

## MUSINGS FROM THE OIL PATCH

October 18, 2016

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Managing Director

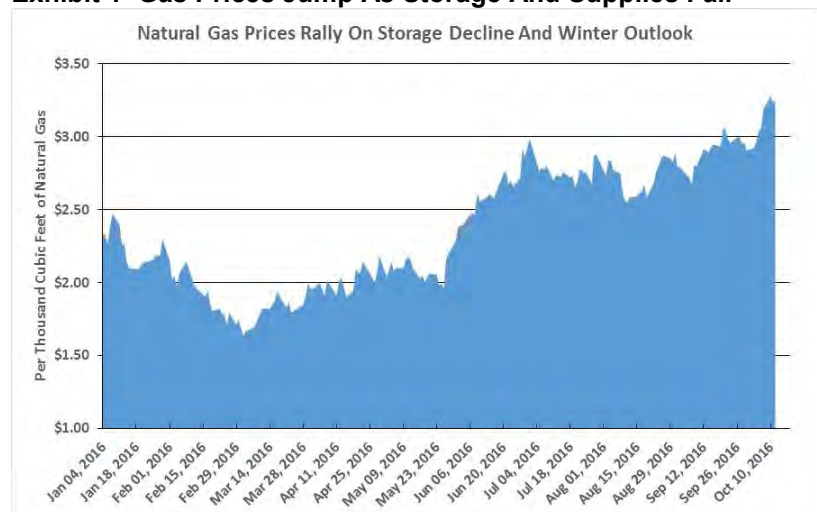
**Note:** *Musings from the Oil Patch* reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every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

### Nat Gas Prices Higher As Output Falls, But Will Winter Help?

**This output segment was down by 9%, or about 2.5 Bcf a day less natural gas production, or about 3% of total gas output**

Natural gas prices have been climbing in recent days, driven, we suspect, by concerns about supply disruptions from Hurricane Matthew and the decline in the output of associated gas due to the downturn in oil well drilling. A recent article in *The Wall Street Journal* pointed out the problem of falling associated natural gas production. They cited data from *Platts Analytics Bentek* suggesting that this output segment was down by 9%, or about 2.5 billion cubic feet (Bcf) a day less natural gas production, or about 3% of total gas output. With the recent climb in natural gas futures prices above \$3.25 per thousand cubic feet, there are questions being asked about how long this shortfall may last.

#### Exhibit 1 Gas Prices Jump As Storage And Supplies Fall

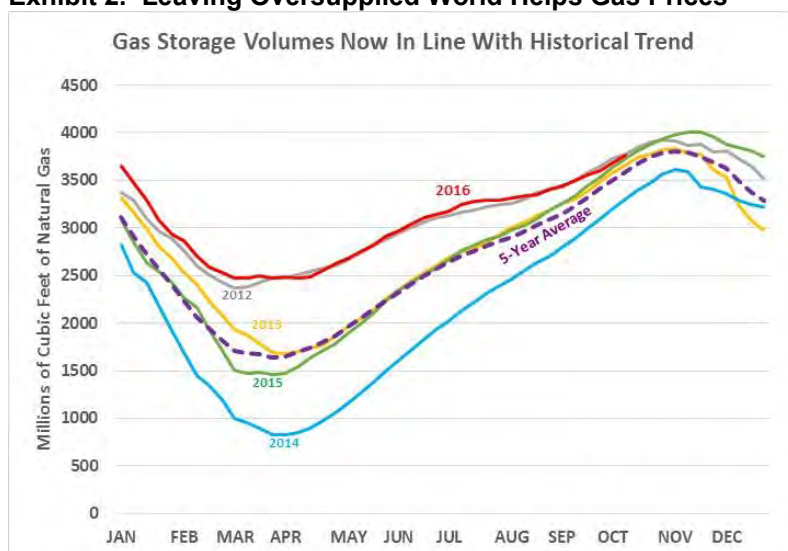


Source: EIA, PPHB

**As of the first week in October, the volume of gas in storage was below the 2012 storage level at the same time as now, and approaching the 2015 storage level**

The *WSJ* article cited the associated gas output decline along with an increase in gas consumption by the nation's power plants this summer due to hot temperatures as reasons why the growth in natural gas volumes going into storage have been increasing at a slower than historical rate in recent weeks. In fact, as of the first week in October, the volume of gas in storage was below the 2012 storage level at the same time as now, and approaching the 2015 storage level. More importantly, the current storage level is rapidly approaching the 5-year average for gas storage volumes. We have moved from a huge oversupply condition that was putting downward pressure on prices to the more current balanced supply situation and higher gas prices.

**Exhibit 2. Leaving Oversupplied World Helps Gas Prices**



Source: EIA, PPHB

**Do we have an oversupplied natural gas market?**

As we await the weekly gas storage injections through the end of October, the issue will become whether we fall below the 5-year average weekly injection volume or not. In other words, do we have an oversupplied natural gas market? If we fall below the average then the likelihood is that natural gas futures prices climb higher in response to growing concerns about whether there will be adequate gas supply available for the upcoming winter should we experience a colder than normal season.

**The concern at that time was whether injection season ending volumes would exceed more than 4,000 Bcf of gas in storage**

We wrote about the outlook for natural gas storage in late August. At that time, we offered two forecasts for eventual storage totals by the end of the injection season. The concern at that time was whether injection season ending volumes would exceed more than 4,000 Bcf of gas in storage, which was perceived as a volume that would meet all upcoming winter needs, yet leaving so much in storage by the end of the winter would depress gas prices during the first half of next year.

**This forecast model produced an estimate of nearly 4,100 Bcf of natural gas in storage at season-end**

**This scenario would certainly be appealing to gas industry executives**

**The weekly gas injection volumes have been close to our model that assumed injections would be only 50% of the 5-year average weekly injection volumes**

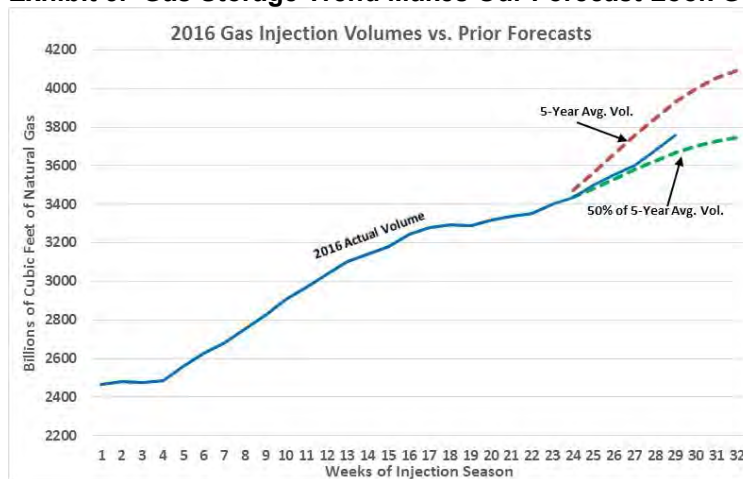
**The models now predict season-ending storage volumes ranging between 3,804 Bcf and 3,929 Bcf**

In developing our forecast, we used the 5-year average for weekly injections as our supply increments to add to the starting base of what was reported to currently be in storage facilities. This forecast model produced an estimate of nearly 4,100 Bcf of natural gas in storage at season-end. Achieving that target would certainly be a serious depressant on natural gas prices and future natural gas drilling activity.

