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Industry Brief

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Energy: Energy Stat of the Week

Energy Stat: Are Electric and Autonomous Vehicles Heading Down the Road to Peak Oil Demand?

Most of our readers, it's safe to say, would rather have us predict oil prices over the next 24 hours than the next 24 years. While we generally stay away from making ultra-short-term trading calls, we are equally averse to throwing out forecasts that extend decades into the future. If you want to read opinions/guesses on where oil prices will be in, say, 2040, there are several options to choose from: EIA, IEA, etc. We are not about to join that club, but we will take this opportunity to provide some thoughts about an increasingly common topic of discussion: when will global oil demand peak? This is a relevant question for energy investors who are making decisions with a long-term timeframe in mind. We would not discourage anyone from taking this issue into consideration. But we want to make our view crystal-clear: while peak oil demand is something that will eventually happen, it is exceedingly unlikely to materialize within what the vast majority of investors would consider an investable timeframe. While it would be rather silly (and academic) for us to specify a particular year, we are comfortable stating that there is no realistic way that global oil demand can peak until after 2025 at the earliest, and more likely beyond 2030.

There are as many predictions out there for when oil demand will peak as there are for who will win an Oscar.
In November 2016, the CFO of Shell stated on the earnings call: "We've long been of the opinion that demand will peak before supply. And that peak may be somewhere between five and 15 years hence, and it will be driven by efficiency and substitution, more than offsetting the new demand for transport." Notice the extremely wide range; in Shell's view, the peak of global oil demand can materialize anytime from 2021 to 2031. Would you like to guess which end of that range the media focused on? Not surprisingly, reporters like to make a splash – we don't blame them – hence this headline from Bloomberg: "Energy Giant Shell Says Oil Demand Could Peak in Just Five Years." Technically true, but not exactly the most balanced summary of what was said. Earlier this year, moreover, Shell's CEO also explained that a peak is unlikely until the late 2020s.

When Will Global Oil Demand Peak? Here Are Some Guesses

Bloomberg New Energy Finance	2025
ExxonMobil	Beyond 2040
IEA	Beyond 2040
McKinsey	Around 2030
OPEC	Between 2029 and 2040
Royal Dutch Shell	Between 2021 and 2031
World Energy Council	2030
Raymond James	Beyond 2025

Source: Bloomberg, FT, IEA, McKinsey, Raymond James research

Shell's forecast is one of numerous such forecasts, from companies as well as public-sector organizations, some of which are shown in the adjacent table. Interestingly, Exxon's forecast matches the IEA's – and both are more optimistic (for oil demand) than OPEC's. The nice thing about all these forecasts from the standpoint of the people issuing them is that there is no way they can be proven wrong for a minimum of five years, and typically a decade or more. It's a bit like trying now to predict the result of the U.S. presidential election in 2028: nothing we say could possibly be disproven anytime soon. The bottom line is that these are all guesses, nothing more.

Does oil demand have to eventually peak?
There is no law of nature that dictates that global oil demand must eventually reach a peak and then begin an irreversible decline. The well-known "law" of Hubbert's Peak applies to supply, not demand, and the advent of modern technology (fracking, horizontal drilling, enhanced recovery, etc.) has led to a fundamental rethink of whether oil supply will peak after all. In this context, we see comments such as the one from Shell, suggesting that peak demand will come first, rendering peak supply a moot point.

