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ENERGY INVESTMENT BANKING

# MUSINGS FROM THE OIL PATCH

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**Allen Brooks**
**Managing Director**

**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

## Estimating The Ownership Cost Of EVs Versus ICE Cars

**What The Economist wrote was: "UBS, a bank, reckons the 'total cost of ownership' of an electric car will reach parity with a petrol one next year – albeit at a loss to its manufacturer"**

Should you consider an electric vehicle (EV) for your next car, or stay with a traditional internal combustion engine (ICE) car? Donn Dears, who writes the *Power For USA* blog, recently authored a refutation to *The Economist* magazine's claim that the total ownership cost between an EV and an ICE car is about to converge. Actually, the magazine was quoting an analysis of investment bank UBS. What *The Economist* wrote was: "UBS, a bank, reckons the 'total cost of ownership' of an electric car will reach parity with a petrol one next year – albeit at a loss to its manufacturer." What we don't know is how big a loss for the manufacturer, but General Motors (GM-NYSE) cited losses on EVs when it introduced the Chevy Bolt, its new EV with a 238 mile range on a single battery charge. Mr. Dears wondered whether the UBS claim was possible. Since the article never set forth the assumptions utilized in the analysis, to him, the claim carried less validity. He decided to analyze the cost of ownership for comparable EV and ICE cars.

Mr. Dears began by setting forth a set of assumptions:

- Cost of gasoline: $2.62/gallon at 30 miles per gallon
- Cost of electricity: $0.125 per kilowatt hour (national average)
- Costs for indicated services are from on-line averages
- Cost of battery: $200 per kilowatt hour
- Each car is driven 10,000 miles per year, or 80,000 miles

His analysis compared a Chevy Bolt, which costs $37,500 before any tax credits, with an ICE car costing $35,000, and which achieves 30 miles per gallon. The Bolt provides an 8-year battery warranty, but GM is optimistic it will last longer.

**The full cost of ownership of an ICE for eight years and 80,000 miles to $44,617**

Beginning with the ICE car, to the initial cost of $35,000, he adds the cost of gasoline ($6,987), the expense of oil and oil filters every 5,000 miles ($1,280), the cost of a full brake job ($700), the cost to replace spark plugs ($270), and coolant flushes every 40,000 miles ($380). These maintenance expenses raised the full cost of ownership of an ICE for eight years and 80,000 miles to $44,617.

**The total ownership cost for the Bolt comes to $56,034**

With respect to the Bolt, Mr. Dears added the cost of electricity ($2,800) to its purchase price of $37,500. The electricity estimate is taken from the Environmental Protection Agency's web site showing that the Bolt requires 28 kilowatt hours (kWh) of power per 100 miles of driving. That equates to 0.28/kWh per mile driven, which is multiplied by 80,000 miles and then by the cost of a kilowatt hour of electricity. To this subtotal is added the cost of a replacement battery pack of $15,734, which is based on the General Motors price list. The total ownership cost for the Bolt comes to $56,034.

**Any unused credit cannot be carried forward or back, so its value is only in the year of the EV's purchase**

At the end of eight years of service, the ownership cost advantage for an ICE car is roughly $12,000. The analysis ignores the benefit from the federal tax credit for the EV, which can make a significant cost difference. The current federal tax credit for a Bolt is $7,500, but the credit's value depends on one's federal income tax bill. The full value requires a tax bill equal to, or greater than, the credit amount. Importantly, any unused credit cannot be carried forward or back, so its value is only in the year of the EV's purchase. Additionally, the tax credit is only available for the first 200,000 units of an EV model sold, something that may impact Bolt and Tesla (TSLA-Nasdaq) Model 3 purchasers in 2018 or 2019.

**If a Bolt is purchased in California, the owner is eligible for a $2,500 cash rebate from the state**

If a Bolt is purchased in California, the owner is eligible for a $2,500 cash rebate from the state. We are not aware of any restriction on this payment, such as with the federal tax credit. Thus, if someone in California is looking at this analysis, the $12,000 disadvantage for the EV would be reduced to $9,500, before any federal tax credit. If California increases its EV subsidy to $10,000, as is currently being discussed, the ICE advantage shrinks to $2,000.

**While Mr. Dears added the cost of a replacement battery pack for the Bolt, he didn't give any credit for the used battery**

There is another potential issue that needs to be assessed. While Mr. Dears added the cost of a replacement battery pack for the Bolt, he didn't give any credit for the used battery. As we have learned in researching battery emissions, once a battery degrades to 80% of initial capacity, it loses its ability to power vehicles. However, used batteries are candidates for backup power storage for businesses and homes using intermittent electricity sources. A recent example is the use of used Renault EV batteries to power two fast-charging stations in the UK.

It is estimated that, depending upon the chemistries of batteries, anywhere from 70% to 100% of a battery's material can be recycled, reducing the cost of new batteries. All the battery studies we have read suggest that recycling lithium-ion batteries will not be profitable

before 2035 due to an insufficient volume of depleted batteries. To the extent used EV batteries can earn something in an alternative market or for its recycled material, the EV ownership cost gap would close further.

What our adjustments to Mr. Dears' analysis demonstrate is the importance of tax credits, both federal and state, for EV economics. Lower electricity prices and higher gasoline costs also impact the gap, but these differences are within a range of a few hundred dollars, so they do not alter the conclusion of the analysis.

**If one wants a complete cost/benefit analysis of ICE versus EV cars, it should include an estimate of the value of the owners' time spent refueling or recharging the vehicles**

If one wants a complete cost/benefit analysis of ICE versus EV cars, it should include an estimate of the value of the owners' time spent refueling or recharging the vehicles. Based on the 30/mpg assumption for the ICE car, the owner needs to purchase 2,667 gallons of fuel. Assuming each refill is done when the fuel warning light comes on, we estimate roughly 14 gallons of fuel at each refill, or 191 times. If each refill required 15 minutes to complete, the owner would spend 47.75 hours of his time refilling his car, or essentially two days.

Estimating the time for EV recharging is more complex. It depends on where the vehicle is recharged and how quickly it can be done, which is a function of how much of a charge is needed. GM offers three charging options for a Bolt: Basic, a 120 volt home charger, which adds about four miles of range per hour of charge. The Fast option, using a 240 volt system, adds about 25 miles of range per hour of charging. The Super-Fast option employs a DC electric charging system, which can add 90 miles of range in about 60 minutes of charging time. The Fast and Super-Fast systems involve additional costs that need to be factored into the analysis, besides the value of the owners' time spent charging the EV.

**With the electrician's cost to install the system ranging between $200 and $800, the total installed cost today is more like $700 to $1,300**

The costs of installing Level 2 charging stations was analyzed by the Rocky Mountain Institute (RMI) in 2014. Costs for charging equipment likely have declined since that report, but we doubt labor, material or permit costs have fallen. According to RMI, a 240 volt Fast home charging system, such as shown in Exhibit 1 (next page), costs $650 to $1,800 for the equipment and installation. The device pictured is an earlier version of a unit that now costs $500, or less than half the high-end estimate from RMI. With the electrician's cost to install the system ranging between $200 and $800, the total installed cost today is more like $700 to $1,300. That price could increase by another $500 to $1,000 if the home needs its breaker service upgraded. Another issue is that a low-end system, which has only about half the power of a regular system and a shorter cable, may limit charging flexibility.