Our second forecast was based on assuming that the weekly injections were only at half the 5-year average rate. Under that assumption, we arrived at a final gas storage volume of about 3,750 Bcf. The significance is that this volume would represent the least amount in storage entering the withdrawal season in recent years with the sole exception of 2014. This scenario would certainly be appealing to gas industry executives.

Now that we are in October, we thought we would update our forecast models to see how they have performed and what it might mean for revised injection season-ending volumes. In Exhibit 3, we show the two original forecasts along with the actual storage volumes since the forecasts were made. It is clear that since the forecasts were made, the weekly gas injection volumes have been close to our model that assumed injections would be only 50% of the 5-year average weekly injection volumes. Only in the last two weeks have weekly injection volumes deviated meaningfully from the model's projections.

**Exhibit 3. Gas Storage Trend Makes Our Forecast Look Good**



Source: EIA, PPHB

Based on our forecasting methodology, in neither forecast do we reach a 4,000 Bcf of total gas storage by the end of the injection season. The models now predict season-ending storage volumes ranging between 3,804 Bcf and 3,929 Bcf. One possible offset is the potential for a near term natural gas demand drop due to Hurricane Matthew's impact on the Southeast region of the country – an area

**Will we have colder-than or warmer-than normal winter temperatures?**

of heavy gas use. With homes and businesses damaged and people still relocated due to regional flooding, both heating and air conditioning use will decline, cutting into gas consumption. We won't know the magnitude of the possible impact, if any, for several weeks due to the delay in reporting consumption and storage data.

With the prospect of natural gas storage volumes ending the injection season below the feared 4,000 Bcf threshold, attention is shifting to the upcoming winter demand. This may become the new fear for natural gas prices. Will we have colder-than or warmer-than normal winter temperatures? The answer to that question will determine if natural gas prices rise further or stop rising and then possibly decline.

**Most of the early winter forecasts are now predicting a stormy winter for the Northeast and southeastern Canada regions**

The conventional outlook for the upcoming winter is based on weather forecasts that assume we will experience a fairly typical La Niña phenomenon in the Pacific Ocean. The development of La Niña has followed the winding down of the unusually strong El Niño warm weather phenomenon. Given that assumption, most of the early winter forecasts are now predicting a stormy winter for the Northeast and southeastern Canada regions, along with cold in the northern and central portions of the United States, as well as in the Canadian Prairie Provinces.

**The impact of volcanoes on our weather is, in our opinion, an under-appreciated variable**

In our opinion, one of the better long-term weather forecasters is Evelyn Browning Garriss of the *Browning™ World Climate Bulletin*. Mrs. Garriss is the daughter of the late Dr. Iben Browning, a biophysicist by training who worked in various scientific fields including artificial intelligence and bioengineering. He was known as a futurist and he applied his studies of climate patterns to offer predictions of world food production, demographic changes and other socioeconomic matters. He is known for his role in the development of high-definition projection television (HDTV) and his warnings of the 1989 San Francisco earthquake and the eruption of Mount St. Helens in 1980. He was a student of the impact of volcanoes on climate patterns, something his daughter also follows closely as she lays out her long-range outlook for the climate. The impact of volcanoes on our weather is, in our opinion, an under-appreciated variable.

**A positive PDO has the effect of reducing the impact of a cool La Niña, which may take months to develop before impacting the weather**

In her October bulletin, Mrs. Garriss lays out in great detail how the conventional view that La Niña will become the driving force behind our winter weather patterns may not be accurate. What we may have instead is a weather pattern of La Niña-like conditions that last for brief spans of time but then followed by neutral periods. Much of this vacillation is attributable to the warm waters of the Pacific Ocean due to El Niño. As the warm waters have spread from the South Pacific Ocean to the Northern Pacific, they have helped to create a positive Pacific Decadal Oscillation (PDO). A positive PDO has the effect of reducing the impact of a cool La Niña, which may take months to develop before impacting the weather.

**She points out that currently the Arctic winds have been near neutral – neither particularly positive, which would create a warm winter, nor negative, which could allow the cold Arctic winds (polar vortex) to plunge into Canada and the United States**

**The rainfall and harvest delay will require more energy as the wet crops will need to be dried for storage**

**We are likely to have a warmer than average winter with bursts of severe cold and stormy weather**

Mrs. Garriss writes, “The big question will be which fades first, the warm positive PDO or the cool La Niña. Many forecasts, such as the recent Accuweather winter projection, are based on a stronger La Niña pattern while our current outlook reflects the fact that the positive PDO is moderate and the La Niña is weak to non-existent and expected to be gone by February.”

Another consideration in projecting the upcoming winter weather will be the impact of the polar winds. Given a mixed Pacific Ocean temperature profile and a warm Atlantic Ocean, then the Arctic winds, the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) will become important factors in the outlook. She points out that currently the Arctic winds have been near neutral – neither particularly positive, which would create a warm winter, nor negative, which could allow the cold Arctic winds (polar vortex) to plunge into Canada and the United States causing a cold winter. These neutral winds might be altered should there be a large polar volcanic eruption or multiple moderate ones. That would create a negative AO, and thus alter the Arctic winds. She also notes that the North Pacific volcano belt has been restless recently, creating a condition meriting watching.

Mrs. Garriss concludes that without a volcanic eruption episode, the conditions are strong for a warm fall season and limited cool winter conditions. One aspect of her forecast for a positive to neutral PDO and a weak La Niña is that the U.S. harvest season would experience different conditions than normally. During a typical La Niña, the harvest season would be dry, but this year it has experienced very substantial rainfall in the Western Midwest. That will not impact the size of the harvest, but it will delay its timing. The rainfall and harvest delay will require more energy as the wet crops will need to be dried for storage. While the harvest will still be large, farmers will see their harvest profits shrink because of the cost of the additional fuel needed to dry the crops. That is good news for the suppliers of propane.

The *Browning™ World Climate Bulletin* provides its forecasts in colorful and illuminating maps such as the winter outlooks for both the United States and Europe in Exhibits 4 (next page) and 6 (page 7). In the case of the United States, Mrs. Garriss predicts that we are likely to have a warmer than average winter with bursts of severe cold and stormy weather within the northern, northeastern and eastern regions. She expects that most of these storms will occur in January and early February.

