PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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Note: *Musings from the Oil Patch reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every two weeks, but periodically events and travel may alter that schedule. As always, I welcome your comments and observations.* Allen Brooks

Did We Just Spend Two Years In Hell For Nothing?

While the details of the agreement have yet to be spelled out, the preliminary numbers suggest nearly a 900,000 barrels a day reduction

The word out of Algeria last week was that OPEC's major domos – Saudi Arabia and Iran – have been able to overcome their past feuds over oil policy and agree to a deal to cap the organization's output at 32.5 million barrels a day (mmb/d). Based on the International Energy Agency's (IEA) September estimate, OPEC produced 33.45 mmb/d in August, up from the 33.0 mmb/d average it posted for the second quarter. While the details of the agreement have yet to be spelled out, the preliminary numbers suggest nearly a 900,000 barrels a day reduction, scheduled to be implemented in November. Of course, seasonally, Saudi Arabia's domestic oil consumption drops by 300,000-400,000 barrels a day, which would make meeting OPEC's reduced output cap much easier during the winter months. On the other hand, the strains of the nearly two-year oil price free-market experience are evident in Saudi Arabia as well as its fellow OPEC members.

Ministerial salaries are being cut by 20%

Just a week ago, the Saudi Arabian government announced pay cuts for its ministers along with reductions in financial benefits for most other government employees. Ministerial salaries are being cut by 20% and housing and car allowances for members of the appointed Shoura Council will be reduced by 15%. Overtime bonuses for government employees who are primarily Saudi Arabians are being limited to between 25% and 50% of base salaries, while annual leaves are being limited to 30 days. These cuts are effective October 1st except for military and government officials overseas.

Last month, the government raised many fees including those for visas and fines for some traffic violations, such as "skidding," the high-speed sliding of cars engaged in by many Saudi youths. It was last December the government cut

subsidies for power and water, while also boosting gasoline prices, none of which were welcomed by the population accustomed to a coddled lifestyle.

Many of these actions are consistent with Vision 2030

Many of these actions are consistent with Vision 2030, the plan introduced by Deputy Crown Prince Mohammed bin Salman bin Abdulaziz Al-Saud designed to restructure the Saudi Arabian economy and boost citizen employment in the private sector, something that has largely been dependent on foreign guest workers. Recently, there were several media stories about a growing movement by Saudi Arabian women seeking changes in the policy of male control over the freedom of family females. The female population represents a significant untapped economic resource, something identified in the country's new economic plan.

These cuts are a recognition of the financial pressures the country is experiencing due to low oil prices

The increase in fees, along with cuts in subsidies and compensation, and demanding more work time, are all part of beginning Saudi Arabia's economic readjustment process. These cuts are a recognition of the financial pressures the country is experiencing due to low oil prices. Since OPEC decided to let markets determine oil prices, Saudi Arabia has spent $167 billion of its foreign reserves to offset the lower oil income. They spent $115 billion in 2015 and another $52 billion so far this year. The International Monetary Fund (IMF) projects Saudi Arabia will have a fiscal deficit equal to 13.5% of its gross domestic product this year, heightening the financial strain on the government. The government has sold debt for the first time since 2008 and has another very large bond deal in the wings. There is also a question about the impact of the U.S. decision to allow 9/11 victims to sue Saudi Arabia.

The royal family sees the potential for the country to become a social powder-keg, putting the existence of the kingdom at risk

While the financial strain is showing, and the social pressures within the economy are building, Saudi Arabia probably reacted more to the latest warnings about slowing global economic growth, weak oil demand growth and a projected rise in non-OPEC oil output next year in its decision to moderate its position on oil prices. The combination of those factors likely convinced Saudi Arabian officials that they might be facing another year of low, or possibly even lower oil prices. And what if the desired results of low oil prices didn't happen until 2018 or even 2019? In that case, Saudi Arabia would find their foreign reserves depleted and they would be heavily in debt. This would happen despite the potential revenues from the planned privatization of Saudi Aramco. Putting all these factors together, one could draw the conclusion that the royal family sees the potential for the country to become a social powder-keg, putting the existence of the kingdom at risk. Given their responsibility as the protectorate of Islam's holy sites, the possibility that the royal family might be deposed and the country thrown into chaos certainly has to scare the senior royal family members.

The answer to the question asked in the article's title is probably No. Yes, it has been a painful period, but the result has been a more

efficient industry, and in a higher oil price environment, a more profitable business. That may result in oil being able to better sustain its future against efforts to fight its existence. The transition to our next energy future has been pushed off as a result of the recent downturn, but technology will not be denied forever.

Continuing Examination Of EV Impact On Gasoline Demand

The recovery in global oil prices so far in 2016 has been driven by the growth in vehicle miles traveled (VMT) and its impact on gasoline demand

In the last *Musings*, we wrote an article examining the issue of gasoline demand and whether it would be able to withstand attacks on the use of automobiles and the societal pressures for autonomous and self-driving cars along with a significant push to electrify our personal transportation system. As we reported, the recovery in global oil prices so far in 2016 has been driven by the growth in vehicle miles traveled (VMT) and its impact on gasoline demand. The growth in VMT started several years ago and reversed the decline that occurred with the financial crisis and subsequent recession. It also came as the growing millennial population began adopting more traditional attitudes towards work, shopping, socializing and traveling.

He believes that too many people in the oil business dismiss the impact of these technologies on the industry's future

Shortly after publishing the article, we received an email from an old friend and reader whom we hadn't been in contact with for quite a while. He is a long-time oilfield service company executive who spent his career in the technology segment of the business. He offered comments about renewables, in particular his view that the growth of autonomous and electric vehicles (EVs) would have a more significant impact on gasoline demand, and in turn on the oilfield service industry, than many of his peers expect. He believes that too many people in the oil business dismiss the impact of these technologies on the industry's future. He encouraged us to keep investigating and writing about the vehicle revolution, as well as the impact of renewables in the energy market in order to educate the leaders of the industry. This article is in response to that urging, despite the fact we only addressed the topic two weeks ago. I also can ensure you that this will not be the last article on EVs and autonomous vehicles, as we believe it is an important issue whose potential impact (unclear) needs to be explored.

We felt we needed to attempt to quantify the potential impact on gasoline consumption from a more rapid penetration of EVs into the American vehicle fleet

In order to advance the discussion from our last article, we felt we needed to attempt to quantify the potential impact on gasoline consumption from a more rapid penetration of EVs into the American vehicle fleet during 2016-2035. Now, we could have merely turned to the Energy Information Administration's (EIA) latest annual energy outlook to see what the government is projecting, but the rigor of building one's own model forces one to acknowledge the multiple assumptions necessary to make a model work. We will comment on the EIA's 2016 outlook later.

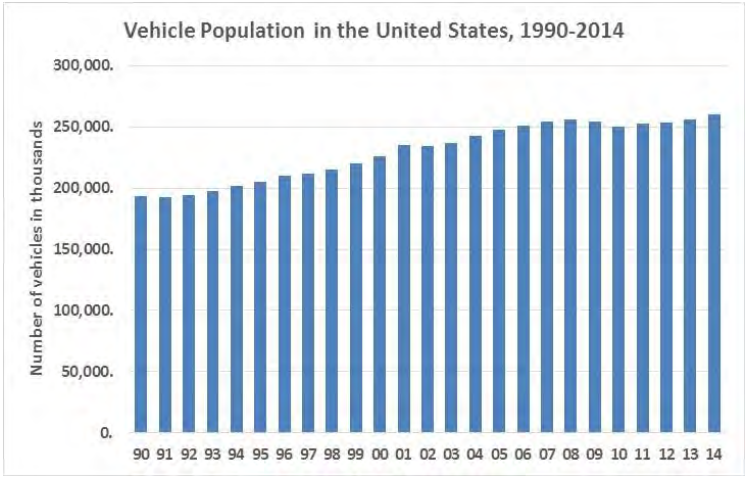
Our rough model involved forecasting U.S. vehicle fleet growth, EV growth and the resulting gasoline consumption outcome

In our long career of forecasting, we have built many models and found that fewer variables (following the KISS philosophy) helped produce reasonable results we can study and fine tune. Our rough model involved forecasting U.S. vehicle fleet growth, EV growth and the resulting gasoline consumption outcome. To do this, we had to make assumptions such as how fast the vehicle fleet would grow, how fast EVs would penetrate the fleet, how current and future fuel-economy standards may impact annual fuel consumption, how the shifting fleet mix among cars and the truck sector might impact the fleet's fuel consumption, how much people would drive, etc. As we began to wrestle with these issues to make informed assumptions, we discovered how challenging the issues are.