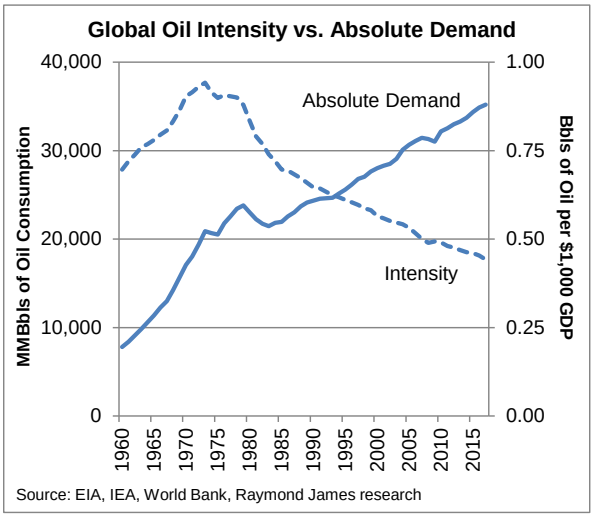
There is no direct historical precedent for worldwide demand for a major energy commodity to peak on a sustained basis. (Sorry, whale oil doesn't count.) Despite all of the regulatory and other headwinds, for example, global consumption of coal is still growing. But it is true that there is precedent for national and even regional demand to peak. Coal demand in Europe peaked in the 1960s, and has since fallen to substantially lower levels. Oil demand in Japan peaked in the 1990s. Oil demand in Europe peaked more

Please read domestic and foreign disclosure/risk information beginning on page 8 and Analyst Certification on page 8.

recently, in 2006, one year after the U.S. By definition, a peak is something that can only be known in retrospect, but with a decade having passed, it seems abundantly clear that European oil demand will never get back to its pre-2006 levels. With regard to the U.S., the situation is less clear-cut because of the demand recovery in recent years, but 2005 may well be the all-time peak. The theory of peak global oil demand holds that when enough parts of the world reach a peak, a global peak will result, because the few places still growing will not be enough to offset the decliners. In this sense, the theory is conceptually valid. Thus, we would not argue with the notion that peak oil demand is a matter of time. The real question is: how much time?

Oil intensity is steadily declining… and yet global oil demand continues to rise.

Economic growth and rising oil consumption (and energy consumption more broadly) go hand in hand. The relative rate of change between the two mostly depends on where a country is in its economic development. Oil intensity – a metric that readers of our research will surely be familiar with – is defined as oil consumption per unit of economic output (GDP). In the early stages of development, countries build energy-intensive manufacturing bases, and oil consumption increases faster than overall GDP growth. As economies mature, oil intensity peaks and begins to decline, for two key reasons. First, maturing economies typically shift from energy-intensive manufacturing to less energy-intensive service sectors. Second, more advanced economies tend to be more energy-efficient across the board.



Over the past half-century, the world in aggregate has seen more economic development than in all the previous centuries combined – that is hardly a revelation. What's more intriguing is that decline in oil intensity – that is to say, greater efficiency of how oil is consumed – has accompanied the economic boom for the vast majority of that time, as shown in the adjacent chart. With the exception of the financial crisis year of 2009 – when global GDP briefly fell more steeply than global oil demand – the last time that oil intensity did not show decline was all the way back in 1976. Conventional wisdom may hold that oil intensity only started improving due to, for example, the proliferation of U.S. and European auto efficiency mandates in the 1990s. In actuality, oil intensity has declined nearly every year for the past four decades. It is hard to find any trend in the oil market that is more durable and consistent than this one. Again, let's underscore that what we are looking at here is a global average. There are, of course, variations from country to country. In the U.K., for example, oil intensity peaked in 1969, whereas in India it didn't peak until 2000. But the overall decline in global intensity is taking place at a steady pace, basically linear since around 1985.

Avg. Growth in Global Oil Demand	
1960-1970	8.2%
1970-1980	3.0%
1980-1990	0.6%
1990-2000	1.4%
2000-2010	1.4%
2010-2016E	1.4%

Source: EIA, Raymond James research

Despite the nearly four consecutive decades of declining oil intensity, global oil demand has grown every year since 1982, with the exception of (not surprisingly) 2008 and 2009. At the risk of stating the obvious, the lesson here is that falling oil intensity does not imply an absolute decline in oil consumption, as long as GDP is growing enough. In fact, history shows us that, while there is certainly variability from year to year (and country to country), there has been remarkable consistency in the trajectory of global oil demand over the past quarter-century. As shown in the table, demand growth has averaged 1.4% per year thus far this decade, identical to the 2000s and the 1990s. And given that oil intensity is declining at a fairly linear rate, there is no reason to envision an imminent breakdown of the relationship between GDP and oil demand. Assuming that oil intensity continues to decline at its 20-year annualized average of 0.0075 barrels per $1000 per year, it will take approximately 30 years for it to drop by half from the current level of 0.45 barrels per $1000.