The winter in Europe will be shaped by the heat in the Atlantic Ocean and the action of the polar jet stream. The Atlantic Ocean and Mediterranean Sea waters are warm, ranging anywhere from 0.5oC to 2.5oC warmer than normal. With a northward flow of tropical waters, it is likely that the waters should remain warmer all winter. The key variable influencing the weather will be the flow of



**Exhibit 4. Our Winter May Be Warmer Than Hoped For**

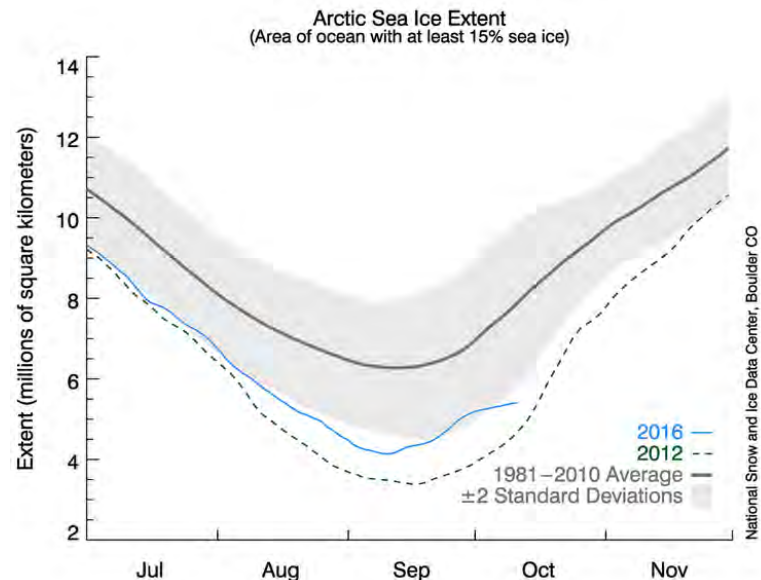


Source: *Browning™ World Climate Bulletin*

**The climate news has been dominated by media coverage of the rapid melting of the Arctic ice**

the polar jet stream. For most of the summer, the climate news has been dominated by media coverage of the rapid melting of the Arctic ice, exemplified by the attention paid to the journey of the Crystal Serenity cruise ship from Seward, Alaska, through the Northwest Passage, and ending in New York City. What hasn't received any media attention is that the Arctic ice stopped melting earlier than in any year since 1997 and is reforming at a record-setting pace.

**Exhibit 5. Arctic Ice Is Growing At Record Rate**



Source: National Snow And Ice Data Center

**In the 20 days following the low, Arctic sea ice extent had increased to 2.00 million square miles, which is an increase of 405,000 square miles**

**In 80% of years with similar weather conditions, Eastern Europe and Western Russia had colder mid-and-late winters than normal**

According to data from The National Snow and Ice Data Center in Colorado, the summer seasonal low for ice was reached on September 10<sup>th</sup> with 1.6 million square miles (4.14 million square kilometers) of Arctic sea ice. The lowest level recorded since scientists began tracking it by satellites was in 2012 when Arctic sea ice shrank to 1.31 million square miles (3.39 million square kilometers). While this year's seasonal ice low is the second lowest level, the growth rate since the low was reached has been extremely rapid due to a shift in the polar weather. In the 20 days following the low, Arctic sea ice extent had increased to 2.00 million square miles (5.19 million square kilometers), which is an increase of 405,000 square miles (1.05 million square kilometers). The seasonal low for Arctic ice and its subsequent rapid growth are shown in Exhibit 5 (previous page).

The Arctic air is unusually cool now and will become intensely cold when a polar front hits Europe this winter. At the moment, the warmth of the Atlantic waters is protecting Western Europe, so any cold fronts will target Eastern Europe and Western Russia. It will take time for the current Atlantic Ocean warmth to subside, but, according to Mrs. Garriss, in 80% of years with similar weather conditions, Eastern Europe and Western Russia had colder mid-and-late winters than normal.

**Exhibit 6. Winter In Europe Will Be Both Warm And Cold**



Source: *Browning™ World Climate Bulletin*

**A weather pattern such as this will draw media attention, making it increasingly likely that climate change will be linked to the pattern, which is guaranteed to make it a hot discussion topic**

**If weekly gas injections over the next month continue to be at the lower end of our forecast range, then gas prices should be supported**

One of the downsides to the winter weather forecast made by Mrs. Garriss is that whenever there are radical shifts in weather, especially if short severe storms interrupt a spell of warm weather, people will notice and comment on the changes. A weather pattern such as this will draw media attention, making it increasingly likely that climate change will be linked to the pattern, which is guaranteed to make it a hot discussion topic. This will present an excellent opportunity for the federal government to use the winter weather pattern to promote new environmental actions designed to address climate change, regardless of whether those actions would have any impact on the causes of this weather pattern.

If the 2016 winter weather outlook forecasted by the *Browning™ World Climate Bulletin* becomes reality, demand for natural gas may not be as great as suggested by other winter forecasts. That could leave the industry facing greater storage volumes by the end of the withdrawal season than currently anticipated, which will depress late-winter natural gas prices. If weekly gas injections over the next month continue to be at the lower end of our forecast range, then gas prices should be supported. Natural gas prices will likely be under pressure as a warm fall and early winter depress gas demand. The most likely scenario for the winter is one of increased natural gas price volatility as storms alternate with periods of warm weather. The next six months will be an interesting time for the natural gas business, and it all starts with the weekly injections over the next 4-5 weeks.

## Canada Working To Gain Market Share In Ontario Gas Market

**The problem Canada has is that its neighbor to the south, the United States, ranks as the largest gas producer based on 2014 data**

**America's natural gas industry found itself unable to satisfy consumption needs from domestic wells, forcing the country to have to rely on Canada**

Canada is the world's fourth largest producer of natural gas. The problem Canada has is that its neighbor to the south, the United States, ranks as the largest gas producer based on 2014 data. Canada also has a population about 11% of the U.S. population, meaning that Canada is dependent on export markets for much of its gas sales. That was not a bad situation for many years until the emergence of the American shale revolution and, in particular, the development of shale formations in the Marcellus region of the Northeast. Pennsylvania, West Virginia and Ohio are old petroleum producing regions of the country, so seeing the shale formations there being exploited is not surprising. In fact, Pennsylvania was the birthplace of the petroleum era with the drilling of the successful Drake Well in western Pennsylvania in 1859.

During most of the 1980s and 1990s, the use of natural gas in the U.S. increased as the industry's marketing programs to convince homeowners and businesses to switch from using dirty fuel oil to burning clean natural gas to heat their homes and power their businesses were successful. Unfortunately, America's natural gas industry found itself unable to satisfy consumption needs from domestic wells, forcing the country to have to rely on Canada for

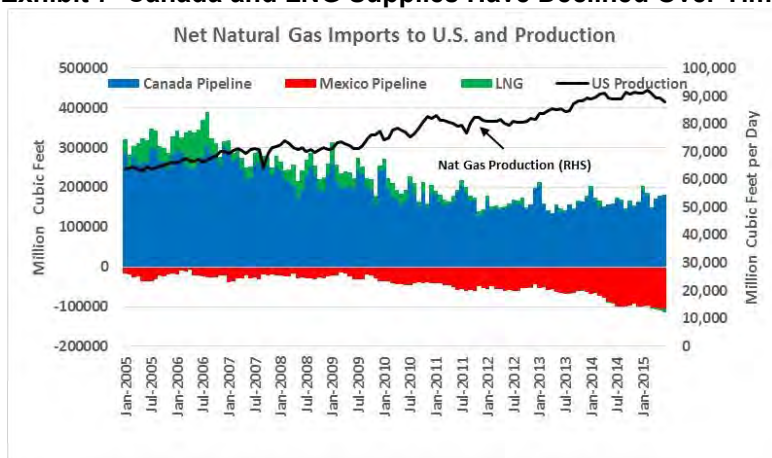


**The country has increasingly become an exporter of natural gas due to its lower delivered cost to international buyers**

additional gas supplies. That export demand was a catalyst that spurred growth in the Canadian petroleum industry.