The cost to put a Level 2 charging system in a parking garage was estimated by RMI to cost between $3,550 and $7,500, while a curbside installation would increase the cost to $5,600 to $13,150.

**A Super-Fast DC connection, which is generally found only on highways and in commercial locations, has an estimated cost of $29,650 to $80,400**

A Super-Fast DC connection, which is generally found only on highways and in commercial locations, has an estimated cost of $29,650 to $80,400, however, many recent estimates suggest the cost may be closer to the mid-point of that range today. A DC device also requires a Bolt owner to buy a special vehicle receptacle, adding $750 to the car's purchase price.

**Exhibit 1. A 240-Volt 30 Amp Level 2 System**

**Source: Siemens**

**If all his neighbors do the same thing, there could be a problem**

If a homeowner installs a charging station in his garage, there may not be much impact on the grid. However, if all his neighbors do the same thing, there could be a problem. Transformers are necessary to regulate the power flowing into a home, and they usually service multiple homes, generally four at a time. A problem is that utility companies do not know exactly how much power is being used by a particular home relative to its neighbors until a transformer fails. Upgrading transformers can be expensive and limited by weight limits for units mounted on power poles. One estimate suggests moving from a 50KVA pad-mounted transformer serving four homes to a 75KVA unit costs about $3,000.

**Sustained excess current will eventually 'cook' a transformer's copper windings, causing a short and blacking out of the homes**

For underground power installations, upgrading the transformer units may be easier, but not necessarily less costly. One study by the Institute of Electrical and Electronics Engineers says that the problem is at the local level. If multiple Level 2 chargers that fully recharge a car in 2-3 hours, are plugged in at the same time at night, they may prevent transformers from cooling as they are designed. Sustained excess current will eventually 'cook' a transformer's copper windings, causing a short and blacking out of the homes

**Exhibit 2. Pole Mounted Residential Power Transformer**


**Source:** ***freefoto.com***

**Residents tended to recharge their EVs at the same time**

attached to the device. This problem was observed from a study of the habits of EV owners in an Austin, Texas suburb. Over a two-month period, the residents tended to recharge their EVs at the same time – when returning from work – that coincided with air conditioning loads increasing along with the use of other appliances.

**The study's result show that at least a third of the UK's power grid will need to be upgraded to support an EV sales rate of 40% of new car sales by 2023**

A similar study was conducted in the UK, which conducted an 18-month study of resident habits when 100% were using EVs. The study's result show that at least a third of the UK's power grid will need to be upgraded to support an EV sales rate of 40% of new car sales by 2023. That doesn't address the load issue if 40% of the entire UK vehicle fleet were plug-in EVs.

If you are only charging with a 120-volt home plug, it would take 10 hours to boost the EV's range by 40 miles, suggesting the charging will only be done at night, or whenever the car is not needed for an

**Exhibit 3. A Ground Level Residential Transformer**

**Source:** ***keywordsuggest.org***

extended period of time. A 240-volt system would deliver 50 miles of range in two hours. However, if one needed to charge an EV for a 200-mile trip, the owner is facing an eight hour ordeal, most likely an overnight charge. In making long-distance trips, a driver would be looking for Super-Fast charging stations, but facing stops of two hours or so to fully replenish the EV's total range. What's the value of two hours of time, especially every 180-200 miles?

**What's the value of two hours of time, especially every 180-200 miles?**

To put into perspective the EV charging time, if the Bolt is recharged when it needs 190 miles, or 80% of its estimated 238-mile range, driving 80,000 miles would require 421 full charges. Using a 240-volt system requires 7.25 hours for a single charge, or a total of 127 days of time. If it is always done at night, it may not be a big deal, but if not, the EV owner can look forward to being out of commission for an extended period of time during each charging session. Valuing the time issue is further compounded by the need to find charging locations that are available. Planning the logistics of a long-distance trip adds another dimension to an EV's cost.

**Planning the logistics of a long-distance trip adds another dimension to an EV's cost**

If a buyer can utilize all the available tax credits, an EV is only slightly more expensive than an ICE car, but the owner may need to readjust his vehicle use patterns due to driving distances and time of use. Calculating the true cost of the charging requirements and vehicle use adjustments will vary by owner. On the other hand, if the buyer can't use the tax credits, the EV is a much more expensive option, but may be offset by psychic income. The analysis demonstrates that the future of the EV industry will remain highly dependent on government support. EV buyers who fail to understand the adjustments they must make in purchasing an EV may be highly disappointed, as many Chinese EV buyers told reporters after this past winter's experience in Beijing.

**If the buyer can't use the tax credits, the EV is a much more expensive option, but maybe offset by psychic income**

# The Gas Market's Enthusiasm Is Slowly Being Sapped

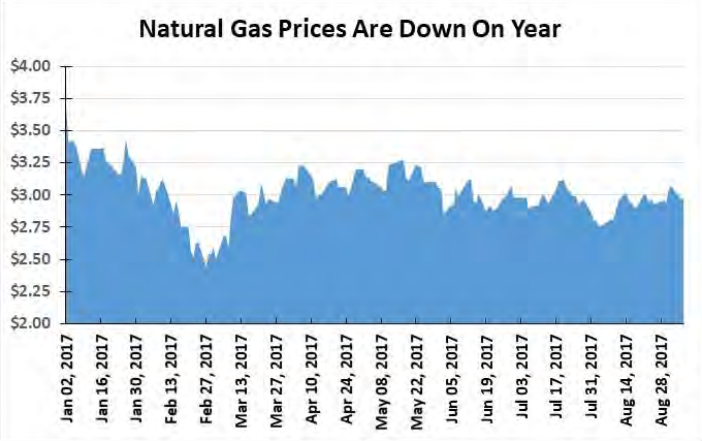
**Prices were high in response to the early cold weather experienced in the 2016-2017 winter**

There was a time in late 2016 when some, including us, thought the U.S. natural gas market might be the surprising energy story of 2017. It actually has become a story, but not for its strength but rather for its weakness. We entered 2017 with spot natural gas prices at $3.71 per thousand cubic feet (Mcf). Prices were high in response to the early cold weather experienced in the 2016-2017 winter. The problem was that the early cold temperatures disappeared and the season turned unusually warm, leaving substantial volumes of natural gas stuck in storage.

**Gas prices fell steadily, bottoming at $2.50/Mcf at the start of March**

The warmer weather coincided with low coal prices that encouraged utility companies to substitute coal for natural gas. Lower gas demand contributed to weaker prices as buyers realized that higher prices were not necessary to entice more supplies to rebuild natural gas storage volumes to levels customers would perceive as adequate for the upcoming winter. The result was that gas prices fell steadily, bottoming at $2.50/Mcf at the start of March.