The challenge then becomes determining how many of those vehicles are gasoline powered

Gasoline consumption is reported on a regular basis by the EIA, as are new vehicle sales by the auto manufacturers. The biggest challenge is estimating how many vehicles comprise the current U.S. fleet, and how the fleet size and composition has changed over time. The annual statistical report of the Department of Transportation (DOT) provides estimates for the U.S. fleet based on state registration data. While this provides an easy estimate of the entire fleet, the challenge then becomes determining how many of those vehicles are gasoline powered, as opposed to diesel or alternatively powered. This is especially a challenge when looking at the pickup truck category.

Exhibit 1. Historical Growth Of U.S. Vehicle Fleet

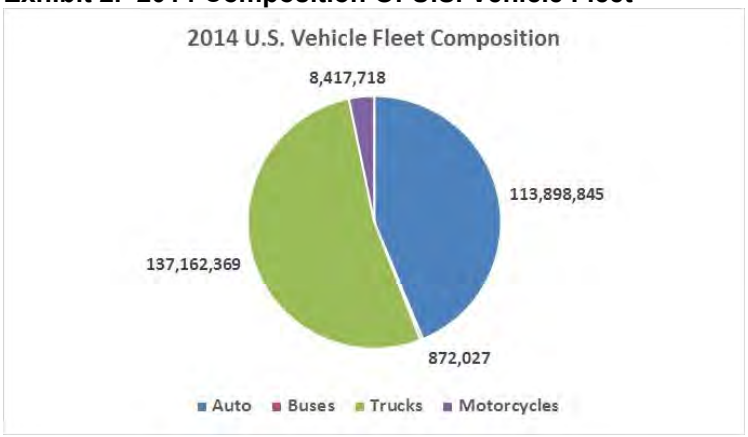


Source: ***Statistica,*** **PPHB**

The data in Exhibit 1, compiled by *Statistica* from DOT annual reports, shows the total U.S. vehicle fleet. When we examined the detail from the 2014 DOT report, we found the U.S. fleet composition shown in Exhibit 2 (next page).

What was interesting was finding that the number of trucks represents nearly 25 million more units than autos. We assumed that buses were diesel or alternatively powered, while motorcycles

Exhibit 2. 2014 Composition Of U.S. Vehicle Fleet

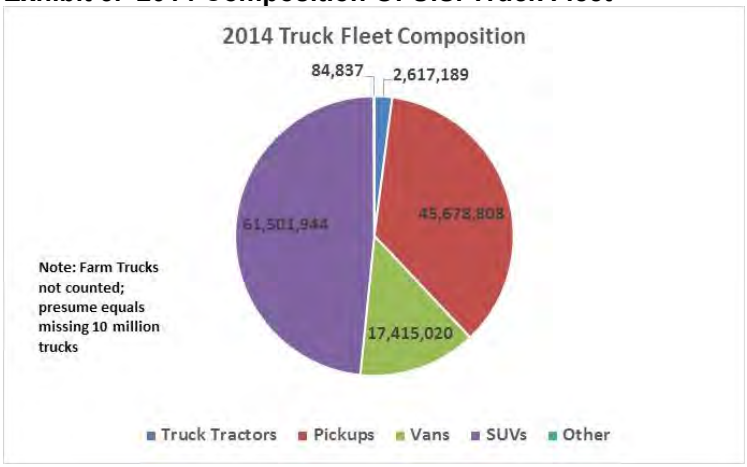


Source: DOT, PPHB

The biggest challenge was understanding the composition of the truck category – the largest segment of the American vehicle fleet

are all gasoline powered. While we can safely assume that there is a small portion of the auto fleet powered by diesel or alternative fuels, we don't think it is a large share. The biggest challenge was understanding the composition of the truck category – the largest segment of the American vehicle fleet. To estimate that segment, we examined the state data on truck registrations, only to find that the number is about 10 million units below the figures provided in the total fleet table.

Exhibit 3. 2014 Composition Of U.S. Truck Fleet



Source: DOT, PPHB

According to DOT reports, there were six categories of trucks. However, the registration numbers for one category, farm trucks, are no longer being collected. Does this represent the missing 10 million units? Most likely, but we are not sure.

The remainder of the truck fleet is composed of truck tractors, pickups, vans, SUVs and other. Exhibit 3 shows the makeup of the truck fleet, ignoring the category of farm trucks as well as the

The remainder of the truck sector is made up of three segments – pickups, vans and SUVs – most of which we assume are gasoline powered

missing 10 million units. While truck tractors are the units that pull trailers on highways, we assume they are 100% diesel powered. The remainder of the truck sector is made up of three segments – pickups, vans and SUVs – most of which we assume are gasoline powered. But just how many is a question given that a proportion of the pickups and vans are owned by and used in business. Remember, these three truck categories total more units than all the autos counted in the vehicle fleet total.

Another key assumption influencing the fleet growth is the rate of vehicle scrappage

Another key assumption influencing the fleet growth is the rate of vehicle scrappage. In general, it has been a relatively stable ratio, but it was interrupted in recent years by the financial crisis, a recession, the Cash for Clunkers economic stimulation program, and the rapid recovery in new vehicle sales. We have assumed a steady scrapping rate for the near-term but then accelerating as the aging vehicle fleet wears out.

We are assuming that new vehicle sales remain around 15 million units for the next few years before trending lower

Given continued low interest rates, domestic vehicle sales should stay relatively high, but probably not as high as they have been in recent years. The rebound in sales has probably satisfied most of the unfulfilled demand postponed from the financial crisis and recession years. Thus, we are assuming that new vehicle sales remain around 15 million units for the next few years before trending lower based on assumptions about the growth in ride-sharing options, a growing urban population with multiple transportation options and a growing millennial population segment with different attitudes toward vehicle ownership and usage. Lastly, there is the aging population demographic further lowering the demand for new vehicles.

Besides a lower-trending vehicle fleet growth rate, we reduced the starting estimate of total vehicles by 11% to reflect that portion of the fleet not in the gasoline powered population – trucks, buses and autos powered by either diesel or alternative fuels.

Given the historical vehicle population figures, we reduced them by our 11% assumption for non-gasoline powered vehicles

With our estimate of the number of gasoline powered vehicles, we can then calculate the annual volume of gasoline consumed. Given the historical vehicle population figures, we reduced them by our 11% assumption for non-gasoline powered vehicles. We can now track annual vehicle gasoline consumption. We were able to see how consumption has changed over time given the shifting vehicle mix (more SUVS and pickups), the impact of the increased fuel-economy regulations and the growth in vehicle miles traveled. As we assume the current American love-affair with SUVs and pickups continues into the future, we see the annual vehicle fuel consumption continuing to rise through 2035.

The next issue is trying to assess the future of EVs. They are barely registering in the current fleet despite the hype they are receiving in the media. However, they will carve out a niche, and when and if they can deliver a driving range on a single battery charge

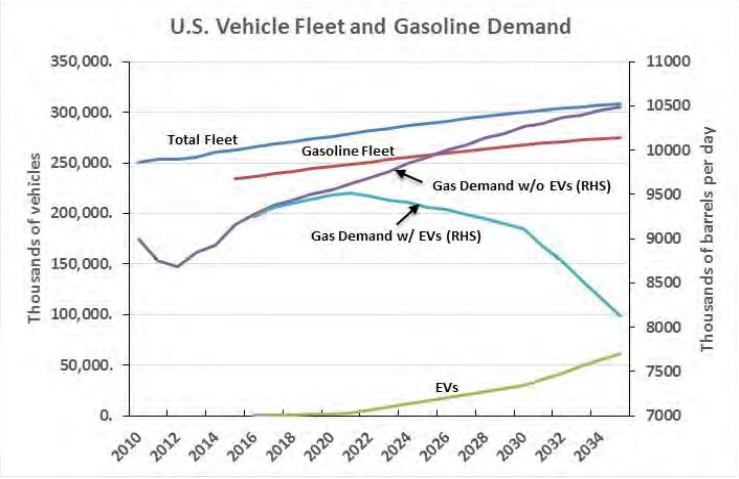
The problem is that most EV users don't appreciate the true cost of the batteries in their cars

comparable to what the public can get from a tank of gas, EVs will gain a greater market acceptance. That said, given the greater number of EV options available in the marketplace, there may be more drivers in the future who find a model meeting their needs. The problem is that most EV users don't appreciate the true cost of the batteries in their cars, making them more expensive than gasoline powered alternatives. Those promoting the idea of rapid EV acceptance by the public are implicitly marrying them to self-driving vehicles. Since more self-driving experiments are targeting urban use where trips are short and speeds aren't high, the big impact on the gasoline market would come from swapping no-gas cars for gasoline powered cars with inefficient engines that spend a lot of time in traffic jams burning fuel.