Today, as a result of the success exploitation of America’s shale gas resources, the country has increasingly become an exporter of natural gas due to its lower delivered cost to international buyers than supplies available from their traditional suppliers. While the most visible evidence of this development has been the start of exporting natural gas to overseas markets via liquefaction (LNG). In North America, the U.S. has been exporting increased volumes of natural gas to its neighbors – Mexico and Canada – while in some instances also buying gas from these same neighbors. Exhibit 7 shows what has happened to net natural gas imports to the United States along with the country’s domestic gas output.

**Exhibit 7 Canada and LNG Supplies Have Declined Over Time**



Source: EIA, PPHB

**As time passed and America’s natural gas output grew due to the exploitation of shale resources, both Canadian and LNG volumes declined**

As seen, in the early years of the past decade, the U.S. received most of its imported natural gas from Canada with LNG imports providing additional supplies. The U.S. was, and has remained, an exporter of gas to Mexico, with those volumes growing in recent years. As time passed and America’s natural gas output grew due to the exploitation of shale resources, both Canadian and LNG volumes declined.

**That monthly volume is about 10% more than Canada’s daily average natural gas production during 2015**

In recent years, the exploding growth of natural gas output from the Marcellus region, cheap gas has been flowing north into Canada’s Ontario province at the expense of western Canadian gas supply. The most recent data from the Energy Information Administration (EIA) for August shows the Marcellus producing 16.4 billion cubic feet (Bcf) per day of natural gas. That monthly volume is about 10% more than Canada’s daily average natural gas production during 2015. The problem for the Marcellus producers is that there has been a problem with takeaway pipeline capacity to other regions of the United States, primarily the Southeast and Midwest. Although

**As cheap Marcellus gas flows into Ontario, it limits the market opportunities for Alberta, British Columbia and Saskatchewan natural gas supplies**

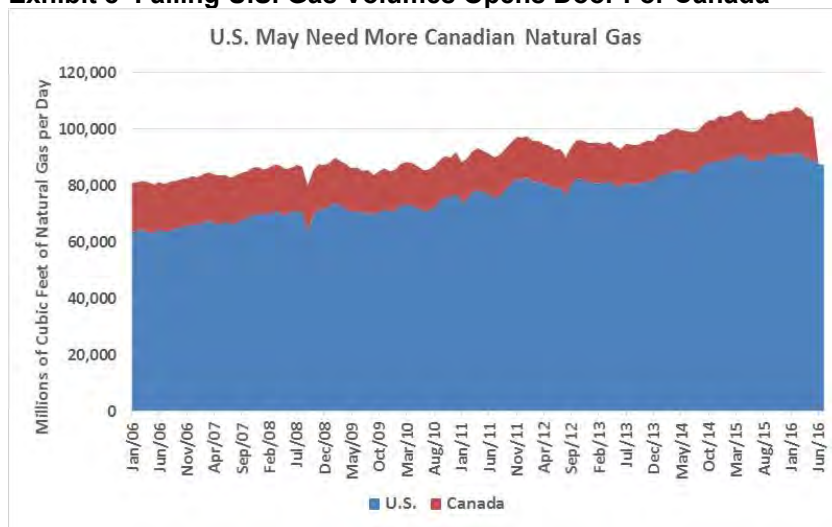
**TransCanada announced it was willing to cut its transportation tariff roughly in half**

gas use in the Northeast continues to grow, the opposition to constructing more pipelines into the region have limited Marcellus output to the region, forcing it to find other markets to supply. As a result of these pipeline capacity issues, often times the wellhead price for gas produced in the Marcellus falls to a fraction of its value in other producing and consuming markets.

One market outlet that Marcellus gas has found attractive is Ontario Province across the St. Lawrence Seaway from New York State. As cheap Marcellus gas flows into Ontario, it limits the market opportunities for Alberta, British Columbia and Saskatchewan natural gas supplies, and certainly has had the effect of depressing the wellhead price that producers in those provinces can realize in order to compete. Recently, natural gas from wells in certain areas of the Marcellus was sold for \$0.25 per thousand cubic feet (Mcf) compared to Henry Hub prices at that time in excess of \$3.00/Mcf.

To try to counter the growth of Marcellus gas in Ontario, TransCanada (TRP-NYSE), the operator of a major west-to-east natural gas pipeline network in Canada announced it was willing to cut its transportation tariff roughly in half for the portion of its pipeline network that is idle, assuming producers will commit to shipping 1.5 billion cubic feet (Bcf) per day of supply for 10 years with an option to cancel the agreements early. Those terms are much more lenient than the normal terms of 15-20 year terms and non-cancellable contracts. The current pipeline tariff from Alberta to Southern Ontario is C\$1.41 per Gigajoule. TransCanada is proposing a new tariff somewhere between C75 cents and C82 cents, down from the range of C82- cents to C\$1.10 suggested when the company first floated the idea of a lower tariff to generate greater shipments about a month ago.

**Exhibit 8 Falling U.S. Gas Volumes Opens Door For Canada**



Source: National Energy Board, EIA, PPHB

**Canada may have an opportunity to ship more natural gas to the United States in the coming months**

From an overall perspective, U.S. natural gas production is falling due to the lack of associated natural gas from oil wells as that drilling effort has been reduced in response to low global oil prices, and the normal reservoir decline rates from existing dry natural gas wells. That means that Canada may have an opportunity to ship more natural gas to the United States in the coming months. On the other hand, with the Marcellus region being takeaway-capacity limited, producers in that region may become more aggressive in trying to gain greater market share in Ontario.

**The Ontario market situation would be quite different had environmentalists in the U.S. not fought and successfully derailed several key pipeline capacity expansion efforts designed to add capacity to service the Northeast natural gas market**

While the petroleum industry has always been dependent on logistics for its development – seldom is oil and natural gas found close to consuming markets. Natural gas, however, is totally dependent on pipelines because of its gaseous quality. That dependency means natural gas producers are always at risk of being held hostage to the operators of pipelines. While pipeline operators have no reason to battle the producers, especially in an era where they are merely transporters of the hydrocarbons from the well to the consumer, their role has been identified as mission-critical by the environmentalists fighting the war against fossil fuels. The Ontario market situation would be quite different had environmentalists in the U.S. not fought and successfully derailed several key pipeline capacity expansion efforts designed to add capacity to service the Northeast natural gas market. Natural gas producers and gas pipeline operators will seek to exploit every market opportunity available to them. The battle beginning between TransCanada and Marcellus gas producers will not end soon, unless other markets open up that provide more attractive profit opportunities for Marcellus supplies. Declining U.S. production may become the wildcard in this market.