Is there about to be a game-changer that will drastically accelerate the decline in oil intensity?

The many decades of declining oil intensity encompass a complex, interconnected series of trends in vehicle ownership, driving habits (including fleet management), mass transit availability, engine technology, automotive and aircraft design (remember, not all oil goes to gasoline), petrochemical production (ditto), and substitution to fuels other than petroleum. Even more broadly, the nature of the modern economy and social structure (e.g., an aging population) has changed in countless ways during this time. All of this has been happening, and yet growth in global oil demand has remained steady over the past quarter-century.

Only two things can disrupt this long-standing paradigm. Either (1) global GDP growth must slow down sharply, or (2) the relationship between oil consumption and GDP must break down. In short, the argument that global oil demand is on the cusp of peaking depends on the emergence of a game-changer. It is not enough to say that "cars will get smaller," or "more aircraft will

deploy winglets," or "biofuel blending ratios will rise further." Something has to happen that's truly out of the ordinary, beyond what we've been accustomed to over the past several decades. We will not attempt to provide our own long-term forecast for GDP growth – that's far outside our expertise – but we don't see any rational basis for arguing that the global economy will grow at a dramatically slower rate over the next two decades than over the past two. The growth drivers can certainly shift – for example, more emphasis on India and Africa rather than China – but we think that the OECD's forecast for 3.1% to 3.4% annualized growth in global GDP for the period 2020-2040 (marginally slower than the 3.6% assumption for 2010-2020) is broadly reasonable.

As we think about potential game-changers for oil intensity, the most frequently cited candidate is electric vehicles. Even after six years of robust sales growth, their penetration is minimal (aside from a handful of countries). In the next section, we will address the question: how long will it be before EVs can displace needle-moving amounts of global oil demand? We will also address the even more long-term/theoretical question of how autonomous driving is likely to impact oil demand.

Even under an aggressive EV sales scenario, all of the world's EVs on the road by 2025 will displace only 1.6 million bpd.
In March 2016, we published our first-ever forecast of the effect of EV sales on oil demand. That forecast (which we recently updated) ran to 2020, and today we extend it to 2025 (with the obvious caveats). When it comes to quantifying how much oil demand EVs will displace, here are some simplifying assumptions. We assume that every new EV is displacing a conventional vehicle with better-than-average fuel economy (30 miles per gallon). We also assume that all new EVs purchased in 2012 and later years will remain on the road indefinitely. Finally, we assume annual usage of 12,000 miles per car.

As shown in the following table, our 2017 estimate for global EV sales is 1.2 million – the first year, as it happens, above the one-million mark. For some perspective, global car sales totaled ~77 million in 2016, and should be slightly higher in 2017. Combining EV sales in 2017 with all of the EVs sold in prior years, the cumulative impact on global oil demand stands at 80,000 bpd. Taking our analysis through 2020 – the furthest we can go without getting into the realm of total guesswork – we project a cumulative impact of 270,000 bpd. That is to say, if our sales forecast proves accurate, every EV sold worldwide, between 2012 and 2020, will have the aggregate effect of displacing 270,000 bpd of petroleum demand, which would shave off 0.25% from global oil demand by 2020.