**Exhibit 4. The Troubled 2017 Natural Gas Market**




**Source: EIA, PPHB**

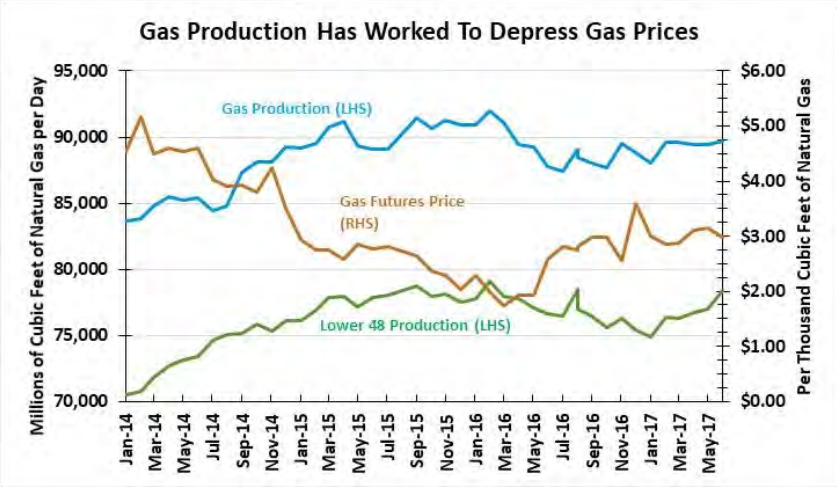
**Gas prices are now slightly below $3/Mcf**

Gas prices subsequently rallied, climbing back up to the $3/Mcf level, and have then traded within a range of plus-or-minus 5% of $3/Mcf until late summer, at which time the trading range widened to plus-or-minus 10%. Gas prices are now slightly below $3/Mcf. The current price is being impacted by concerns over gas supplies and demand as a result of Hurricane Harvey and the massive flooding of the upper Texas Gulf Coast, and now the potential disruption due to Hurricane Irma' hammering of Florida. Although Irma's track took it onshore more than anticipated, it avoided entering the Eastern Gulf of Mexico and disrupting offshore gas production. But Irma has significantly damaged Florida, a large natural gas consumer, which is likely to hurt demand in the near-term, and possibly for much longer.

**Lower 48 natural gas output (excluding Alaska and the Gulf of Mexico) has increased steadily since the start of 2017, at the same time overall gas production has been essentially flat**

The greatest challenge for the natural gas market is production growth, which has resumed, driven by a rebound in associated gas coming from shale oil wells, in particular those in the Permian basin, as well as continued output growth from the Marcellus region. The June natural gas production data from the Energy Information Administration's (EIA) Form 914 producer survey showed total output reaching a near-term high, rising following declines for the prior two months. Total production has yet to exceed the peak established in September 2015. However, when we examine Lower 48 natural gas output (excluding Alaska and the Gulf of Mexico), we find that it has increased steadily since the start of 2017, at the same time overall gas production has been essentially flat.

**Exhibit 5. Growing Gas Output Has Hurt Gas Prices**



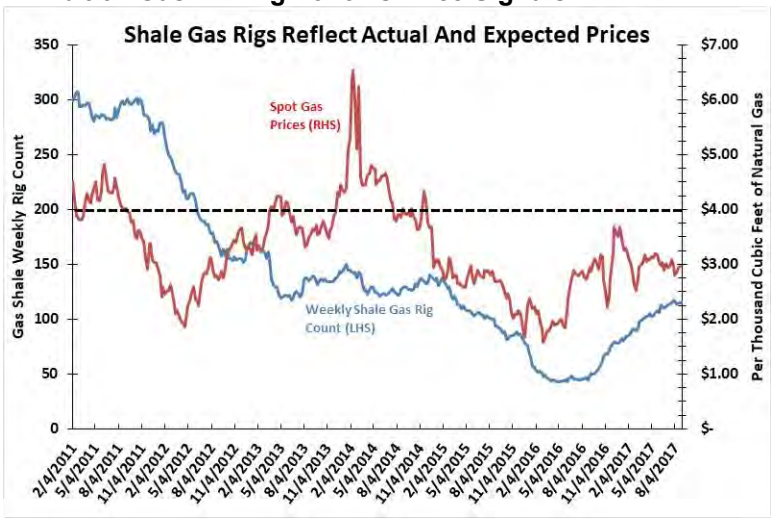

**Source: EIA, PPHB**

Climbing gas production has come as gas futures prices are down from the peak recorded in late 2016. A series of two charts below show the relationship between gas prices and drilling, and importantly what is happening now that expectations for meaningfully higher gas prices in the future are disappearing.

**The peak gas drilling activity in 2011 reflected the much higher gas prices experienced in 2007-2009 when demand was perceived to be outgrowing supply**

Exhibit 6 (next page) shows the relationship between spot gas prices and an estimate of the weekly shale gas rig count. The peak gas drilling activity in 2011 reflected the much higher gas prices experienced in 2007-2009 when demand was perceived to be outgrowing supply. That was before gas consumption was hit by the 2009 recession, at the same time shale gas output surged. Falling gas prices drove a falling gas rig count, which only stabilized when gas prices rebounded to a modern day peak in excess of $5/Mcf. Once that price spike passed, they began sliding lower, pulling down the rig count. Both gas prices and gas drilling began rebounding in 2016. Gas prices, the signal to producers that more supplies are needed, began rising early in 2016, and was followed by higher gas drilling in late 2016.

**Exhibit 6. Gas Drilling Follows Price Signals**

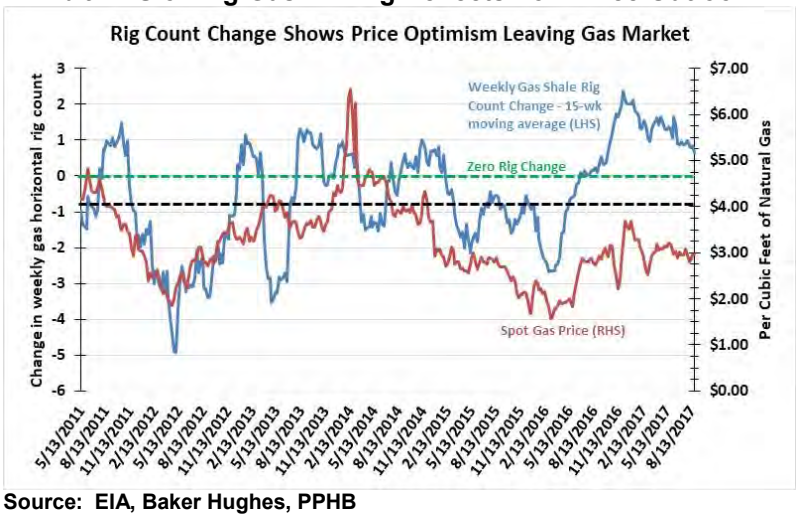



**Source: EIA, Baker Hughes, PPHB**

**Fifteen weeks appears to reflect the best estimate of the length of the lag time from decision to drilling**

While the above charts deal with history, it is interesting to note what has been happening in recent months is observing how the market's optimism for natural gas prices to reach the $4/Mcf level has disappeared. In Exhibit 7, we have plotted a 15-week moving average of weekly shale gas rig count changes against gas prices. The rig count moving average was determined by seeking the best fit between these two data series after considering the price movements against weekly rig count changes ranging from eight to 16 weeks. The lag in the rig count reflects an approximation of the lag time from when producers, reading the market's price signals, decide to begin drilling and when rigs actually start turning to the right. Fifteen weeks appears to reflect the best estimate of the length of the lag time from decision to drilling.