## **A Different From Usual Driving Trip Home From Rhode Island**

**We hoped to see the fall colors splashed throughout the mountains**

In contrast to our normal routine in driving between our homes in Houston and Rhode Island, we took extra time to drive through the mountains of Virginia and North Carolina – along the Skyline Drive and the Blue Ridge Parkway. We hoped to see the fall colors splashed throughout the mountains, but it wasn't until the second day that we got to see the reds, yellows and oranges of the leaves. Unfortunately, those views were accompanied by heavy rains and, at times, dense fog that made driving the curvy mountain roads difficult while also obscuring the scenic overlook views.

**We saw heavy truck traffic in only a couple of locations during the journey – Connecticut and Pennsylvania**

From an economic point of view, we saw heavy truck traffic in only a couple of locations during the journey – Connecticut and Pennsylvania. There were times in Virginia and Mississippi when traffic bunched up, but it seemed to result from a couple of trucks attempting to pass each other that caused the traffic to backup. The most amazing observation to us was the lack of police presence anywhere. Occasionally you see a federal ranger's or sheriff's car in the mountains, but the largest number of police cars – three - we

**This was the least police presence we can ever recall seeing**

saw was monitoring traffic at a construction site in Alabama. Other than those units, we seldom saw a police car. Since this was the least police presence we can ever recall seeing in our long history of making these drives, we wondered whether it had to do with changes in policing the interstates in response to either the economy or the highly publicized risk during traffic stops. We don't know, so we can only speculate.

**We were shocked to see the huge cranes and concrete support structure for the new bridge and the extensive amount of the highway already constructed over the river leading to and away from the bridge**

As we came around the Interstate 287 highway curve leading from White Plains, New York, and heading toward the Tappan Zee Bridge that spans the Hudson River, we were shocked to see the huge cranes and concrete support structure for the new bridge and the extensive amount of the highway already constructed over the river leading to and away from the bridge. The new bridge, when completed, will dwarf the older bridge, which will eventually be torn down. That will be an interesting emotion for us, having crossed the Tappan Zee Bridge when it was originally built, saving the time of driving further north to cross the Hudson at Bear Mountain, a short distance below the military academy at West Point. The new Tappan Zee Bridge will not make the trip any shorter distance-wise, but it will be easier, as well as helping river traffic given the higher clearance for ships.

**We experienced an increase in the number of near-misses with distracted drivers – often trailer trucks**

Surprisingly, there were only a few construction sites along the rest of the route that slowed us down, but that didn't stop the traffic backups caused by imaginary factors when you finally are released from the jams. We experienced an increase in the number of near-misses with distracted drivers – often trailer trucks. We also held our breath driving through the stretch of Interstate 10 east of Houston where we always seem to encounter drivers with death wishes! They all seem to be cars driven by young people.

**We then noticed that they were escorting two Trump/Pence decorated buses**

During the afternoon of our first day, as we were driving south on I-81 in northern Virginia, we saw several police cars with flashing lights on the other side of the highway heading north. We then noticed that they were escorting two Trump/Pence decorated buses. We speculated that they might hold Mike Pence and his entourage as the vice presidential debate had been the prior night. We later learned from the news that he was coming from an afternoon rally in Harrisburg, Virginia and was heading to an evening rally in Gettysburg, Pennsylvania.

**As we drove those roads, we noticed there were Trump/Pence signs and bumper stickers everywhere**

After our first day on the Skyline Drive and Blue Ridge Parkway, we ventured off onto back roads through the Shenandoah Valley to Hillsville, Virginia to spend the night. As we drove those roads, we noticed there were Trump/Pence signs and bumper stickers everywhere. We could not find a Clinton sign. Then again, that was conservative Republican country, in contrast to the Democratic Virginia stronghold in the bedroom towns surrounding Washington, D.C. The next morning as we drove more Virginia country roads back to the entrance to the Blue Ridge Parkway, we spotted a lone



**Exhibit 9. Our Route: Skyline Drive And Blue Ridge Parkway**



Source: irresponsibilityengine

**That was the only Clinton sign we saw in our four days of travel**

Clinton campaign sign. In fact, that was the only Clinton sign we saw in our four days of travel. Amazingly, as pointed out by a friend with whom we had lunch in Rhode Island the day before leaving to come home, there were lots of Trump/Pence campaign signs and bumper stickers throughout the state and no Clinton signs. That was an amazing sight given the staunchly Democratic orientation of Rhode Island politics.

**The survey had several flaws: it surveyed the rest areas at 10 am in the morning, when most trucks are on the road; and it extrapolated the survey count over seven days rather than the five-day workweek**

Even though the truck traffic wasn't as much in many areas as we expected, it was heavy enough that we noticed the truck stops and rest areas being packed by early evening. Seeing all those parked trucks in Pennsylvania reminded of a local media article we read discussing the shortage of overnight truck parking spaces and the need for the state to build more. In the past ten years, Pennsylvania has conducted numerous studies documenting a shortage of truck parking spaces along the state's interstate highways. With the new work rules for drivers limiting their daily hours for driving and growth of the trucking business, the need for additional parking spaces is growing and state officials are clamoring to build them. We have commented in numerous *Musings* describing our driving trips of seeing trucks overflowing the rest areas, lining up on entrance and exit ramps, and overflowing at regular truck stops. It was interesting to read a competing study from the truck stop operators association that conducted a survey of parked trucks in highway rest stops and concluded that there was no parking shortage. However, the survey had several flaws: it surveyed the rest areas at 10 am in the morning, when most trucks are on the road; and it extrapolated the survey count over seven days rather than the five-day workweek,



**We noticed is that these three trucks and the extra-long long trailer (several hundred feet long) took up more than half the length of the rest stop, meaning there was less room for other trucks**

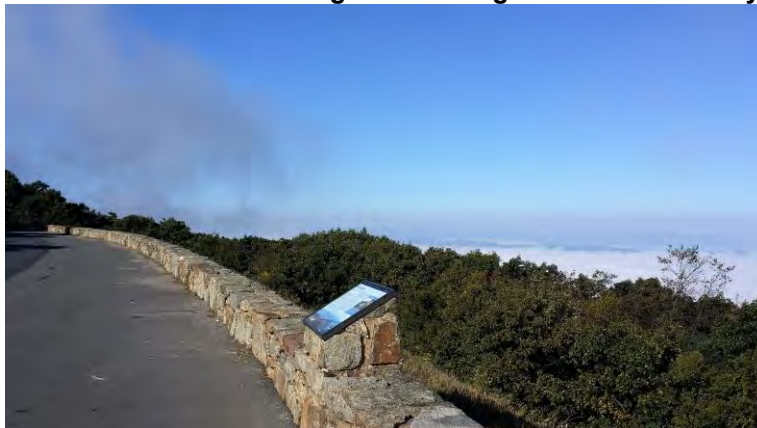
**We ate at two local restaurants along the way – one on Mount Mitchell in North Carolina, the tallest peak east of the Mississippi River**

which increased the number of estimated empty parking spots each day. We guess the truck stop operators don't want increased competition from the State of Pennsylvania.

