad terms. Like total US energy output relative to domestic demand, however, direct US strategic dependence on world energy exports is only part of the story.

US economic dependence on the secure overall flow of global energy exports continues to increase. As the "great recession" showed all too clearly after 2007, the US economy is critically and steadily more dependent on the health of the global economy.

The US also pays world prices for energy, and 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 US economy must pay such prices regardless of where the interruption occurs.

Much also depends on how import dependence is assessed, and most current assessments of strategic dependence rely far too much on direct imports. Indirect imports of energy in the form of imports of manufacture goods dependent on the predictable flow of energy exports from key areas like the Gulf are almost certainly are now of greater strategic importance than direct imports.

## The Vulnerability of World Oil Exports

The importance of Gulf exports, and their strategic vulnerability is shown in **Figure 7**. There are good reasons why the US defense strategic guidance issued in early 2012 gave the same strategic importance to the MENA region as rebalancing to Asia, why the US has since built up is asymmetric warfare capabilities in the Gulf, why US forces are involved in Iraq and Yemen, and why recent US Navy seapower studies project an increase in US naval deployments.

As the EIA noted in a report issued in November 2014, [9]

> 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.

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

**The Importance of Indirect Imports to US Trade and Economic Stability**

The broad impact of the flow of indirect exports on the US economy is clear, although sources differ in detail. The CIA *World Factbook* estimates that US had a $16.72 trillion economy in 2014. The data on US imports and exports lag, but total US exports were $1.575 trillion in 2013, or roughly 9% of the US GDP. US imports were $2,273 trillion in 2013, or roughly 14% of the US GDP.

These percentages understate the importance of manufacturing US imports, since most of the US manufacturing center and high technology activity is not dependent on the steady flow of imported elements and components. The US growth and health of the US economy, and the vast majority of American jobs depend on the flow of such imports to the US.

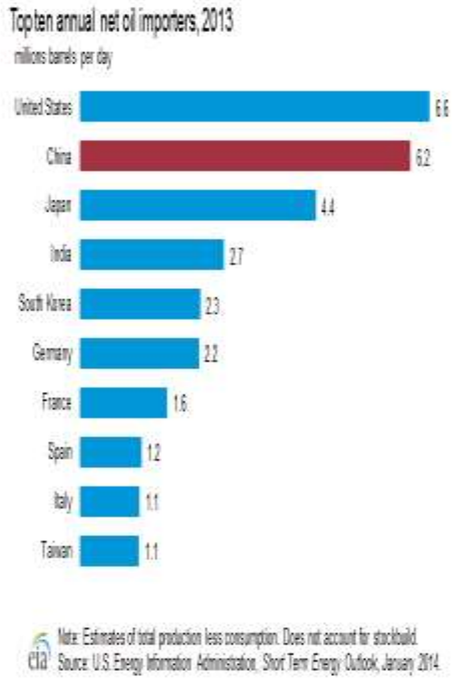
In practice, US indirect dependence on the overall flow of energy exports to key exporters to the US has long been at least as important as direct US dependence in on energy imports. In 2013, at a time when US direct dependence on energy imports remains far higher that is projected for the future, the CIA estimates that energy imports only accounted for 8.2% of total US imports.

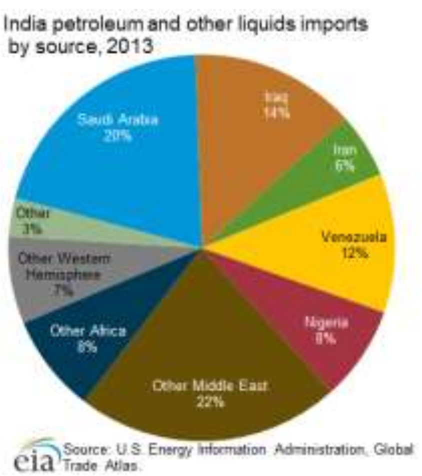
In contrast, 24.7% of total US imports were are industrial supplies, 30.4% were capital goods, and 31.8% were consumer goods – for total of 86.9% of all US imports. **Figure 8** shows that China, Korea, Japan and other key exporters to the US are critically dependent on Gulf energy exports. These nations that accounted for over 33% of all US imports – a percentage of US trade roughly four times larger than direct US dependence.

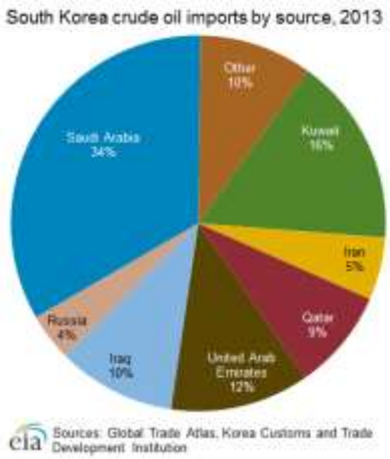
These data clearly indicate a level of strategic dependence that goes far beyond the uncertain future US need for crude oil imports. It also indicates a critical need for the US to reappraise how it assess strategic dependence and its vital national security interests. Almost none of the official estimates of US import dependence – past, current- or future – take indirect imports into consideration.

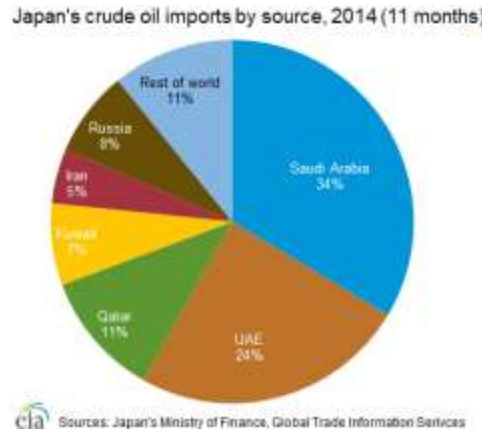
Moreover, at least the unclassified official assessments of the impact of major energy interruptions have not kept current with these shifts in direct and indirect strategic dependence, and are badly out of date. Some excellent work has been done by outside think tanks, but the public model by the Department of Energy – and by the International Energy, as well – badly needs 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 US import dependence, such assessments need to focus more on the impact on indirect imports and world trade, and on the nature of regional dependence on energy imports to sustaining exports to the US, particularly in the case of Asia.

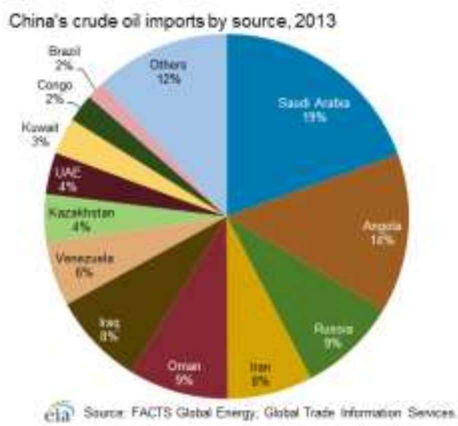
**Figure 8: Asian Strategic Dependence on Gulf Energy Exports**






Source: Energy Information Agency (EIA), US 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;

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

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

[3] 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

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

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

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

[7] http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, pp. ES-4,

[8] http://www.eia.gov/forecasts/aeo/pdf/0383%282015%29.pdf, pp. 18-19.

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