**Exhibit 7. Slowing Gas Drilling Reflects Low Price Outlook**




**Source: EIA, Baker Hughes, PPHB**

**As gas prices began recovering, and talk suggested that they might return to the $4/Mcf level, producers shifted into drilling mode**

As seen in Exhibit 7 (prior page), when gas prices were above $4/Mcf in 2013-2014, the rig count was rising, but that optimism was washed out of the market as gas prices fell steadily to sub-$2/Mcf by 2015-2016. As gas prices began recovering, and talk suggested that they might return to the $4/Mcf level, producers shifted into drilling mode. The gain in the weekly addition of drilling rigs peaked just before gas prices peaked. Rig counts then began falling as spot gas prices fell below $3/Mcf.

**They are assuming a bias for lower prices in 2018**

The evaporating gas price optimism is highlighted by one energy investment bank recently reducing its price forecast. The firm is now using the futures price curve from the New York Mercantile Exchange (NYMEX) through 2020, which is currently around $2.89/Mcf. They are assuming a bias for lower prices in 2018. Long-term, or from 2021 forward, the firm is using a $2.75/Mcf price, with a bias higher. The problem for natural gas prices is the firm's conclusion that there is lots of gas supply available at these forecasted price levels, and that demand growth will not help drive prices higher. As the firm wrote, it cannot foresee a scenario where gas prices range much outside of a band of $2.50/Mcf to $3/Mcf during the forecast period.

**Assuming gas injections only match 90% of the remaining weekly estimates for the season, there should be adequate supply at the start of winter**

Assuming weekly gas storage injections match the 5-year weekly injection averages for the rest of this injection season, total natural gas volumes in storage will be sufficient for the upcoming winter, reducing any near-term upward pressure on gas prices. To test this conclusion, gas storage injections so far this year have achieved 90% of the 5-year weekly averages. Assuming gas injections only match 90% of the remaining weekly estimates for the season, there should be adequate supply at the start of winter. Under this scenario, the volume of gas in storage would be less than was in storage at the start of the two past winters. However, there will be more gas in storage than was available for the 2014 winter, but less than the starting storage volumes for all the withdrawal seasons of 2008-2013. This may help gas prices. We will monitor the weekly storage injections to see if our model's assumption is accurate, but the still large gas supplies in storage will keep prices in check.

Lower natural gas prices and adequate supplies provides a scenario that is positive for gas-fired electric utilities and their customers, natural gas pipeline companies and liquefied natural gas (LNG) exporters. It is not positive for natural gas producers. As with all forecasts, it will remain in place until it needs to be changed in response to market forces. We will be watching.

## EV Sales Are Growing, But Not As Much As Expected

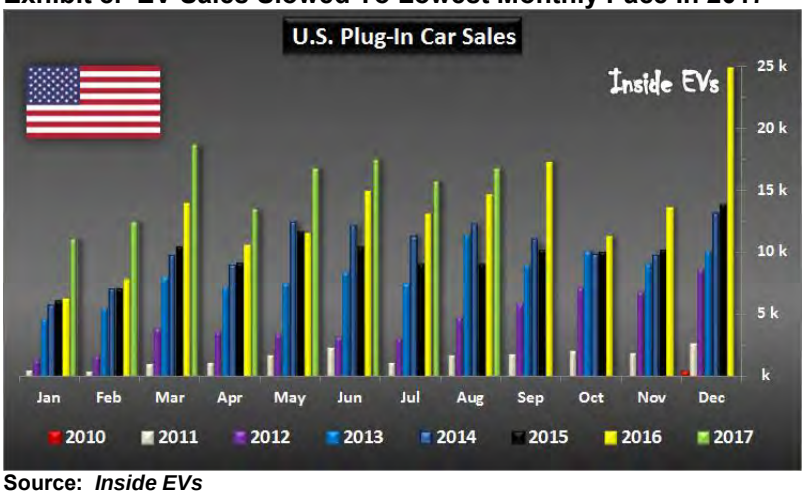
U.S. electric vehicle (EV) sales for August were recently reported. The 16,624 EVs sold in the month, which includes an estimate of monthly Tesla (TSLA-NASDAQ) sales who only reports sales quarterly, showed strong performance for the new Chevy Bolt. That

model sold 2,107 units in August, slightly below the estimated Tesla Model S sales of 2,150, but now it has nationwide availability, which suggests it may have more sales momentum, given its 238-mile driving range per charge and modest sales price.

**August EV sales increased only 13.9% over the same month in 2016, the smallest year-over-year gain recorded all year**

August EV sales increased only 13.9% over the same month in 2016, the smallest year-over-year gain recorded all year. In fact, August monthly sales were almost 2,000 units below the March 2017 monthly peak. Is this signaling a problem for EVs?

**Exhibit 8. EV Sales Slowed To Lowest Monthly Pace In 2017**

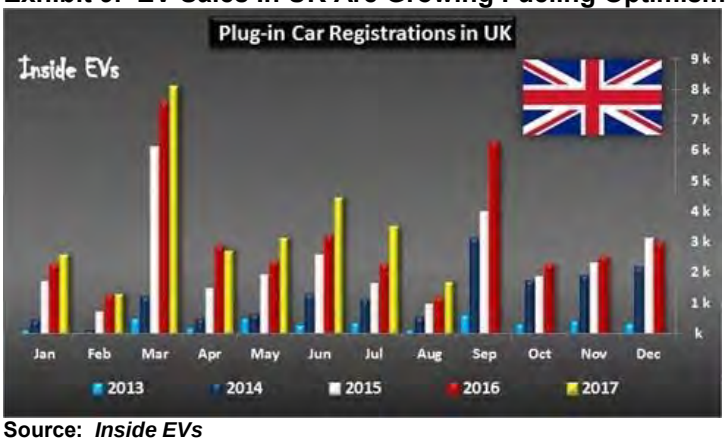



**Source:** ***Inside EVs***

**Of the 1,691 EV sales in August, 476 were battery electric vehicles (BEV), while 1,215 were plug-in hybrid electric vehicles (PHEV)**

In the UK, the story is different as EV sales for August increased by 45%. As noted in Exhibit 9 (next page), the UK has established two peak automobile registration months – March and September. There is growing enthusiasm within the UK EV community that September will set another record month. What we found interesting was that of the 1,691 EV sales in August, 476 were battery electric vehicles (BEV), while 1,215 were plug-in hybrid electric vehicles (PHEV). Those PHEVs, while plugged in to be recharged, also have internal combustion engines to power the car when the battery cannot do it alone. This means gasoline is needed. Hybrids are the backbone of Exxon Mobil Corp.'s (XOM-NYSE) long-term energy forecast that calls for gasoline consumption to continue to grow. Hybrids have always been the focus of the Toyota Motors (TM-NYSE) strategy for alternative vehicles. It still believes strongly in the long-term opportunities for hydrogen-powered cars.