One sight at a rest stop that added to our concern about the potential shortage of truck parking spaces was observing an extremely long trailer hauling a wind turbine blade to its final location. Because of the length of the truck and trailer, it required vehicles in front and behind to warn drivers of the hazard. What we noticed is that these three trucks and the extra-long long trailer (several hundred feet long) took up more than half the length of the rest stop, meaning there was less room for other trucks. It may have prevented upwards of half a dozen trucks from parking in that rest area. We never saw another wind turbine blade being moved, so we don't know whether this was a regular route or not. If it is, we can see how these units could significantly distort the truck parking situation, possibly forcing drivers to drive illegally in order to find a safe parking space. That is a prescription for more truck accidents, a phenomenon that is happening. Between 2004 and 2013, the registered truck fleet grew from 8.2 million units to 10.6 million. The growth of the fleet has been accompanied by more truck accidents.

As this was not our normal trip route, so too did it cause us to alter our eating habits. We ate once at a Cracker Barrel – lunch on our last day. In Meridian, Mississippi, at a few minutes after noon, we actually had to wait for a table. In contrast, our one stop at McDonald's was for a late lunch so there was no crowd. We ate at two local restaurants along the way – one on Mount Mitchell in North Carolina, the tallest peak east of the Mississippi River. Unfortunately, given the fog and rain, there wasn't much of a view beyond about 10 feet! The other local spot was an Italian restaurant located in a shopping center about two miles from the hotel. All the local restaurant choices were in that shopping center, as our alternative location was a half-an-hour drive to the next town.

#### **Exhibit 10. Above The Fog Overlooking Shenandoah Valley**



Source: PPHB

**Earlier that day, as we drove west on I-40, we saw caravans of utility trucks heading east to help with recovery efforts once Hurricane Matthew passed**

One of the lasting impressions came at the end of our second day on the Blue Ridge Parkway when we reached Asheville, North Carolina. We exited the Parkway in order to reach Interstate 40 and reduce the time to our hotel. Throughout most of the day we experienced the early wrath of Hurricane Matthew, which was moving up the East Coast from Florida. The storm brought wind and rain. Earlier, when we stopped at the Blue Ridge Music Museum, the ranger on duty there asked us where we were heading. When we told her we planning to drive down the rest of the Blue Ridge Parkway, she suggested we consider getting off because the weather would be getting worse. She also suggested we should make sure we had a hotel reservation. We tried that morning, but in the mountains cell phone signals are sparse. We tried booking through the hotel apps on our cell phones but found no rooms available in either Knoxville or Chattanooga, Tennessee. We did find a room in Cleveland, about 30 miles north of Chattanooga, but while we were on hold with the hotel staff, someone booked the room. We did find a room in Athens, about 20 miles further north than Cleveland. When we arrived at the hotel that evening, it was totally sold out due to evacuees from the hurricane. Earlier that day, as we drove west on I-40, we saw caravans of utility trucks heading east to help with recovery efforts once Hurricane Matthew passed.

**While we always enjoy observing the changing of the seasons in the Shenandoah Valley area, the rain made it a less than enjoyable experience this time**

It was an interesting trip home. Had we not run into Hurricane Matthew, we might have added an additional day to our trip in order to enjoy the scenery. While we always enjoy observing the changing of the seasons in the Shenandoah Valley area, the rain made it a less than enjoyable experience this time. The absence of all but a small handful of oil-related vehicles between Pennsylvania and Texas was both surprising, but not completely unexpected given the two-year old oilfield recession we have been living through. In thinking about our trip north next spring, we wonder what will be the country's mood toward the economy and our politics. Hopefully, the oil business will be healthier than it is right now.

## California Updates Autonomous Car Testing Regulations

**The bill, sponsored by Democratic Assemblywoman Susan Bonilla, allows testing in Contra Costa County, northeast of San Francisco, of the first full-autonomous vehicle without a steering wheel, brake and accelerator pedals, or an operator**

After the U.S. Department of Transportation issued its guidelines for how to regulate the testing and approval of autonomous vehicles, California updated its testing regulations making them more consistent with the federal rules. California Governor Jerry Brown (Dem) signed a bill into law approving the changes on September 29<sup>th</sup>. The bill, sponsored by Democratic Assemblywoman Susan Bonilla, allows testing in Contra Costa County, northeast of San Francisco, of the first full-autonomous vehicle without a steering wheel, brake and accelerator pedals, or an operator. That vehicle description is the key difference between the prior regulations for the testing of autonomous vehicles in the state and the new rules. In fact, at the time California issued its initial testing regulations, some of the companies leading the development of autonomous vehicles, in particular Google (GOOG-Nasdaq) were shocked that the

**In completing its testing loops through the office park, the vehicle involved in this test would cross a public road, which, under the prior rules, would have been illegal**

vehicles to be tested required a steering wheel, brake and accelerator pedals, and a licensed driver, things the company planned to eliminate from day one. Now, a company can test any type of autonomous vehicle.

Several of the media stories announcing the newly passed legislation focused on how the California rules were modified to comply with the federal government's guidelines. In reality, the new legislation, while it makes those changes, was driven by specific issues related to a testing location and not in response to bringing California's testing rules into compliance with the federal guidelines. The Contra Costa County project was set up to test an autonomous vehicle built by the French company Easymile at the Bishop Ranch office park in the city of San Ramon. The project was on hold awaiting the passage of the bill. The reason it was on hold is that under the prior California autonomous vehicle testing rules, a driverless vehicle without the required equipment and an operator could be tested on private land such as the Bishop Ranch office park. However, in completing its testing loops through the office park, the vehicle involved in this test would cross a public road, which, under the prior rules, would have been illegal. With the new law in place, the two cube-like Easymile shuttles that travel no faster than 25 miles per hour, do not have a steering wheel, brake or accelerator pedals, or an operator can now be tested for a period of up to six months before being deployed and used by people. Twenty-five miles per hour is not much faster than the average golf cart, a vehicle used extensively in gated golf communities and many retirement communities, but they do require an operator to run.

#### **Exhibit 11. Cube-like Autonomous Vehicle To Be Tested**



Source: Easymile

The Easymile vehicle pictured in Exhibit 11, looks more like the shuttle cars used by automated trains at many airports for moving people between one terminal and another. They are not the image of autonomous vehicles being popularized by most of the 15

**Easymile has many tests ongoing throughout Europe as well as in Japan and Dubai**

companies developing these vehicles and approved for testing them in California. Easymile has many tests ongoing throughout Europe – Norway, France, the Netherlands, and Finland – as well as in Japan and Dubai. Numerous people associated with the development of autonomous vehicles believe that they will be initially employed on campuses and in business parks and other controlled environments that have less traffic and fewer distractions than busy urban streets.