If he really meant 5% of the total American vehicle fleet of approximately 260 million units, then it would equal 13 million EVs

A Ford Motor Company (F-NYSE) senior executive told security analysts at the company's analyst day that EVs would represent 5% of the vehicle fleet in 2025. That was how it was reported. We are not sure whether he meant to say 5% of new car sales for that year. The difference is significant! If future annual light duty vehicle sales remain at the current rate of 17 million units, then we talking about 850,000 EVs. On the other hand, if he really meant 5% of the total American vehicle fleet of approximately 260 million units, then it would equal 13 million EVs. If we restrict the 5% to only the estimated gasoline powered vehicles in the fleet, then we are at 11.6 million units. At the current annual run rate for 2016 EV sales of 139,100 units, reaching the 5% of the American fleet goal in nine years would represent a major accomplishment. Is that possible?

Exhibit 4. EVs Will Impact Gasoline Demand



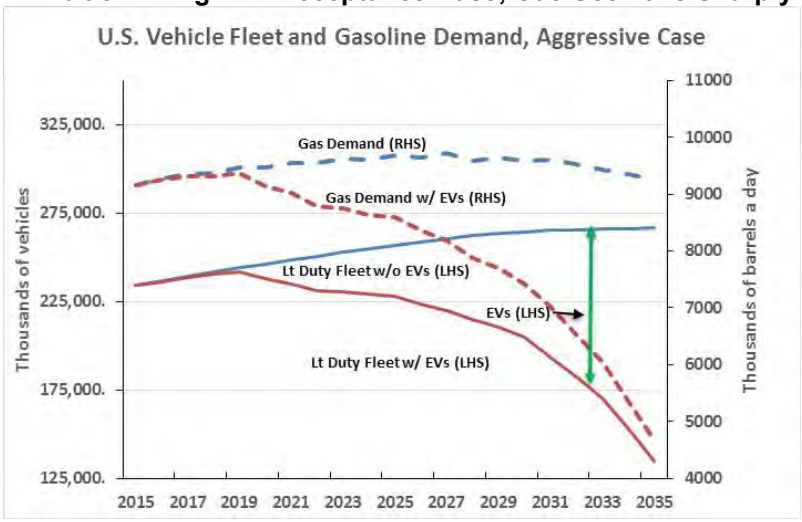
Source: DOT, EIA, PPHB

In our modeling, we have assumed that the Ford executive's total fleet estimate is achievable. We have assumed the total gasoline powered fleet continues to grow, but after a few years the rate of growth slows until it is at an extremely slow rate after 2030. At the same time, we expect the annual fuel use per vehicle to continue

In 2025, the increased EVs in the fleet result in about 556,000 barrels a day (b/d) less in gasoline demand

rising for a few more years as a result of the increased percentage of pickups and SUVs in the fleet with lower fuel-efficiency ratings than autos entering the fleet. As we move beyond 2025, the increased fuel standards for vehicles will slowly erode the annual volume of fuel consumed as more fuel-efficient vehicles account for a greater share of the total fleet. Our forecast calls for annual fuel use to fall from 599 gallons to 584, or a decline of 2.5%. Exhibit 4 shows the total fleet and the gasoline powered fleet without accounting for any EVs in the fleet. We show the projected EV fleet growth reaching the 5% target in 2025 and then accelerating during the remainder of the forecast. Our rationale is that scrapping of older gasoline powered cars will accelerate and EVs will gain greater public acceptance. From these vehicle forecasts, we are then able to estimate the annual gasoline demand both with EVs and without EVs, which are shown on the chart. In 2025, the increased EVs in the fleet result in about 556,000 barrels a day (b/d) less in gasoline demand. Five years later, the difference widens to 1.151 million barrels per day (mmb/d) and to 2.352 mmb/d in 2035.

Exhibit 5. In High EV Acceptance Case, Gas Use Falls Sharply



Source: DOT, EIA, PPHB

We see a gasoline demand gap of 318,000 b/d in 2020, rising to 1.085 mmb/d in 2025, then 2.148 mmb/d in 2030 and 4.571 mmb/d by 2025

As companies such as Ford, BMW (BMW.F-Nasdaq) and Tesla (TSLA-Nasdaq) push forward with aggressive EV programs, and the economics of EVs improve with lower battery costs and greater range-per-charge, we expect sales of EVs to take off. In our more aggressive EV model, we see the penetration rate doubling the base case at 10% in 2025. We expect EVs to represent 44% of the vehicle fleet by 2035. A result of this shift is that the annual fuel use per gasoline powered vehicle falls from 599 gallons in 2015 to 533 gallons in 2035, a decline of 66 gallons per vehicle, or an 11% drop. As a result of the combination of increased EV fleet penetration and greater fuel efficiency in the gasoline powered fleet, we see a gasoline demand gap of 318,000 b/d in 2020, rising to 1.085 mmb/d in 2025, then 2.148 mmb/d in 2030 and 4.571 mmb/d by 2035.

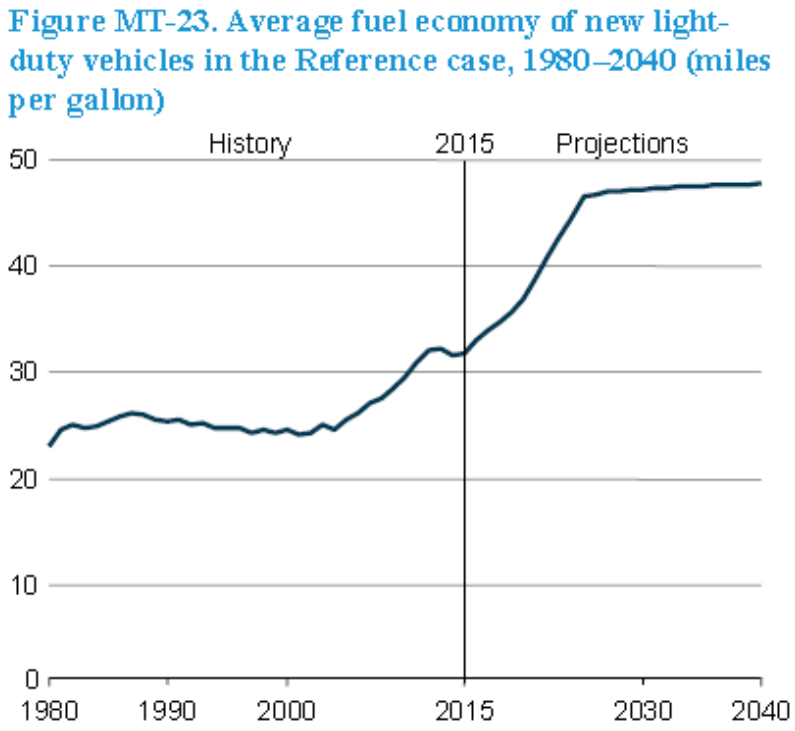
In their base case forecast for gasoline use, consumption is projected to fall by 24.5% between 2015 and 2035

How realistic are these scenarios? To try to answer that question, we turned to the EIA's Annual Energy Outlook 2016 (AEO 2016). The government provides detailed forecasts for energy categories between 2015 and 2040. In their base case forecast for gasoline use, consumption is projected to fall by 24.5% between 2015 and 2035. That decline compares to our forecasts, taking into account our EV growth projections, of declines of 11.2% for our base case and 48.8% for the aggressive case. Does that mean that the EIA is assuming a faster penetration rate of EVs than we are in our base case, or is it more about driving in general and greater impact from the adoption of higher fuel efficiency standards?