**Exhibit 9. EV Sales In UK Are Growing Fueling Optimism**




**Source:** ***Inside EVs***

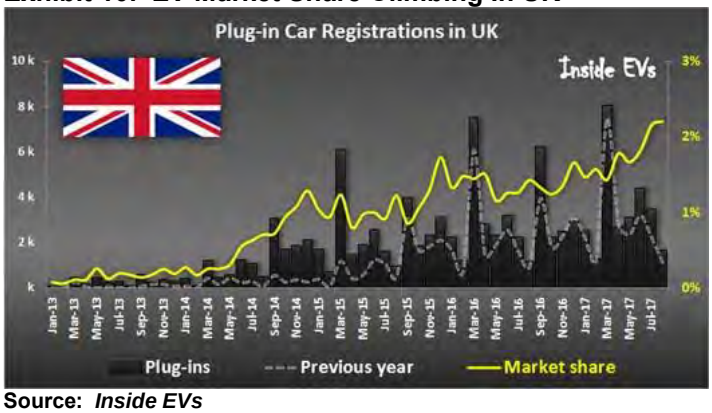
**"…we're skeptical there would be a rapid shift to pure electric vehicles, given questions over user convenience"**

Takeshi Uchiyamada, chairman of Toyota told *CNBC*, "I must say up front that we're not against electric vehicles. But in order for electric vehicles to cover long distances, they currently need to be loaded with a lot of batteries that take a considerable amount of time to charge. There's also the issue of battery life." He went on to say, "But as laws and regulations (that encourage the development of electric vehicles) come into effect in places like China and the U.S., car makers will have no choice but to roll out electric vehicles or risk going out of business. Toyota is no exception, but we're skeptical there would be a rapid shift to pure electric vehicles, given questions over user convenience."

**Toyota is already working on developing better batteries to power its cars**

Mr. Uchiyamada said he believes there are two or three more technological breakthroughs needed before vehicles can be fully powered by batteries. He didn't identify what those breakthroughs are, or will entail. However, he admitted that some form of electrification is inevitable and that Toyota is already working on developing better batteries to power its cars. As we have reported, they have filed patents on solid lithium-ion batteries that would allow more power to be installed in smaller spaces.

**Exhibit 10. EV Market Share Climbing In UK**




**Source:** ***Inside EVs***

**UK auto sales were down in August, which contributed to the EV market share rising to 2.2%**

UK auto sales were down in August, which contributed to the EV market share rising to 2.2%. EV sales have quite a ways to go to meet the 9% of 2020 sales target endorsed by the country's Committee on Climate Change. However, the government's official target is lower, between 3% and 7% of auto sales in 2020. There is an excellent chance the low end of the forecast range will be met. A key helping EVs is that as of the end of 2016, 98% of UK highway service stations were equipped with fast chargers. The industry is estimating that by 2020, charging stations will outnumber gasoline stations in the UK. With significant charging infrastructure already in place, and coupled with substantial EV financial incentives, it is difficult seeing UK EV sales slowing.

## Hurricane Harvey Leaves Texas Gulf Coast With L-T Impact

**A greater problem for the Texas Gulf Coast was the lack of steering winds moving between the high pressure centers that would have moved Harvey out of the region**

Hurricane Harvey, a Category 4 tropical storm with wind speeds of around 130 miles per hour, stormed ashore near Rockport, Texas, about 20 miles northeast of Corpus Christi, at 9:43 pm CDT on August 25th, according to the National Oceanic and Atmospheric Administration (NOAA). Although Harvey quickly weakened to a tropical storm, it found itself caught between two extremely large high pressure centers – one centered over the Southeast including the eastern Gulf of Mexico and the other covering the Southwest and the southern states of the Central Midwest. A greater problem for the Texas Gulf Coast was the lack of steering winds moving between the high pressure centers that would have moved Harvey out of the region.

**"Unprecedented" became the popular description of conditions in the region, as thousands saw their homes and vehicles flooded, lost electricity and were forced to seek help in evacuating to the scores of shelters established to house Harvey's refugees**

Given Harvey's size, strength and slow northeast drift resulted in it continuing to pull moisture from the Gulf of Mexico and dropping it in a days-long rainstorm over the region. Rainfall amounts exceeding 50 inches pummeled portions of Houston and the surrounding area causing greater challenges than those of a typical hurricane moving through the region. As the rains fell, the water's natural path of exit via the streams and bayous throughout the coastal region resulted in them being overwhelmed. The sheer volume of rainwater exceeded anything ever planned for, and led meteorologists to characterize the flooding as a 500-year or 1,000-year event. "Unprecedented" became the popular description of conditions in the region, as thousands saw their homes and vehicles flooded, lost electricity and were forced to seek help in evacuating to the scores of shelters established to house Harvey's refugees. The pictures of the rescues and the scope of the flooding were both amazing and heartbreaking. Our prayers and thoughts go out to those seriously impacted by the storm and the rising flood waters.

As the rains fell and flood waters rose, the attacks on Houston began. One of the early attacks was a tweet from University of Tampa visiting assistant professor of sociology Kenneth L. Storey. That tweet, and two response tweets, were eventually removed in response to their crass nature. Prof. Storey tweeted: "I don't believe

in instant Karma but this kinda feels like it for Texas. Hopefully, this will help them realize the GOP doesn't care about them." He added that "the good people there need to do more to stop the evil their state pushes. I'm only blaming those who support the GOP there." Prof. Storey also said that the supporters of President Donald Trump in hurricane-prone Florida deserved a similar fate. His was not the first use of claiming moral justice from natural disasters. Televangelist Reverend Pat Robertson's comments about the damage caused by Hurricane Katrina in 2005 was an earlier example. Prof. Storey might have been better served had he done some research: Senator Ted Cruz (R) won the Texas Republican Primary by 44% to President Trump's 26.7%. Yes, President Trump won the Texas popular vote by slightly over 52%, but Hillary Clinton soundly beat him in the Houston and Harris County votes.

**His was not the first use of claiming moral justice from natural disasters**

The attacks on the state and Houston went way beyond the last election, to how the city's lack of zoning caused the flooding; why the energy business needs to consider relocating; and whether "big business" will repay the generosity it has received from Houston through tax credits and other financial incentives. In our view, all of these attacks demonstrate a lack of understanding of how Houston/Harris County has grown into the fourth largest city in the nation with a metropolitan regional population of over six million people. Between 2010 and 2016, the county's population grew by 500,000, or 12%, the largest rate of increase of any major city during that time period.

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Houston and the metropolitan region has the most diverse population of any major metropolitan area in the United States, with Anglos representing 36.2% of the total population, Blacks at 16.5%, Hispanics 38.3%, and Others 9.0%. The region has a very large and dynamic Asian population. According to the Texas Demographic Center's Moderate Scenario projection for the region's population, it will increase by a third by 2050 from its current 6.6 million people estimate for 2017. By 2045, Hispanics will account for slightly over half the region's population.