Electric Vehicle Sales (000's)											2025 Scenarios		
	2012	2013	2014	2015	2016	2017E	2018E	2019E	2020E		Low	Mid	High
China	NA	11	60	189	352	528	760	1,072	1,479				
Europe	38	67	100	159	222	310	416	545	697				
U.S.	53	97	119	114	157	226	309	414	546				
All Other	33	36	39	23	44	97	188	328	533				
World	**124**	**211**	**318**	**485**	**774**	**1,162**	**1,673**	**2,358**	**3,255**		**9,000**	**13,500**	**18,000**
% Change		**71%**	**51%**	**53%**	**60%**	**50%**	**44%**	**41%**	**38%**	**(per year)**	**23%**	**33%**	**41%**
Est. Cumulative Displacement of Global Oil Demand (Mbpd)						**80**	**124**	**185**	**270**		**1,085**	**1,350**	**1,598**

Source: EDTA, EV Sales, Raymond James research

All right, let's do some guesswork. How should we attempt to forecast EV sales into the next decade? There is a wide range of variables, such as (1) how quickly battery costs will drop; (2) how consumer preferences may change; (3) the extent to which EV charging infrastructure gets deployed; and (4) whether EVs will become mainstream in emerging markets other than China. The only reasonable approach, in our view, is to assume a market share. This, of course, raises the question of what total car sales will be in 2025. Our working assumption is 90 million cars, up from ~77 million in 2016, equating to annualized growth of around 1.5%. In the table above, we show three scenarios: the "low" scenario assumes EVs at 10% of global car sales, the "mid" scenario is 15%, and the "high" (aggressive) scenario is 20%. For context, the 2016 global average was 1%, with only one country – Norway – above 10%. Our forecast for 2020 is 4%, quadrupling over four years. Our mid-case forecast for 2025 implies another quadrupling over five years.

Even under the aggressive scenario, all of the world's EVs on the road by 2025 would displace only 1.6 million bpd of oil demand. To clarify, this is **not** the incremental impact of the sales during the year 2025. That figure is much smaller: 470,000 bpd under the aggressive scenario. If global oil demand in 2025 were to grow on par with our medium-term forecast of 1.0 million bpd without taking into account the impact of EVs, then EVs could theoretically cut that growth rate in half. That is needle-moving, though still not transformative. Into the second half of the 2020s, we cannot rule out the possibility that EV penetration could, under some circumstances, ramp up to a level that cancels out much of the growth in global oil demand, eventually leading to a demand peak. However, we think that a more realistic timeline for a peak on this basis would be beyond 2030.

Above and beyond passenger cars, there is an even more early-stage market for electric buses. (We wrote about one such company, Proterra, earlier this year.) The impact here would be on diesel rather than gasoline demand. Given the very small size of the electric bus market everywhere except China, it is currently too early to quantify the impact, but it is something to keep an eye on.

Autonomous driving: Is this another long-term megatrend that could lead to a peak in oil demand?

Autonomous driving is undoubtedly a hot theme in the tech sector. Last week, investor interest in this theme went into overload due to a high-profile M&A deal. For a broad-based perspective on autonomous driving, we would encourage readers to check out our colleague Tavis McCourt's recent report. What we will focus on here is the much narrower question of how the emergence of self-driving vehicles is likely to impact oil demand.

First, let's emphasize that self-driving vehicles can have any powertrain. Autopilot software may lead some people to associate self-driving vehicles with EVs, but there is no inherent linkage. What is more directly relevant from the standpoint of oil demand is that self-driving vehicles can operate more efficiently. The reason, quite simply, is that a computer's artificial intelligence can make driving decisions both more rapidly and more accurately than a human. Acceleration, braking, idling at a traffic light: all of these functions can, in principle, be made more efficient (i.e., less fuel usage) with a computer at the proverbial wheel. Thus, conceptually speaking, the read-through from autonomous driving for oil demand seems, more likely than not, to be negative. However, there may also be some offsetting factors. For example, what if autonomous driving encourages people to use their cars more? It is possible that some current users of public transport will see autonomous driving as a good alternative. Just as commuters can check email or eat breakfast while on a bus or train, they could do the same thing while sitting in a self-driving vehicle. Many more cars on the road would actually translate into more fuel usage, even if each one is slightly more efficient than before.