EIA has expectations for reduced fuel consumption per vehicle

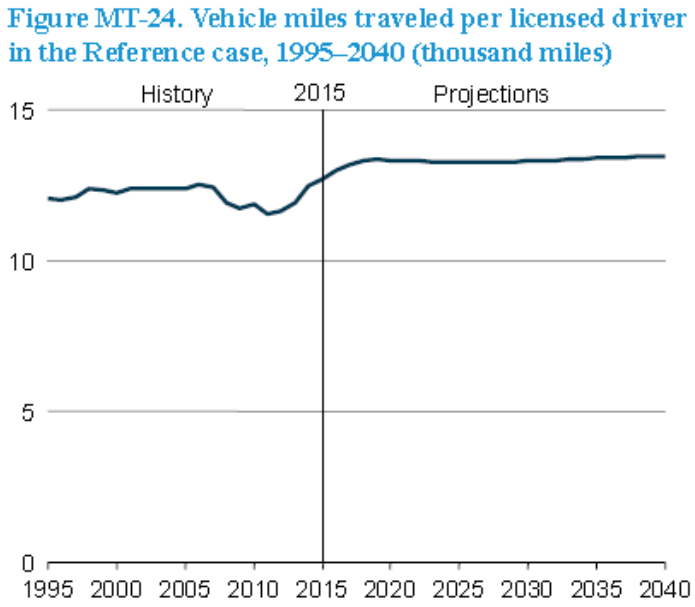
A series of exhibits from the AEO 2016 report shows how the EIA views some of the key drivers for gasoline demand. The first chart shows that the EIA sees average fuel efficiency of new vehicles improving dramatically. This expectation, coupled with no growth after 2018 for vehicle miles traveled (Exhibit 7, next page), sets up expectations for reduced fuel consumption per vehicle.

Exhibit 6. U.S. Fleet Fuel Efficiency Rises Sharply



Source: EIA

Exhibit 7. VMT Remains Flat After 2018

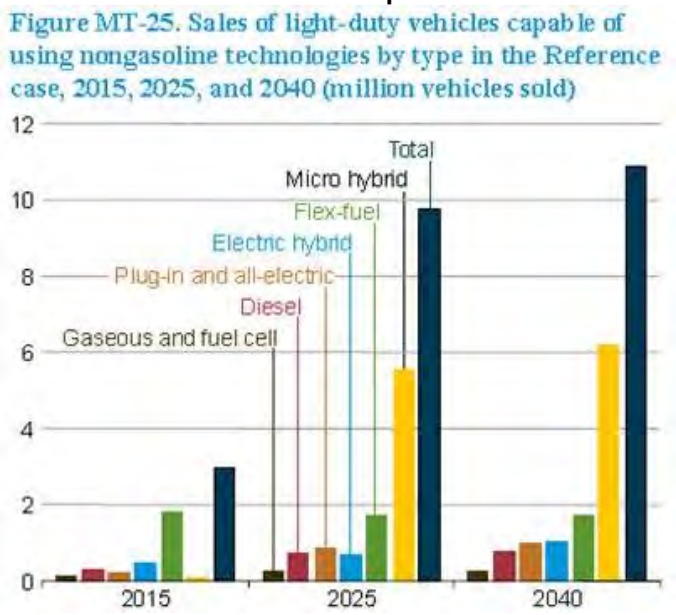


Source: EIA

The EIA sees E-85 consumption increasing fivefold between 2015 and 2035

These automobile market dynamics are then enhanced by the penetration of non-gasoline fueled vehicles. It appears that a major difference between what we modeled for our base case and what the EIA has for its base case is the impact of Flex Fuel vehicles that use E-85 fuel. The EIA sees E-85 consumption increasing fivefold between 2015 and 2035.

Exhibit 8. EVs Have Low Acceptance In EIA Outlook

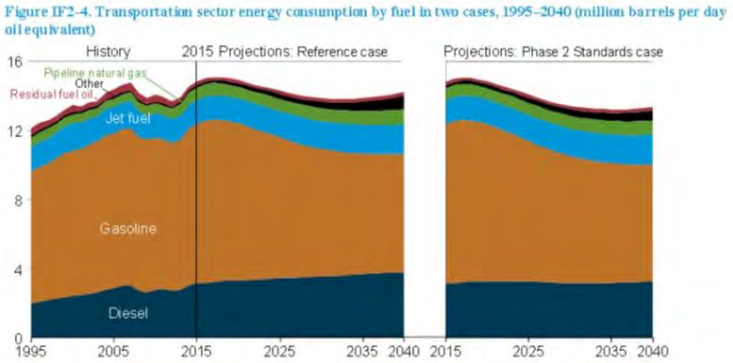


Source: EIA

The EIA's sales total for EVs is less than one million units in 2040

What we found surprising in the EIA's forecast was the lack of penetration by EVs into the vehicle fleet. Based on the bars shown in Exhibit 8 (prior page) for plug-in and all-electric vehicles, the EIA's sales total is less than one million units in 2040. To be honest, we find that acceptance rate to be extremely low given what the automobile industry is planning, at least based on their rhetoric. As a result, we are not sure what to make of the EIA's outlook for gasoline consumption, which is shown in Exhibit 9.

Exhibit 9. EIA Transportation Fuel Forecast



Source: EIA

Regardless of whether our forecasts are right or not, the issue of EVs, and the associated issue of self-driving cars, will have an impact on oil demand, forcing the oil producing and refining sectors to have to re-examine their long-term strategies

We will be working in the future to improve our forecasting model, but the conclusion we derive from our work is that the growth of the EV segment of the vehicle fleet will have an impact on gasoline consumption. The question is how much that impact will be. By 2025, according to our forecast, the impact may be anywhere from 500,000 barrels a day (b/d) to 1.0 million barrels a day (mmb/d) of reduced gasoline consumption. That is the equivalent of one to two huge refineries in this country. Moreover, the destruction of gasoline demand in later years becomes even more meaningful – nearly 2.5 mmb/d to 4.6 mmb/d - a huge impact on the refining industry let alone overall oil consumption in America. If we extrapolate the U.S. experience to the rest of the world, there will be a noticeable impact in transportation fuel markets. Regardless of whether our forecasts are right or not, the issue of EVs, and the associated issue of self-driving cars, will have an impact on oil demand, forcing the oil producing and refining sectors to have to re-examine their long-term strategies.

Challenge For Oil Industry Rebalancing Supply/Demand

The IEA explicitly cited the fact that oil demand was falling faster than previously anticipated

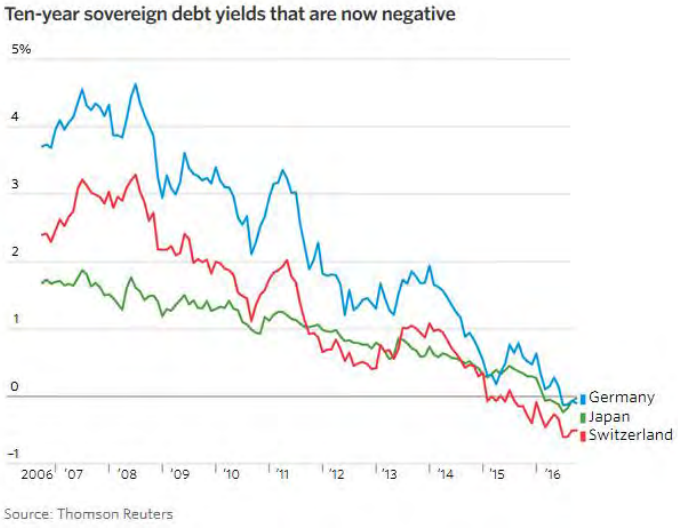
Two weeks ago, the International Energy Agency (IEA) along with the Organization of Petroleum Exporting Countries (OPEC) reduced their respective estimates for oil consumption growth. The IEA explicitly cited the fact that oil demand was falling faster than previously anticipated. On the day these organizations announced their reduced demand forecasts, oil prices were slammed, falling over 3% that day. Given the persistent output of oil production,

despite the collapse of oilfield capital spending and the drilling rig count, market seers shifted the target oil market rebalancing timeframe from later in 2016 to after mid-year 2017 or possibly as late as 2018.