**It will increase by a third by 2050 from its current 6.6 million people estimate for 2017**

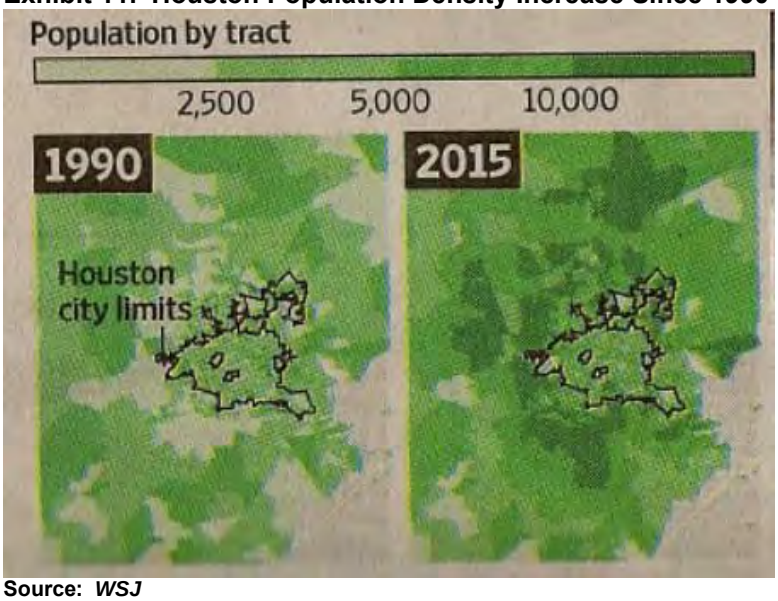
The Houston metropolitan region is an important economic engine with over three million high-paying jobs. The area's gross domestic product in 2015 was estimated at $503 billion. That year, Houston area auto dealers sold slightly over 375,000 vehicles. An estimate of damage to the region's vehicle fleet from flooding claims between 500,000 to as many as one million vehicles will be scrapped. If they are replaced at the average sales price of $35,000 (national average this year), that would add $18-$35 billion to the auto industry, quite a shot in the arm for a business struggling with overcapacity and lagging sales this year. Overall, damage estimates for the region, which are very preliminary (really guestimates), suggest they could range anywhere from $40 billion to in excess of $125 billion. Anybody have a truck to drive through the estimate?

**An estimate of damage to the region's vehicle fleet from flooding claims between 500,000 to as many as one million vehicles will be scrapped**

**On the issue of zoning and flooding, numerous media people have made the claim in articles that the lack of one caused the other**

On the issue of zoning and flooding, numerous media people have made the claim in articles that the lack of one caused the other. These reporters and columnists claim that if Houston, which is famous for being the largest city in the nation without a formal zoning program, actually had zoning, the building of neighborhoods, retail and office complexes would have been done outside flood-prone areas. *The Wall Street Journal* carried such an article that contained two maps of South Texas with an outline of the City of Houston superimposed on it. One map shows population density in 1990 and the other in 2015. The areas colored in dark green show higher density, and there are more areas now.

**Exhibit 11. Houston Population Density Increase Since 1990**




**Source:** ***WSJ***

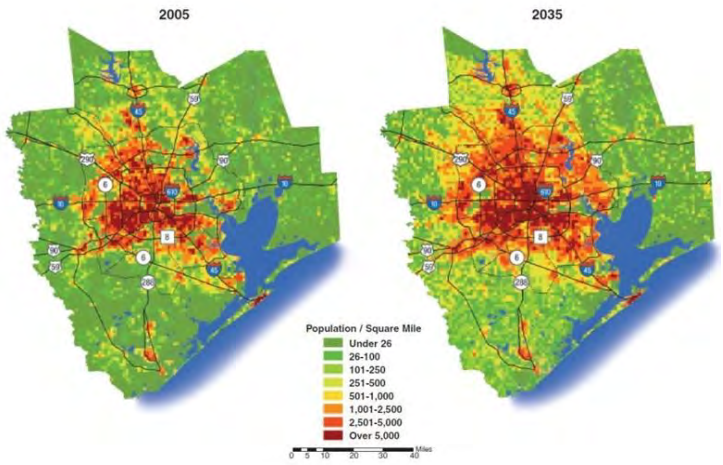
**Houston has always been a city with urban sprawl and dependent on mobility, now the automobile**

Houston has always been a city with urban sprawl and dependent on mobility, now the automobile. That mobility-orientation was demonstrated early in the city's history by the decision to create access from the Gulf of Mexico for shipping vessels, which helped kicked off its early economic growth. Wealthy residents in the 1880s escaped the city's heat by carriage to reach their lodges built on Buffalo Bayou near the edge of a local forest, about five miles from downtown. Growth projections suggest even greater future density, which raise questions about how the region will deal with unusual rainfall events. (See Exhibit 12, next page.)

**"For those who embrace urban planning, such deregulation has made Houston a chaotic, even ugly, city"**

Scott Beyer, the owner of a media company called *The Market Urbanism Report*, which works to advance free-market policy ideas for cities, wrote on the blog *Forbes* that "For those who embrace urban planning, such deregulation has made Houston a chaotic, even ugly, city." For Houstonians, those may be fighting words.

**Exhibit 12. How Houston's Population Will Grow**




**Source:** ***agrilife.com***

**_The Houston Chronicle_ published an article showing that in the previous 40 years, rainfall in the Brays Bayou watershed had increased by 26%, but water runoff by 204%**

The zoning issue surfaced in late 2016 when *Pro Publica* wrote about Houston's flooding during Hurricane Rita in 2005. It argued that urban development had reduced water-absorbing prairie, and instead covered it with impervious surface, creating runoff problems. A few weeks later, *The Houston Chronicle* published an article showing that in the previous 40 years, rainfall in the Brays Bayou watershed had increased by 26%, but water runoff by 204%.

As *Slate* columnist Henry Grabar wrote: "The flood-absorbent grasslands of the Katy Prairie have been cut by three-quarters over the past few decades as Houston sprawled west. The state played along, funding expansion of I-10, 'the Katy Freeway,' and another road, the Grand Parkway, which further opened that land up for development. To make matters worse, money-hungry officials also encouraged development in low-lying, flood-prone areas without regard to future risk. There have been more than 7,000 units built in the hundred-year floodplain since 2010."

**More than 60% of homes in the larger Houston metro area are considered affordable for median-income families**

The issue of development in the Houston region is a double-edged sword. The question is whether traditional zoning would damage the economic engine of the region. *The Wall Street Journal* wrote about it in April 2016 after the "tax day" flood. The *WSJ* stated: "From 2010 to 2014, the Texas city added more than 140,000 people, a 6.7% increase and second only to New York in the U.S. But the difference between Houston and other high-growth cities is that it has expanded its housing stock to accommodate its new residents. In roughly the same period, the Houston metro area issued construction permits for 189,634 new units, the most in the nation. It is not surprising, then, that more than 60% of homes in the larger Houston metro area are considered affordable for median-income families, according to the National Home Builders Association, compared with about 15% in the Los Angeles area."