There are two difficulties when trying to quantify any of this. First, it is simply too speculative to predict how much more efficient, in aggregate, self-driving vehicles will eventually be. Any such analysis will hinge on context-specific variables: the driver with certain habits and preferences, the car with its autonomous capabilities, the city with its traffic pattern, etc. Second, and more relevantly for us, true autonomous driving is not remotely realistic anytime soon. As outlined by Tavis McCourt, autonomous emergency braking should become a standard feature for vehicles sold in industrialized markets by 2025, but vehicles with fully autonomous functionality (what's known as Level 4 and 5) will only start shipping in the middle of the next decade. Thus, any resulting impact on oil demand would not show up in a meaningful way until the late 2020s or even later. And, to state the obvious, the timing will hinge on not only the pace of technological evolution but also the required regulatory changes. If regulators retain their current skepticism towards autonomous driving, all of this may get pushed out even further in time.

Conclusion

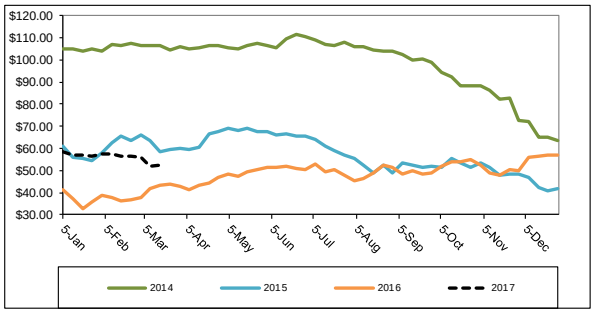
Amid huge changes in the global economy and how energy is consumed, growth in global oil demand has proven resilient, averaging 1.4% per year thus far this decade, on par with the average of the prior two decades. This growth has materialized despite the long-term trend of declining oil intensity. Simply extrapolating from historical trends, global oil demand could grow sustainably towards mid-century. The mainstreaming of electric vehicles is set to eventually become a game-changing trend that has the potential to cancel out much of the growth in global oil demand in the long run. However, even under aggressive EV sales assumptions, this would not happen until after 2025, and more likely, after 2030. Any impact on oil demand from autonomous driving is also unlikely to become significant until the late 2020s. Thus, we see no chance of global oil demand peaking within an investable timeframe.

Raymond James Weekly Oilfield Review

For Week Ending: 3/17/2017

12 Month Oil Calendar Strip

Brent

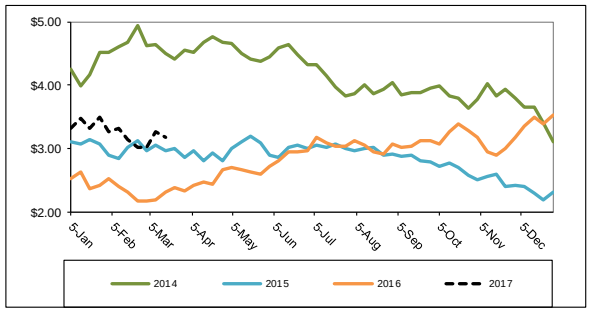


	This Week	Last Week	Beginning of Year	Last Year
Price	$52.30	$52.03	$58.34	$43.81
Percent Change		0.5%	-10.4%	19.4%

Source: Bloomberg, Raymond James

12 Month Gas Calendar Strip

Henry Hub



	This Week	Last Week	Beginning of Year	Last Year
Price	$3.19	$3.27	$3.33	$2.38
Percent Change		-2.6%	-4.2%	33.8%