A recent series of central bank meetings have reinforced the view that a negative interest rate is an acceptable monetary policy tool

While markets are highly focused on what is happening with oil supply, the issue of oil demand remains a key ingredient in the rebalancing equation. We recently saw a chart associated with an article discussing the movement of interest rates showing how many foreign government bonds now carry negative yields. This is a challenge for investors as negative yields are the antithesis of what they expect, which is to see a positive return on their fixed income investments. As pointed out by James Grant of *Grant's Interest Rate Observer*, this is an unusual strategy and never tried before. A recent series of central bank meetings have reinforced the view that a negative interest rate is an acceptable monetary policy tool. Many of these central banks have actually engaged in using that tool.

Exhibit 10. Many Government Bonds Have Negative Yields



Source: Mauldin Economics

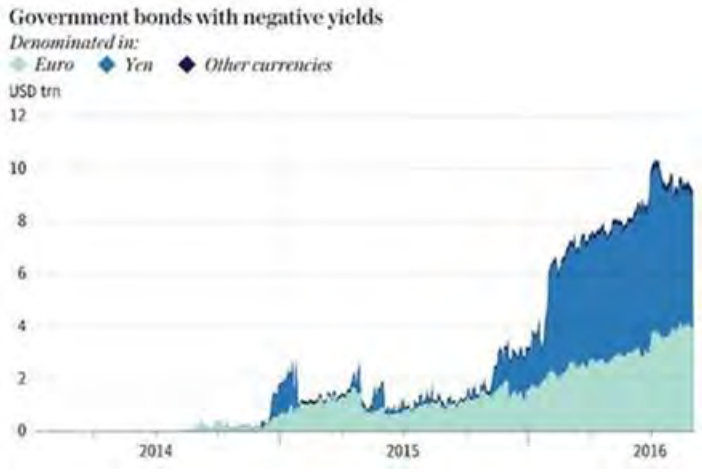
Economists believe that the U.S. Federal Reserve is preparing to use such an aggressive monetary policy to try to pump up the low-growth rate U.S. economy

The question that world governments are dealing with is just how much to use negative interest rates on short-term government debt instruments to try to stimulate their economies. A recent estimate is that there is about $9.5 trillion in government bonds with negative yields, mostly denominated in Euros and Yen. Another estimate suggested that the amount of debt with negative yields has declined from $10 trillion in July to $8.3 trillion now. Economists believe that the U.S. Federal Reserve is preparing to use such an aggressive monetary policy to try to pump up the low-growth rate U.S. economy. This view was reinforced by a series of papers presented at the Federal Reserve's summer research retreat at Jackson Hole, Wyoming at the end of August. One of the leading proponents of the use of negative interest rates is Harvard University economist

However, many prudent people might withdraw their funds in $100 bills and place them in safe deposit boxes

Kenneth Rogoff. Dr. Rogoff recently published a book, The Curse of Cash, that makes the case that the U.S. should outlaw $100 bills as currency as they facilitate crime and the underground economy. His case evolves into an argument that by restricting the amount of cash available, government monetary policy could more easily implement negative interest rates. The argument is that people who don't want to pay banks for the privilege of parking their money in checking and savings accounts, would instead begin spending it. However, many prudent people might withdraw their funds in $100 bills and place them in safe deposit boxes. By holding their money in cash rather than as bank deposits, people will increase cash transactions, i.e., possibly expanding the underground economy while also exposing themselves to increased crime. Thus, the government would be helping protect people by outlawing $100 bills.

Exhibit 11. Magnitude of Debt Priced With Negative Yields



Source: Mauldin Economics

Mr. Grant commented that never in 5,000 years have governments resorted to negative interest rate policies until now.

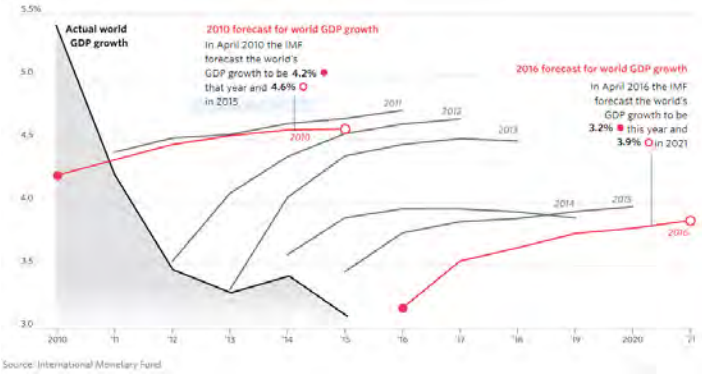
In his review of Dr. Rogoff's book in *The Wall Street Journal*, Mr. Grant commented that never in 5,000 years have governments resorted to negative interest rate policies until now. Mr. Grant opined that this experiment in generating economic stimulus through using negative interest rates was failing as an effective monetary tool. In Japan, the first central bank to experiment with negative interest rates, the policy has failed to turn savers into spenders. Negative interest rates have actually convinced people who are worried about having enough money to support themselves in retirement to boost their savings, concluding that they need an even greater amount of financial resources if they want to have the same retirement they would have had if interest rates were higher. So rather than stimulate economies, negative interest rates force reduced spending, while also penalizing savers who manage their financial affairs responsibly.

Monetary policy debates are the topic de jour because most western governments are so fractiously structured that they cannot agree to

The over-regulation of economies, especially the shackling of the U.S. economy by the Obama administration, has restricted economic growth

nor implement fiscal policies that will stimulate economic growth. At the same time, the over-regulation of economies in reaction to the 2008 financial crisis, especially the shackling of the U.S. economy by the Obama administration, has restricted economic growth. This message was driven home by the chart showing the history of global economic growth forecasts issued by the International Monetary Fund (IMF) since 2010.

Exhibit 12. IMF Economic Growth Estimates Remain Low



Source: ***The Wall Street Journal***

The low growth of world economies is contributing to problems for oil demand growth, critical for rebalancing the global oil market and eventually boosting oil prices

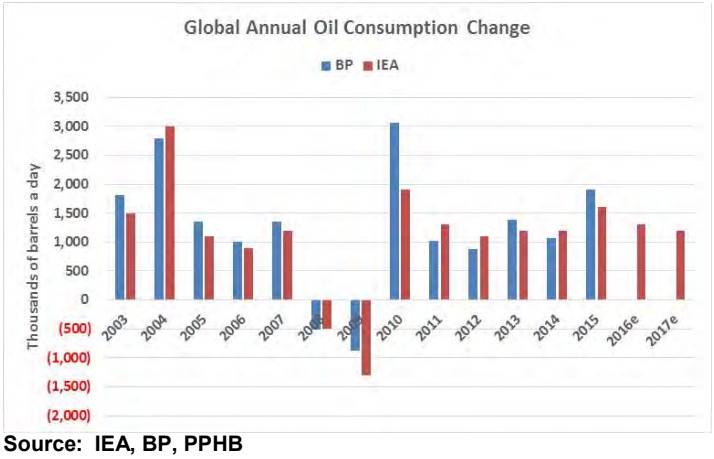
As global economic growth fell by nearly two full percentage points between 2010 and 2012, IMF forecasts repeatedly projected higher growth, always beginning the next year. All the forecasts for 2010 through 2013 pointed to growth reaccelerating to over 4.5% per annum over the next several years. The 2014 and 2015 forecasts, coming off starting points between 3% and 3.5% growth, project returning to growth rates closer to 4%. The April 2016 IMF forecast calls for global growth to reach 3.2% for 2016 and eventually rise to 3.9% by 2021. The low growth of world economies is contributing to problems for oil demand growth, critical for rebalancing the global oil market and eventually boosting oil prices.

As shown in Exhibit 13 (next page), we have calculated the annual absolute growth in global oil demand as reported by BP plc (BP-NYSE) and the IEA. The forecasts of the IEA for 2016 and 2017, which were recently reduced, show annual increases more in line with those posted by the economy in 2011-2014. We know from tracking the history of IEA oil demand forecasts that in recent years they frequently had to be reduced as the year progressed. We would not be surprised to see that happen again.