**A lack of zoning makes it easier and faster to build, especially in response to changing economic and democratic conditions**

"Houston has "shown a capacity to grow without the kind of massive real-estate inflation that makes settling into places like New York, San Francisco, Boston, as well as London, all but impossible for middle-class families," says Joel Kotkin, a fellow in urban studies at Chapman University in Orange, California, and executive director of the Houston-based Center for Opportunity Urbanism. The dramatic job growth of the city due to the energy boom was facilitated by affordable housing. The lack of traditional zoning was a contributing factor. A lack of zoning makes it easier and faster to build, especially in response to changing economic and democratic conditions. Because a developer can avoid a lengthy and expensive rezoning process, decaying neighborhoods can be replaced with new townhomes. The developer will likely have to upgrade infrastructure such as sewer lines, street and sidewalks as part of securing building permits. Although prices have risen as these renewal efforts occur, Houston remains affordable because so many new homes can quickly be built to meet demand. According to Houston architect Tim Cisneros, the lack of zoning "actually does give the developer and design communities the ability to do things unlike anywhere else." Mr. Kotkin opined that "While many on the ocean coasts yearn to restore the 19th-century city, the Texas cities are creating a template for this century."

**The idea that "these magic sponges out in the prairie would have absorbed all that water is absurd"**

*Pro Publica* interviewed Mike Talbott, former director of the Harris County Flood Control District for its 2016 article. The idea that "these magic sponges out in the prairie would have absorbed all that water is absurd." He pointed out that the region has suffered from some unusually large rainfalls, and has had trouble handling them because it is abnormally flat and the streams and bayous don't efficiently push water eastward to the Gulf of Mexico, and are subject to overflowing. Historian Phil Magness commented, "If Harvey happened in 1850 instead of today, the results would be nearly identical in terms of land flooded…No zoning law or ban on parking lot construction would ever have 'fixed' anything about that." In fact, in December 1935, Houston received 25 inches of rain over two days, flooding a much smaller downtown, which had substantially less impervious surfaces than now. (See Exhibit 13, next page.) None of this negates the need for the region to address the water retention reservoirs and improvements in the bayous to enable them to move more water away from population centers faster and with less overflow.

**This helps explain why 13 of the top 20 metropolitan GDPs in the U.S. are located on the country's three coasts**

How about the idea that Houston's energy business should consider relocating due to the damage it sustained from hurricanes? First, throughout history, the development of a country's coast is one of the most natural events. Trade and mobility are eased because of access to the coast. This helps explain why 13 of the top 20 metropolitan GDPs in the U.S. are located on the country's three coasts. One opinion offered why such an energy migration is not likely to happen is because only Texans are receptive to the industry. That may be true if states voted on whether to welcome

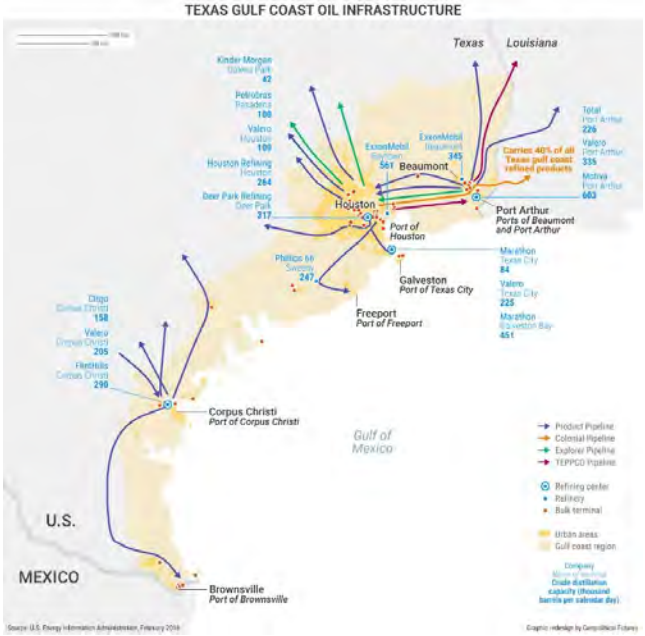
**Exhibit 13. 1935 Flood Looking East Over Downtown**

**Source:** ***sfgate.com***

**Tankers hauling oil to the Gulf Coast was the easiest and least costly option**

the industry or not. The bigger issue is that the industry has developed around the state's oil production and the need to be able to concentrate refinery operations with a maximum number of input and distribution outlets, of which coastal access is an important factor. When the nation's oil production peaked in 1970, the refining industry needed to be able to easily and steadily receive imported oil. Tankers hauling oil to the Gulf Coast was the easiest and least costly option. A look at the Gulf Coast oil infrastructure map shows the truth of this concentration.

**Exhibit 14. Gulf Coast Is Center Of Refining Industry**




**Source: EIA**

The map doesn't reflect the massive petrochemical complex along the Gulf Coast that relies on raw material from refineries. In addition, the Houston region is also a hub for the nation's natural gas pipeline network. One also cannot ignore the Gulf Coast's energy infrastructure's importance in enabling oil and gas to reach shore from the offshore Gulf of Mexico fields.

**What those who suggest the energy business relocate fail to understand is that the current structure and location of companies is largely the culmination of a consolidation effort spanning the past two decades**

What those who suggest the energy business relocate fail to understand is that the current structure and location of companies is largely the culmination of a consolidation effort spanning the past two decades. The 1990s marked the beginning of a phase of significant industry consolidation, despite the growth of new exploration and production and oilfield service companies in response to mushrooming shale activity. Seeing that this phase has largely ended, it is difficult to find a reason why companies would relocate at this time. Instead, we see the industry continuing to consolidate operations to reduce their overhead and operating expenses. Industry concentration also helps companies to recruit new employees as needed because trained employees are often easier to hire if relocation is not a requirement and an impediment.

**We also doubt there will be any significant change in zoning practices, but we are sure there will be lots of 'learnings' gleaned from the flood and the response effort**

We will reserve commentary on the issue of big business (largely the energy industry) and Houston's generosity. There is important history of business and politics that needs to be understood in order to address the issue, which we will deal with in a future article. In the meantime, we don't expect an energy industry exodus from Houston. We also doubt there will be any significant change in zoning practices, but we are sure there will be lots of 'learnings' gleaned from the flood and the response effort. The idea of increasing housing density in the area between Beltway 8 and the 610 Loop by reducing lot size may not be such a good idea. On the other hand, requiring improved draining infrastructure as a condition of new developments may gain a higher priority. The recovery of Houston will lead to many changes in the city, the zoning issue is merely one. We will be watching and commenting on the changes.

## Autonomous Cars On The Road Sooner Than Expected

Last week Congress returned to work after its summer break facing a jam-packed agenda. Included in the agenda for the U.S. House of Representatives was a vote on the Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act, or SELF DRIVE Act (H.R. 3388). It was unanimously approved; the Senate is next.