Source: Bloomberg, Raymond James

	17-Mar-17 This Week	10-Mar-17 Last Week	18-Mar-16 Last Year	Change From: Last Week	Change From: Last Year
1. U.S.Rig Activity					
U.S. Oil	631	617	387	2.3%	63.0%
U.S. Gas	157	151	89	4.0%	76.4%
U.S. Miscellaneous	1	0	0		
U.S. Total	**789**	**768**	**476**	**2.7%**	**65.8%**
U.S. Horizontal	658	639	369	3.0%	78.3%
U.S. Directional	61	61	49	0.0%	24.5%
U.S. Offshore	19	20	27	-5.0%	-29.6%
U.S. Offshore Gulf of Mexico					
Fleet Size	97	97	116	0.0%	-16.4%
# Contracted	31	32	45	-3.1%	-31.1%
Utilization	32.0%	33.0%	38.8%	-3.1%	-17.6%
U.S. Weekly Rig Permits *	673	828	389	-18.7%	73.0%
2. Canadian Activity					
Rig Count	276	315	69	-12.4%	300.0%
3. Stock Prices (3/17/17)					
OSX	168.1	166.8	163.2	0.7%	3.0%
S&P 500	2,380.7	2,372.6	2,049.6	0.3%	16.2%
DJIA	20,914.5	20,903.0	17,602.3	0.1%	18.8%
S&P E&P Select Index	5,559.6	5,505.9	4,700.0	1.0%	18.3%
Alerian MLP Index	317.3	320.2	274.3	-0.9%	15.6%
4. Inventories					
U.S. Gas Storage (Bcf)	2,242	2,295	2,478	-2.3%	-9.5%
Canadian Gas Storage (Bcf)	450	471	504	-4.4%	-10.7%
Total Petroleum Inventories ('000 bbls)	1,338,993	1,346,825	1,316,390	-0.6%	1.7%
5. Spot Prices (US$)					
Oil (W.T.I. Cushing)	$48.78	$48.44	$39.44	0.7%	23.7%
Oil (Brent)	$51.78	$51.35	$41.20	0.8%	25.7%
NGL Composite	$23.20	$24.54	$18.33	-5.5%	26.6%
Gas (Henry Hub)	$2.95	$3.04	$1.91	-3.0%	54.5%
Residual Fuel Oil (New York)	$7.48	$7.73	$4.36	-3.2%	71.8%
Gas (AECO)	$1.91	$1.99	$1.15	-4.0%	66.1%
UK Gas (ICE)	$5.22	$5.20	$4.58	0.4%	14.0%

Sources: Baker Hughes, ODS-Petrodata, API, EIA, Oil Week, Bloomberg, Raymond James

** Note: Weekly rig permits reflect a 1 week lag*

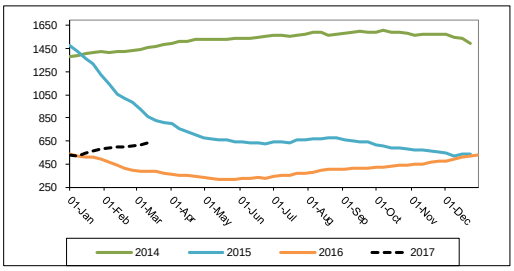
U.S. Rig Count Breakdown

	3/17/2017	3/10/2017	W/W Δ	YTD Δ	YTD % Δ	Y/Y Δ	Y/Y % Δ
Total Count							
U.S. Rig Count	789	768	21	131	20%	313	66%
By Basin*							
Permian	304	305	(1)	42	16%	155	104%
Eagle Ford	77	75	2	28	57%	29	60%
Cana Woodford	69	67	2	9	15%	26	60%
Bakken	42	38	4	9	27%	11	35%
Marcellus	39	39	0	2	5%	10	34%
Haynesville	37	37	0	9	32%	23	164%
DJ Basin	24	23	1	1	4%	11	85%
Utica	21	21	0	2	11%	11	110%
Pinedale	9	9	0	0	0%	2	29%
Uinta	9	7	2	5	125%	8	800%
Arkoma Woodford	9	6	3	5	125%	6	200%
Mississippi Lime	9	3	6	3	50%	2	29%
Granite Wash	8	8	0	-7	-47%	3	60%
Powder River Basin	7	8	(1)	-2	-22%	6	600%
Piceance Basin	6	5	1	2	50%	4	200%
San Joaquin Basin	4	4	0	1	33%	-1	-20%
Barnett	3	2	1	1	50%	1	50%
Fayetteville	1	1	0	0	0%	1	NM
Other	111	110	1	21	23%	5	5%
Drill For							
Oil	631	617	14	106	20%	244	63%
Dry Gas	74	72	3	18	31%	46	164%
Wet Gas	83	79	4	8	10%	22	36%
Miscellaneous	1	0	1	0	0%	1	0
Trajectory							
Horizontal Oil	530	516	14	102	24%	232	78%
Horizontal Gas	128	123	5	24	23%	57	80%
Horizontal	658	639	19	126	24%	289	78%
% Horizontal	83%	83%	0%	3%		6%	