For struggling oil exporting countries and oil producers, greater oil demand would help expand the pie that they are fighting over

For struggling oil exporting countries and oil producers, greater oil demand would help expand the pie that they are fighting over. A larger pie would reduce the pressure on these parties to engage in cutthroat commercial warfare. Expanding the global oil pie would lead to a faster rebound for the oil business and the people associated with it. Rather than seeing an expanding demand, it appears that OPEC's members have agreed that they need to begin

Exhibit 13. Rate Of Global Oil Demand Growth Is Slowing



Source: IEA, BP, PPHB

reigning in their production in order to generate higher oil prices and greater government revenues. This effort, given many of the structural changes that have occurred in the oil business over the past several years, may also turn out to be an experiment.

Self-driving Cars Coming To A Street In Your Neighborhood

Self-driving taxis ply the streets of Pittsburgh as Uber's revolutionary experiment continues

Self-driving taxis ply the streets of Pittsburgh as Uber's revolutionary experiment continues. Google (GOOG-Nasdaq) continues to test its autonomous vehicles on the roads of California, Texas, Washington and Arizona. Ford Motor Company (F-NYSE) is testing its robot-cars on the streets of the University of Michigan's M-city test track. But Apple (AAPL-Nasdaq), thought to be interested in building an autonomous car, appears to have given up its fledgling effort. Tesla (TSLA-Nasdaq), on the other hand, is working hard to convince drivers and governments that its "driver-assisted" Autopilot-equipped cars in operation on highways all over the world are really just that – driver-assisted and not fully self-driving vehicles. This need comes after several deadly crashes of Tesla cars when operated in the Autopilot mode.

The guidelines apply to both fully-autonomous vehicles as well as the semiautonomous driving features currently being offered in cars, including the Autopilot system

On September 20, the federal government unveiled its guidance for self-driving vehicle development, testing and implementation, following more than a year of research and preparation. The guidelines apply to both fully-autonomous vehicles as well as the semiautonomous driving features currently being offered in cars, including the Autopilot system. Comments by government officials stated that the guidelines were not targeting Tesla, given its recent accidents, but rather were to provide guidance to all auto manufacturers adopting these technologies. The guideline states that semiautonomous driving systems must take into account the fact that distracted or inattentive drivers may fail to retake control. Therefore, the system could be considered "an unreasonable risk to safety and subject to recall."

Self-driving cars have gone from "sci-fi fantasy to an emerging reality with the potential to transform the way we live"

The safety guidelines were introduced by Department of Transportation Secretary Anthony Foxx and received a full-throated endorsement via an op-ed by President Barack Obama published in the *Pittsburgh Post-Gazette*. While commenting that during his time in office, self-driving cars have gone from "sci-fi fantasy to an emerging reality with the potential to transform the way we live," he added that the real thrust for pushing self-driving technology is to reduce crashes and the human suffering associated with them. President Obama went on to write:

"Right now, too many people die on our roads – 35,200 last year alone – with 94 percent of those the result of human error or choice. Automated vehicles have the potential to save tens of thousands of lives each year. And right now, for too many senior citizens and Americans with disabilities, driving isn't an option. Automated vehicles could change their lives."

The government's guidance set forth a 15-point checklist rather than specific regulations for the development and implementation of self-driving technology

To achieve this objective, the government's guidance set forth a 15-point checklist rather than specific regulations for the development and implementation of self-driving technology. This hands-off approach was welcomed by the auto industry. Included within the guideline document was a list of behavioral competencies that the technology needs to address and the list was adapted from the research performed by the California regulators in their efforts to design state regulations for self-driving cars.

"Detect and Respond to Speed Limit Changes and Speed Advisories
Perform High-Speed Merge (e.g., Freeway)
Perform Low-Speed Merge
Move Out of the Travel Lane and Park (e.g., to the Shoulder for Minimal Risk)
Detect and Respond to Encroaching Oncoming Vehicles
Detect Passing and No Passing Zones and Perform Passing Maneuvers
Perform Car Following (Including Stop and Go)
Detect and Respond to Stopped Vehicles
Detect and Respond to Lane Changes
Detect and Respond to Static Obstacles in the Path of the Vehicle
Detect Traffic Signals and Stop/Yield Signs
Respond to Traffic Signals and Stop/Yield Signs
Navigate Intersections and Perform Turns
Navigate Roundabouts
Navigate a Parking Lot and Locate Spaces
Detect and Respond to Access Restrictions (One-Way, No Turn, Ramps, etc.)
Detect and Respond to Work Zones and People Directing Traffic in Unplanned or Planned Events
Make Appropriate Right-of-Way Decisions
Follow Local and State Driving Laws
Follow Police/First Responder Controlling Traffic (Overriding or Acting as Traffic Control Device)

Follow Construction Zone Workers Controlling Traffic Patterns (Slow/Stop Sign Holders).
Respond to Citizens Directing Traffic After a Crash
Detect and Respond to Temporary Traffic Control Devices
Detect and Respond to Emergency Vehicles
Yield for Law Enforcement, EMT, Fire, and Other Emergency Vehicles at Intersections, Junctions, and Other Traffic Controlled Situations
Yield to Pedestrians and Bicyclists at Intersections and Crosswalks
Provide Safe Distance From Vehicles, Pedestrians, Bicyclists on Side of the Road"

The list has a number of challenging driving situations that introduce a human element that the vehicle must respond to

According to these guidelines, the specific behavioral competencies a particular highly autonomous vehicle would be expected to demonstrate and routinely perform will depend on specifics of the vehicle and its fallback method. The list has a number of challenging driving situations that introduce a human element that the vehicle must respond to, such as in the case of police officers directing traffic or construction zone workers controlling traffic patterns. In those cases, we can envision people carrying electronic devices that send information to autonomous vehicles. On the other hand, we wonder how self-driving vehicles will know how to "respond to citizens directing traffic after a crash," as they are not trained in this role and won't either have electronic equipment or know and use the proper hand signals.

The fallback system must recognize that human drivers may be inattentive, under the influence of alcohol or other substances, drowsy, or physically impaired in some other manner

Another major issue for self-driving cars, especially if they are to achieve the universality many envision for them, will be how to transition from full-autonomy to being humanly-controlled, or at least in a safe position. This is the fallback condition, or as the government refers to it, a "minimal risk condition." Auto manufacturers are going to have to document, to the satisfaction of the regulators, how they will transition to that minimal risk condition when a problem is encountered. So not only must the vehicle be able to know that its autonomous system has malfunctioned, is operating in a degraded state, or is operating outside its operational design domain, the vehicle must be able to inform the human driver in a way that will enable him to regain control of the vehicle safely. In effecting this transition, the guideline specifies that despite laws and regulations to the contrary, the fallback system must recognize that human drivers may be inattentive, under the influence of alcohol or other substances, drowsy, or physically impaired in some other manner. Big Brother?

The fallback system also must make its transition in a manner that will facilitate the vehicle's safe operation and minimize erratic driving behavior

The fallback system also must make its transition in a manner that will facilitate the vehicle's safe operation and minimize erratic driving behavior. The regulators also want the transition to be able to minimize the potential for a lack of human driver recognition and proper decision-making during and immediately after shifting to manual operation. The guidance also recognizes that the fallback system for cars with a higher level of automation, must be able to be

moved into a minimal risk condition without the aid of a human driver. In that case, they expect the fallback system will bring the vehicle to a stop, "preferably outside of an active land of traffic (assuming availability)."

Maybe self-driving vehicles will need a much longer development time than their sponsors claim

These guidelines will create significant challenges for truly self-driving vehicles, especially for those proponents hoping this technology will enable disabled and aged people, along with under driving-age youths, to be able to transport themselves. But when one reviews the entire range of behavioral standards self-driving vehicles must meet, the magnitude of the challenge for the auto industry becomes clear. Maybe self-driving vehicles will need a much longer development time than their sponsors claim.

"57% of Americans are more worried than excited about the rise of automated vehicles"

An op-ed in *The Wall Street Journal* written by Scott Keogh, the president of Audi of America, pointed out that based on a Morning Consult survey, "57% of Americans are more worried than excited about the rise of automated vehicles." He went on to cite that "a plurality thinks that when full automation comes years from now, self-driving vehicles will make roads less safe. And a 54% majority believe that self-driving cars will make traffic worse." These survey results are similar to others we have seen reporting that American's attitudes toward self-driving vehicles are not yet positive. Citizens seem to understand that the technologies being employed in self-driving vehicles are not completely capable of managing the tasks required to safely operate a vehicle.