**This is a key component of Ford Smart Mobility, the company's plan to become a leader in autonomous vehicles, as well as in connectivity, mobility, the customer experience, and data and analytics related to personal transportation**

In mid-August, Ford (F-NYSE) announced its intent to have a high-volume, Society of Automotive Engineers-defined (SAE) level 4-capable fully autonomous vehicle in commercial operation in 2021 in a ride-hailing or ride-sharing service. This is a key component of Ford Smart Mobility, the company's plan to become a leader in autonomous vehicles, as well as in connectivity, mobility, the customer experience, and data and analytics related to personal transportation. To achieve this goal, Ford has announced four key investments and collaborations designed to expand its strong research in advanced algorithms, 3D mapping, LiDAR, and radar and camera sensors. LiDAR refers to Light Imaging, Detection, And Ranging, and is a technology that measures distance to a target by illuminating that target with a laser light. It was reportedly a failure with this technology that contributed to the deadly Tesla (TSLA-Nasdaq) vehicle crash several months ago.

**The company plans to design an autonomous vehicle that will operate without a steering wheel, brake or gas pedals, and that it will be used primarily in commercial mobility services**

According to Ford's press release announcing the investments and collaborations, the company plans to design an autonomous vehicle that will operate without a steering wheel, brake or gas pedals, and that it will be used primarily in commercial mobility services such as ride sharing and ride hailing and confined to specific geo-fenced areas. That means areas that have had their roads completely mapped electronically. To take the first step in executing its plan, in early September, Ford announced it had purchased Chariot, a San Francisco-based commuter ride-sharing shuttle startup that will become the cornerstone of the company's plan to address growing urban congestion.

**The lowest level has no autonomous technology whatsoever – you drive it totally**

Ford states that it plans an SAE-defined level 4-capable vehicle, which means it removes the control of the vehicle from the hands of the driver in most instances. SAE has established six classifications for vessel autonomy systems, from Level 0 to Level 5. The lowest level has no autonomous technology whatsoever – you drive it totally. Each additional autonomous level adds increasingly sophisticated technology until the top level is reached, in which computers handle everything and the passengers in the vehicle are strictly along for the ride at all times.

Level 0 would be the equivalent of Ford's Model T. Today, Ford, like most automobile manufacturers, is at Level 2, which means vehicles have lots of active safety systems like blind spot monitoring, parking assist, pedestrian detection, and adaptive cruise controls, but the driver is always in charge. When you go to Level 3, the vehicle can

**With Level 5 technology, all human involvement is eliminated as well as geographic restrictions – you are along for the ride!**

steer, maintain proper speed, and make decisions like when to change lanes, but the expectation is that the driver will be able to take over the operation of the vehicle if necessary or desirable. At Level 4, or full autonomy, the vehicle does everything and human involvement is restricted to emergency situations, however, the driving range is restricted to highly-controlled geographies. With Level 5 technology, all human involvement is eliminated as well as geographic restrictions – you are along for the ride!

**Ford’s autonomous vehicle plan is to skip Level 3**

Ford’s autonomous vehicle plan is to skip Level 3 because of the great challenge with this technology of how to safely transfer control of the vehicle from the computer to the driver such as in an emergency situation. It is important to note that this is a critical requirement of the federal government guidelines for how autonomous vehicles need to work and what standards the computer software controlling the vehicle must meet.

**Audi says that based on its tests, it takes an average of three to seven seconds, and potentially as long as ten seconds, for a driver to acknowledge and take control of the vehicle, even with flashing lights and verbal warnings**

The challenge in Level 3 is that the technology becomes a balancing act between providing drivers with the benefits of autonomy - like not having to pay attention - yet ensuring that drivers are ready and able to grab the steering wheel should the vehicle encounter a problem the computer cannot handle. Auto manufacturer Audi says that based on its tests, it takes an average of three to seven seconds, and potentially as long as ten seconds, for a driver to acknowledge and take control of the vehicle, even with flashing lights and verbal warnings. If the vehicle is traveling at 60 miles per hour, or 88 feet per second, a lot can happen in the time-span between when a driver learns he needs to seize control and when he can begin bringing the vehicle to a stop or maneuver it in such a way as to avoid the problem.

**They found that 64% of respondents preferred to be in “full control” of their vehicle at all times**

What is fascinating about the evolution of autonomous vehicles is the difference in view of the capability of this technology among auto manufacturers and technology experts. The latter are much less sure that truly autonomous vehicles can be produced before 2030, or even later. This difference in views does not even begin to address the public’s view, which is not in favor of self-driving cars. According to a late September survey by *Kelly Blue Book*, they found that 64% of respondents preferred to be in “full control” of their vehicle at all times. The overwhelming majority of respondents, 80%, want to have the option to take manual control over an autonomous vehicle. These two responses are interesting since autonomous vehicles are being pushed for their safety benefits – eliminating crashes and the deaths and injuries associated with them – that arise from the distractions and poor judgements of human drivers. The survey showed that 51% of respondents prioritize personal control while 49% prioritize collective safety when it comes to autonomous vehicles.

The *Blue Book* survey also found that nearly 60% of respondents would buy a car with Level 3 automation or higher if given options



**The problem with Level 4 vehicles is that they are limited to geographic areas that are well mapped**

across all levels of automation by 2020. The most popular choice among the respondents would be for Level 4 technology, which has the capacity for full autonomy but still allows for manual user input. The problem with Level 4 vehicles is that they are limited to geographic areas that are well mapped, meaning such as the small area of downtown Pittsburgh where Uber ride service is testing self-driving taxis. These survey results reinforce the view of autonomous vehicles initially as urban cars and not for universal service.

**We have yet to figure out how that can occur if the autonomous vehicle doesn't have a steering wheel, brake or gas pedal**

All auto manufacturers working to develop autonomous vehicles are working to develop human machine interface systems that will overcome the issue of safely transferring control of the vehicle from computers to human drivers. We have yet to figure out how that can occur if the autonomous vehicle doesn't have a steering wheel, brake or gas pedal. While Ford wants to start its autonomous vehicle product at the level that skips any general operation of the vehicle by a human, it is really looking at a pod-type unit similar to that of Easymile. Maybe Ford would be better off just buying Easymile.

**His judgement is significant because Carnegie Mellon has been working to develop autonomous vehicles since the 1980s**

An article in *Automotive News* on autonomous vehicles points out that "...experts say a fully automated vehicle that is 100 percent safe 100 percent of the time and can operate on any street in any weather condition in the U.S. is not right around the corner. It's a decade or more down the road." The expert referred to is Raj Rajkumar, co-director of the General Motors-Carnegie Mellon Autonomous Driving Collaborative Research Lab. His judgement is significant because Carnegie Mellon has been working to develop autonomous vehicles since the 1980s.