**The exemption will allow the auto industry to deploy up to 25,000 vehicles without meeting auto safety standards**

The bill facilitates the introduction and testing of autonomous cars by clarifying federal and state roles, and by granting exemptions from motor vehicle standards that have impeded introduction of new automated vehicle technologies. The exemption allows the auto industry to deploy up to 25,000 vehicles without meeting auto safety standards, with an additional 25,000 cars per year for three years. Today, 2,500 autonomous cars are exempt from safety standards.

The latest version of the bill includes a significant section dealing with consumer privacy, which will require that manufacturers create a written “privacy plan” for every automated vehicle deployed. The privacy plan must explain a manufacturer’s collection, use, sharing, and storage of information about vehicle owners and occupants, and would detail the manufacturers’ approaches to core privacy principles like data minimization, de-identification, and information retention. If the information collected by auto manufacturers is de-identified, anonymized, or encrypted, it will not be subject to the privacy plan. As carmakers are interested in the data for research, we expect none of it will be linked to individuals.

**The optimists for rapid penetration of autonomous vehicle technology see 100,000 such cars on the road by 2021**

The optimists for rapid penetration of autonomous vehicle technology see 100,000 such cars on the road by 2021. For them, this technology will mushroom into 100% penetration in a matter of a few years. They particularly see the over-the-road trucking industry as a primary target for autonomous technology, and foresee the elimination of upwards of a million drivers.

**Depending upon the level of autonomy specified, we could achieve 100% of new vehicle sales in the foreseeable future, but not the technology success being implied by many of the forecasts**

The greatest issues for autonomous vehicles are the level of autonomy that will be achieved, and how long it will take? Almost never do forecasters discuss what they mean by autonomous. But, it is generally assumed they mean Level 5, in which the driver does not interact with the vehicle at all. It is important to understand the various levels of vehicle autonomy and how they differ. Depending upon the level of autonomy specified, we could achieve 100% of new vehicle sales in the foreseeable future, but not the technology success being implied by many of the forecasts.

The National Highway Traffic Safety Administration (NHTSA) has adopted the Society of Automotive Engineers' levels of autonomy in its planning for self-driving vehicles. Here are the SAE level definitions:

Level 0: The human driver controls all functions, such as steering, brakes, throttle, and power.

Level 1: Most functions are still controlled by the driver, but a specific function (like steering or accelerating) can be done automatically by the car.

**Level 2: means the driver is disengaged from physically operating the vehicle**

Level 2: At least one driver assistance system of both steering and acceleration/deceleration is automated using information about the driving environment, like cruise control and lane-centering. This means the driver is disengaged from physically operating the vehicle. That means the driver has his/her hands off the steering wheel and his/her foot off pedal at the same time, however, the driver must always be ready to take control of the vehicle.

Level 3: Human drivers are able to completely shift "safety-critical functions" to the vehicle, under certain traffic or environmental

conditions. It means that the driver is still present and will intervene if necessary, but is not required to monitor conditions in the same way as required for the previous levels.

**Level 4 vehicles are "designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip"**

Level 4: Level 4 vehicles are "designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip." However, it's important to note that this is limited to the "operational design domain (ODD)" of the vehicle—meaning it does not cover every driving scenario, yet this is referred to as "fully autonomous." The driver does not have to immediately intervene, as he/she does at the prior levels.

Level 5: This fully-autonomous level expects the vehicle's performance to equal that of a human driver, in every driving scenario—including extreme environments like dirt roads. This level is unlikely to be achieved anytime soon as dirt roads will likely not be mapped for years, if ever.

**However, many cars already have achieved Level 2, meaning that the cars can be assumed to be autonomous, just not "fully autonomous"**

Numerous companies developing autonomous vehicles are striving for Level 4, as they are worried about the human reaction requirement and time necessary for it to happen in Level 3. However, many cars already have achieved Level 2, meaning they can be assumed to be autonomous, just not "fully autonomous." This is another case where words matter in forecasting, but attention is seldom paid to them, much like the lack of distinction between electric and electrified cars, when describing the electric vehicle market. An analyst who has focused on this distinction, Thilo Koslowski, a former analyst for Gartner, believes there are three stages that are relevant: "automated, autonomous, and driverless." The last stage is more advanced than autonomous. While many people will have difficulty drawing distinctions, they will be important for issues such as auto insurance and licensing requirements.

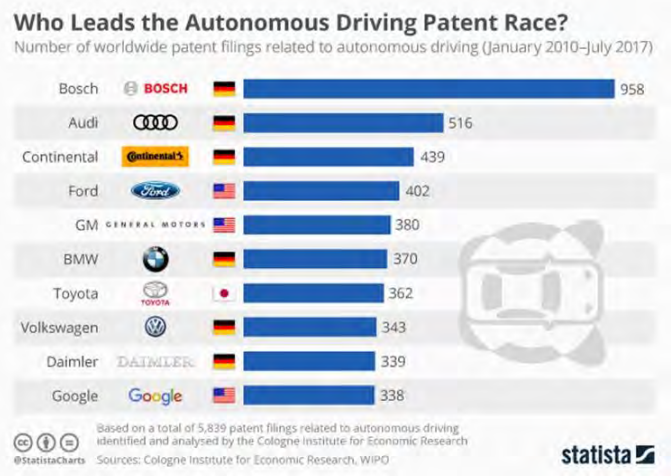
**The number of light duty vehicles sold globally with at least Level 2 capability will grow from more than 250,000 in 2017 to more than 93 million in 2026**

According to Navigant Research in a promotional article for a new study, the number of light duty vehicles sold globally with at least Level 2 capability will grow from more than 250,000 in 2017 to more than 93 million in 2026. While we don't know what their forecast is for total global auto sales in 2026, we believe it will not be 100% of all cars having Level 2 or greater autonomy. It is entirely possible that 93 million vehicles will have Level 2 autonomy, but that only a small percentage with Level 3 or greater autonomy. Predicting the acceptance of new technologies, especially in the auto sector, is tough to get right. We point to Carlos Ghosn, then the head of an alliance that included Nissan and Renault SA, who predicted in 2010 that the two companies would have sold a cumulative 1.5 million EVs by 2016. Actual cumulative EV sales were 490,000. Mr. Ghosn also predicted that 10% of global auto sales would be EVs in 2020. Currently, they account for 1%.

It is interesting to note the companies leading the charge into autonomous vehicles. In looking at who has the most patents for

autonomous technology, it is traditional auto companies and suppliers who are leading the race and not technology companies.

**Exhibit 15. Traditional Car Companies Lead Self-driving Race**




**Source:** ***Statista***

In our view, the most optimistic forecasters who call for autonomous vehicles, which often means electric vehicles, dominating the world's highways within a few years may be too optimistic. But, we also caution that believing these technologies will not impact the global transportation business, including energy, will prove equally wrong.

**Contact PPHB:**
**1900 St. James Place, Suite 125**
**Houston, Texas 77056**
**Main Tel: (713) 621-8100**
**Main Fax: (713) 621-8166**
**www.pphb.com**

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