The reporters also pointed out that the test was in a highly restricted area because of the need to map the streets, a potentially limiting factor for the pace of development of the technology

The reporters who took initial rides in the Uber taxi service in Pittsburgh pointed out how close the cars drove to parked vehicles. They also mentioned that the vehicle was not programed to turn right at red lights irritating drivers following. They did mention that the cars were programed to deal with the Pittsburgh convention that allows the first car at a traffic light waiting to turn left to go before the other traffic preceded through the intersection once the light turned green. The reporters also pointed out that the test was in a highly restricted area because of the need to map the streets, a potentially limiting factor for the pace of development of the technology.

The alert frequency suggests the system still needs much work

In another article, a reporter who took a 20-minute ride in an autonomous truck being developed by Otto, a company that Uber recently paid $700 million to acquire, reported that there were about six times when warning beeps were sounded alerting the driver that the system had detected some trouble, and that it needed him to immediately take over. While all those alerts will be examined by the software engineers, the alert frequency suggests the system still needs much work in order to be ready to function in a manner that provides comfort to drivers and passengers.

The situation of the vehicle sensors not being able to detect the truck involved in the Tesla crash raises questions about how well-developed this technology truly is. While Tesla has provided

Meeting the range of behavioral standards set forth in the government's guidelines may be a more difficult challenge than previously thought

updates to its Autopilot software, the company is making a major public relations push to convince drivers that this is not self-driving technology and that the driver must keep his hands on the wheel. This is the hype about self-driving that Mr. Keogh was warning against in his op-ed. There is no doubt that self-driving technology will have an impact on the vehicle market – the issues become how quickly it happens and what the magnitude is. As the hype over self-driving technology has grown this year, we may need to step back and recognize that meeting the range of behavioral standards set forth in the government's guidelines may be a more difficult challenge than previously thought. Some of the self-driving acceptance scenarios espoused probably must still be classified as in the category of a Jetson's cartoon. It will be interesting to watch how this technology evolves, but we aren't holding our breath that it will transform the automobile industry any time soon.

Asian Market Share Fight Highlights Oil Glut Struggle

When OPEC met on November 27, 2014, that same futures oil price had already declined to $73.69 a barrel, a 31.3% drop

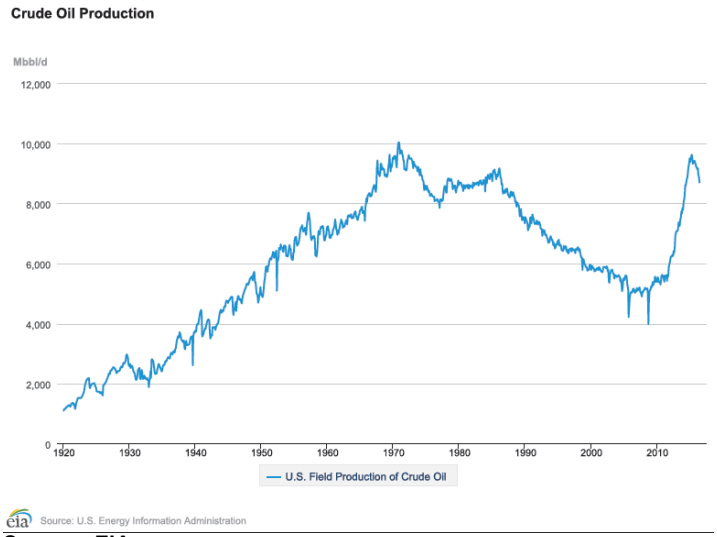
It is hard to remember what conditions were barely two years ago as the oil industry barreled toward the November OPEC meeting, the outcome of which undid the market. U.S. oil prices peaked on June 20, 2014, with futures priced at $107.26 per barrel. When OPEC met on November 27, 2014, that same futures oil price had already declined to $73.69 a barrel, a 31.3% drop. While our memory may be foggy, we don't recall much concern expressed at that time about the decline. In fact, the drilling rig count was still at the same level it was at the June oil peak. The rig count had been sliding in the weeks immediately ahead of the OPEC gathering. No indications of panic among oil industry execs were evident prior to the meeting. In fact, the conventional wisdom was that Saudi Arabia would step in and support the oil price.

The shale revolution was responsible for lifting America's production during the three-and-a-half-year span of 2011-2014 by nearly 3.5 million barrels a day

Conventional wisdom rapidly became that Saudi Arabia's decision to yield its historical role of balancing oil markets by adjusting its oil output and exports was because they needed to teach America's shale oil producers that expensive oil would not be allowed to displace low-cost OPEC oil. The shale revolution was responsible for lifting America's production during the three-and-a-half-year span of 2011-2014 by nearly 3.5 million barrels a day (mmb/d) – back to a level, 9.0 mmb/d (September 2014), not seen since March 1986, some 28 years earlier. Yes, the shale revolution had grown U.S. oil production, enabling the country to reduce its oil import volumes. However, that growth contributed to an increase in global crude oil inventories that pushed oil prices lower. Less recognized was the growing struggle over market share among the world's major oil producers.

As domestic output rose in the U.S. and its need for imports fell, the country was also seeing more oil coming from Canada, some of which wound up being merely exported. The weak global economic

Exhibit 14. Shale Revolution Has Driven U.S. Oil Output

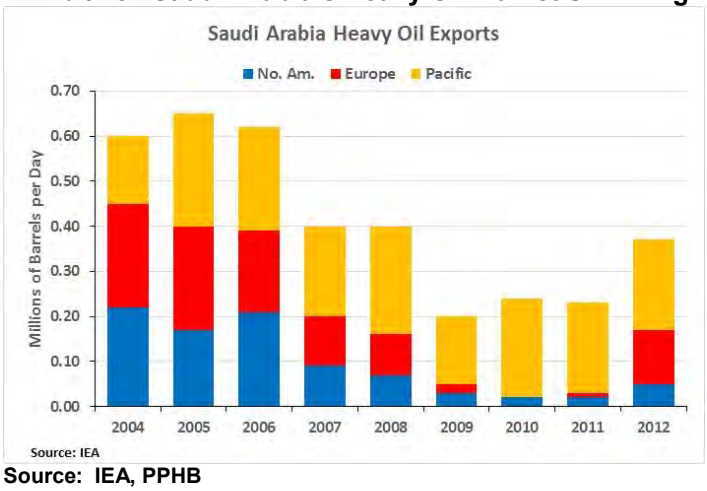


Source: EIA

A weak European economy made that oil market more competitive, especially as oil supplies previously targeting North America sought a new home in Europe

recovery following the 2008 financial crisis and resulting recession was limiting oil demand growth. This was particularly true on a regional basis. The boost in U.S. domestic supply increased the difficulty for exporters to access the North American market. A weak European economy made that oil market more competitive, especially as oil supplies previously targeting North America sought a new home in Europe. This was especially true for West African and Middle Eastern light crude oils that hoped to expand their market share in Europe. In the end, the only bright spot on the globe was Asia, largely due to the booming Chinese economy.

Exhibit 15. Saudi Arabia's Heavy Oil Market Shrinking



Source: IEA, PPHB

In examining the destination of Saudi Arabian crude oil exports, these trends become clearer. The International Energy Agency

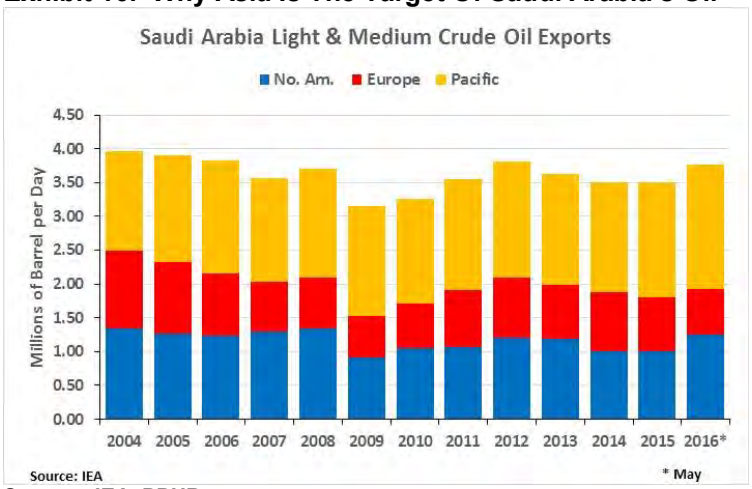
We were surprised to find that the IEA stopped reporting the export volumes of Saudi Arabian heavy oil in 2013

(IEA) produces monthly figures for the destinations of various country crude oils. Unfortunately, the regions tracked are large – North America, Europe and Pacific. To examine what has gone on with Saudi Arabia's exports, we examined their destinations by the oil's quality rating. We were surprised to find that the IEA stopped reporting the export volumes of Saudi Arabian heavy oil in 2013, as that grade was particularly important in competition against the heavy crude oils from Venezuela, Canada Mexico and Russia.