**"Self-driving cars can only do what programmers tell them to do."**

There are two major challenges for autonomous vehicles – software and infrastructure. In the case of software, a vehicle needs to be programmed to recognize and react to virtually every possible situation in all sorts of weather. As Mr. Rajkumar puts it, "We as humans have common sense and reasoning powers that we apply, and most of the time, if not always, we do the right thing. Computers, though very powerful, are unfortunately lacking in common sense." He went on to say, "Self-driving cars can only do what programmers tell them to do. They can't anticipate everything that can happen on the road."

**For a vehicle to drive itself safely in all conditions and at all speeds, it needs to know where it is at all times so it can anticipate events such as a stop sign around a corner**

Potentially the greatest challenge for autonomous vehicles is improving and modernizing the infrastructure. We are talking about improving lane markings and all forms of traffic signals and signs. In addition, vehicle-to-vehicle and vehicle-to-infrastructure communication systems need to be elevated to state-of-the-art status. For a vehicle to drive itself safely in all conditions and at all speeds, it needs to know where it is at all times so it can anticipate events such as a stop sign around a corner. A great investment play may be the companies that paint roads since lane markings will need to be refreshed much more frequently than is done now.

The *Automotive News* article listed the status of many auto companies working on autonomous vehicles, which is an interesting read in of itself.

“Never! – Porsche and Ferrari.

“No set date; adding partial systems – Subaru, Toyota and Honda.

“Doing advanced safety systems – Mazda and Mitsubishi.

“By 2020 – Volvo and Nissan.

“By 2030 – Hyundai and Kia.

“Um, maybe - Volkswagen: I.D. concept features retractable steering wheel for self-driving mode

“Early 2020s - Mercedes-Benz and Ford.”

**An automobile represents the second largest consumer expenditure after the purchase of a home**

The optimists are always optimistic. They always assume that a new technology will emerge and then swell as early adopters demonstrate its success. From then on it becomes more a matter of the developers being able to satisfy demand. That pattern has been repeated numerous times with consumer products as well as social media tools and novelty items that generate tremendous media buzz. In the case of autonomous vehicles, despite vehicle leasing being more readily accepted, we are talking about significant consumer expenditure. In fact, an automobile represents the second largest consumer expenditure after the purchase of a home. It is difficult to believe that jumping on a technology fad is how people will choose their next automobile. Couple that conservatism with respect to choosing automobiles with the Blue Book survey results that, along with other surveys, show the public is not comfortable with autonomous vehicle technology, and you have a scenario for a much longer adoption phase than the optimists are predicting. We will keep watching to see if any of these factors change.

## LED Highway Lights Criticized Over Light Quality

**Cities have converted about 10% of their highway lights to LED lights**

Cities that have installed or are considering installing new light emitting diode (LED) highway lights are taking another look at that decision in light of a recent warning from the American Medical Association (AMA) about the health issues the lights may create for drivers and residents. Currently, cities have converted about 10% of their highway lights to LED lights, primarily switching from high pressure sodium (HPS) lights. They are considering accelerating the pace of conversion, or at least they were until the AMA's health warning.

**LED lights require no warm up time and have a rapid “turn on and off” at full intensity capability**

The advantages of converting to LED lights are numerous. First, they consume about 50% less energy than HPS lights. LED lights require no warm up time and have a rapid “turn on and off” at full intensity capability. They are able to fully turn on immediately after power is restored after having been lost. LED lights have much longer lifespans – 15-20 years, or 50,000 hours, some 2-4 times the lifespan of HPS lights – reducing the maintenance cost of having to

**Exhibit 12. LED Highway Lights May Cause Health Issues**

Source: (Ethan Miller/Getty Images) *Washington Post*

**LED lights do not contain mercury or lead and thus do not release any toxic substances if damaged, unlike mercury or HPS lights**

replace bulbs more frequently. Also, LED lights do not contain mercury or lead and thus do not release any toxic substances if damaged, unlike mercury or HPS lights. Many of these positives for LEDs are why cities have been switching to them, and also why LEDs are taking market share from compact fluorescent light (CFL) bulbs, which do contain mercury and produce harsh light qualities, in household and commercial applications.

While there are many positives for LEDs, the AMA looked at the light output quality and the potential health impact. The AMA committee that examined the issue and issued the health warning explained in great detail how LED lights operate and how they may impact humans and nocturnal wildlife by increasing glare and disrupting the circadian rhythm of humans.

**This light increases glare for drivers and can create long-term health issues for residents**

According to the AMA report, "LED lighting is inherently narrow bandwidth, with 'white' being obtained by adding phosphor coating 18 layers to a high energy (such as blue) LED. These phosphor layers can wear with time leading to a 19 higher spectral response than was designed or intended." The AMA said that excess blue and green emissions from LEDs can increase light pollution. The light pollution comes because the LED wavelengths scatter more within the eye, creating detrimental health and glare effects. How these detrimental effects may be mitigated comes from understanding the light range of LED lights and their characterization by their correlated color (CCT) temperature index. The lights are measured by their heat, or kelvin (K), rating, although it is really not heat as much as a measure of light brightness. Daylight is equivalent to 6500K, while HPS lights have CCT ratings of 2100K. Most of the highway LED lights are 4000K, in which 29% of its light spectrum is emitted as blue light, which the human eye perceives as a harsh white color. This light increases glare for drivers and can create long-term health issues for residents.

**The health problems cited relate to the disruption of the human circadian rhythm that can be detrimental to sleep quality**

Interestingly, the energy efficiency of 3000K lights is only 3% less than 4000K, but the light is perceived as more pleasing to humans and it produces less of an impact on wildlife. The AMA cited many cities where the residents have complained about the 4000K LED lights and are demanding that they be replaced. Many cities are changing them out in response. The health problems cited relate to the disruption of the human circadian rhythm that can be detrimental to sleep quality. This problem can also come from television and computer screen light in the evening. The AMA also stated, "Although data are still emerging, some evidence supports a long-term increase in the risk for cancer, diabetes, cardiovascular disease and obesity from chronic sleep disruption or shiftwork and associated with exposure to brighter light sources in the evening or night."

**If you haven't shopped for light bulbs lately, expect to see much more emphasis on the quality of the light emitted by the more energy-efficient light bulbs – both CFLs and LEDs**

The AMA committee recommended that LED lights be adopted for their energy efficiency and related reduction in the use of fossil fuels. It also recommended that the lowest blue-output LED bulbs be utilized. It encouraged the use of 3000K or lower light bulbs for outdoor installations such as highways, and that they be properly shielded to minimize glare and harmful human and environmental effects. If you haven't shopped for light bulbs lately, expect to see much more emphasis on the quality of the light emitted by the more energy-efficient light bulbs – both CFLs and LEDs. How many cities will be replacing the early LEDs they installed remains to be seen, but we expect most will over time. More LED lights will lead to reduced electricity consumption. Hopefully, the move won't harm the population's health.

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