Source: Baker Hughes, Inc, Raymond James research

Includes all trajectories

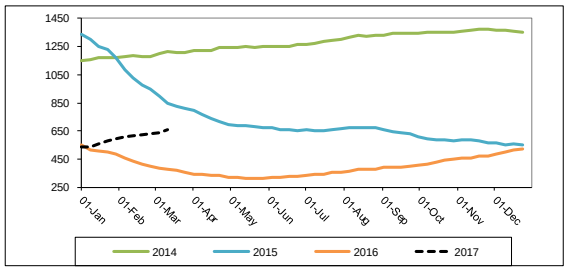
Oil Rig Count



	This Week	Last Week	Beginning of Year	Last Year
Rig Count	631	617	525	386
Percent Change		2.3%	20.2%	63.5%

Source: Baker Hughes

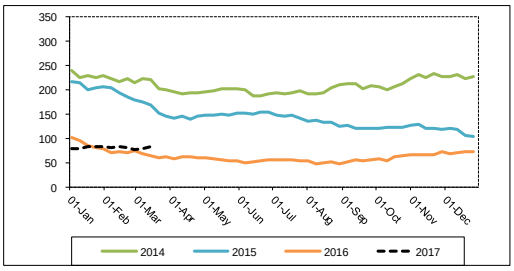
Horizontal Rig Count



	This Week	Last Week	Beginning of Year	Last Year
Rig Count	658	639	532	375
Percent Change		3.0%	23.7%	75.5%

Source: Baker Hughes

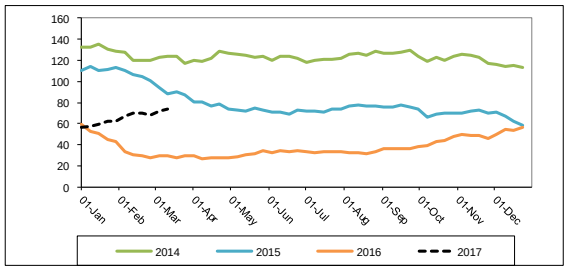
Wet Gas Rig Count



	This Week	Last Week	Beginning of Year	Last Year
Rig Count	83	79	75	64
Percent Change		4.4%	10.0%	29.0%

Source: Baker Hughes

Dry Gas Rig Count



	This Week	Last Week	Beginning of Year	Last Year
Rig Count	74	72	57	30
Percent Change		3.5%	30.8%	148.9%

Source: Baker Hughes

Company Citations

Company Name	Ticker	Exchange	Currency	Closing Price	RJ Rating	RJ Entity
Exxon Mobil Corp.	XOM	NYSE	$	82.00	4	RJ & Associates
Royal Dutch Shell	RDSb.L	AMS	€	24.55	3	RJEE/RJFI

Notes: Prices are as of the most recent close on the indicated exchange and may not be in US$. See Disclosure section for rating definitions. Stocks that do not trade on a U.S. national exchange may not be registered for sale in all U.S. states. NC=not covered.

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	Coverage Universe Rating Distribution*				Investment Banking Distribution			
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Market Perform (Hold)	44%	27%	41%	32%	10%	16%	0%	0%
Underperform (Sell)	5%	1%	0%	14%	4%	0%	0%	0%

* Columns may not add to 100% due to rounding.

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