Those markets shrank quickly in 2007-2008 before virtually disappearing in 2010-2011

If one examines the volumes shipped to Europe and North America, they were very important markets in 2004-2006 for Saudi Arabia's heavy oil. Those markets shrank quickly in 2007-2008 before virtually disappearing in 2010-2011. Both of those regional markets rebounded somewhat in 2012, but Europe's surge we believe was related to the shift in electric power generation and a cold winter. We wonder whether those markets have disappeared again as they did in 2010.

Exhibit 16. Why Asia Is The Target Of Saudi Arabia's Oil



Source: IEA, PPHB

Saudi Arabia is looking to add to its refinery holdings, which would boost the need for an increase in oil it ships to North America.

When we looked at Saudi Arabia's light and medium grade crude oil exports, we find that during 2004-2006 the country's volumes to North America and Europe shrank. Interestingly, when the financial crisis hit the oil market, Saudi Arabia lost market share in both Europe and North America but held on to its volumes in Pacific. We believe the Saudi Arabian volumes coming to North America throughout most of this period largely represent the country supplying the refineries it owned in the region. Saudi Arabia is looking to add to its refinery holdings, which would boost the need for an increase in oil it ships to North America.

The European volumes contracted throughout most of the 2004-2010 period. They started to grow slowly in 2011 and 2012 but shrank in 2013. It was at that point that the European Union (EU) considered banning Canada's oil sands bitumen as "dirty oil" and

The EU actually voted to allow oil sands bitumen to be burned

environmentally unacceptable for use on the continent. That was the regulatory sentiment early in 2014, but by late summer it changed as the EU actually voted to allow oil sands bitumen to be burned. For Saudi Arabia, especially with its heavy oil volumes, this represented another supply market where it found itself challenged by new competitors that made keeping its market share a serious challenge.

These developments highlight how important keeping, and expanding, market share in Asia (Pacific) has become

In looking at the balance of Saudi Arabia's exports to Europe by crude oil grade, we found a shocking development. After 2006, the market for medium oil has not only contracted significantly, but, in recent years, it has virtually disappeared. While not totally comparable to its heavy oil, the lack of competitiveness for Saudi Arabia's medium grade crude oil suggests that Europe became another regional market where the Kingdom's oil was no longer competitive. These developments highlight how important keeping, and expanding, market share in Asia (Pacific) has become. This region, however, is highly competitive due to its size, making it a target of Iran as it restores its oil production following the lifting of sanctions, as well as being a target of Russia's oil business.

Exhibit 17. Saudi's Europe Medium Oil Market Disappeared

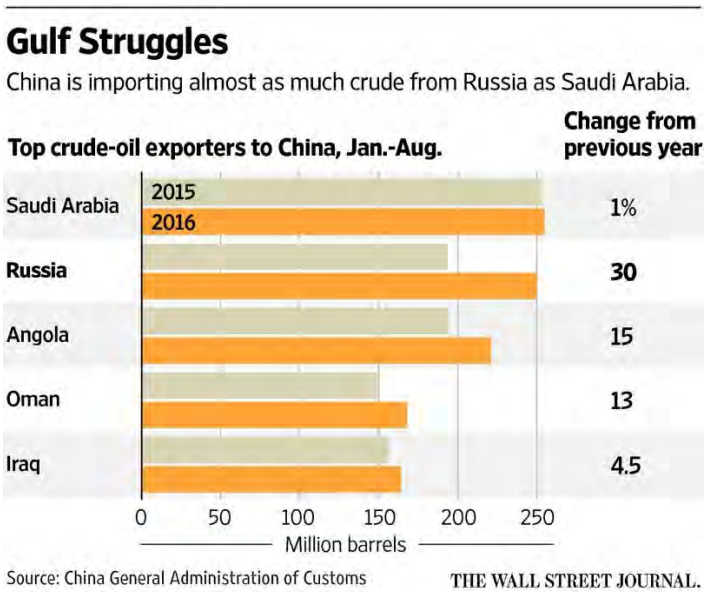
Source: IEA, PPHB

For the first eight months of 2016, compared with the same period in 2015, Saudi Arabia's oil volumes shipped to China grew only 1%, while Russia increased theirs by 30%

With Asia as an important growth market for Saudi Arabia's oil, the opening up of China's refining sector and the subsequent growth of its teapot refineries is creating new opportunities. As an article in *The Wall Street Journal* pointed out, these market changes have led to Russia supplying nearly as much oil to China so far this year as has Saudi Arabia. This came as Saudi Arabia supplied only a single cargo to a teapot refinery, after the Chinese government relaxed its restrictions on these small refineries, allowing them to negotiate their own crude import deals. The article had a chart showing that for the first eight months of 2016, compared with the same period in 2015, Saudi Arabia's oil volumes shipped to China grew only 1%, while Russia increased theirs by 30%. As Iran's oil production recovers, it is becoming more aggressive in seeking out Chinese export deals.

If China's economy slows, or the government reverses its teapot refinery regulations, the Asian oil market will shift once again. How that might impact Saudi Arabia's oil production and OPEC's oil pricing strategies remains to be seen.

Exhibit 18. Oil Exporter Strategies Toward China Important



Source: The Wall Street Journal

The issue of oil demand has become a more prominent consideration

Although the focus in the global oil market is on the pace of decline in U.S. oil output due to less drilling, the issue of oil demand has become a more prominent consideration. At the same time, as we have shown above, other factors, such as crude quality and regional market regulations, are at work in the global oil market. These factors will force producers and exporters to adjust. At times, the implications of these adjustments may not be clear. We usually only discover later what motivated the actions as contemporary market clarity seldom exists.

Australia – On The Move But Don't Trust Your GPS

In Australia's case, its plate is moving quickly northward at about 2.7 inches a year along with a slight clockwise rotation

Have you ever checked your cell phone's GPS when in Australia? If so, you might find out that you are not where your phone says you are. We recently learned that Australia is the fastest moving continent on the planet, meaning it is shifting its location every day. Continents float on tectonic plates that slide slowly over upper mantle of the Earth's surface. In Australia's case, its plate is moving quickly northward at about 2.7 inches a year along with a slight clockwise rotation. Putting this movement in context, North America is moving at only about one inch a year.

Exhibit 19. The Australian Continent Is Moving Northward

Source: nationalfleetaustralia.wordpress.com

Due to this movement, Australia must periodically adjust its latitude and longitude markings. Plans are to make the next adjustment at the end of this year. The lines will be moved by 4.9 feet. According to *The New York Times*, Australia has adjusted its latitudes and longitudes four times in the past 50 years. The last adjustment in 1994 saw the lines shifted by 696 feet. That is more than two football fields away from where you thought you were. As the *Times* wrote, that shift might explain why a deliveryman drops your packages at your neighbor's home.

The last adjustment in 1994 saw the lines shifted by 696 feet

What does this continental drift mean? If you're a farmer using GPS readings to manage your agricultural equipment, you might plow the wrong pattern. On the other hand, if you're in a self-driving car, you could be on the wrong side of the road, if not in a different neighborhood. The GPS devices in self-driving cars and agricultural equipment are much more sensitive than the GPS in your cell phone, so your phone might have you in generally the right location. Reading about Australia's drift, we wondered about the increased risk of self-driving cars? If there is a problem, who is liable – the car manufacturer, the software creator or the government?

On the other hand, if you're in a self-driving car, you could be on the wrong side of the road, if not in a different neighborhood

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