
MUSINGS FROM THE OIL PATCH

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

As Oil Prices Fluctuate, Attention Shifts To Natural Gas

Natural gas, on the other hand, has always been an after-thought in the media's coverage of the global petroleum industry

Recently, the media's attention has been riveted on the volatile pattern of global crude oil prices. Much of the current volatility is due to geopolitical news, something the media relishes as it helps make front page headlines. Natural gas, on the other hand, has always been an after-thought in the media's coverage of the global petroleum industry. Unfortunately, it has often been an after-thought even within the industry. Why is natural gas so boring? Is it because prices move in increments of pennies rather than dollars, so the headlines are considerably less dramatic? Equally as important is that market shifts require longer time horizons before becoming obvious, frustrating our instant-response society. For the media, it equals reporting on paint drying.

The month kicked off with Royal Dutch Shell plc and its partners in the LNG Canada project reaching a Final Investment Decision

Given the dynamics of the global natural gas industry, October is turning out to be a notable month in the industry's history as we are seeing new supply announcements for the first time in a long while. The month kicked off with Royal Dutch Shell plc (RDS.A-NYSE) and its partners in the LNG Canada project reaching a Final Investment Decision (FID), which will facilitate moving immediately to begin construction. As a first step, LNG Canada will build Cedar Valley Lodge, a workforce accommodation center adjacent to the construction site with a capacity of housing up to 7,500 workers in single-room accommodations. The facility will provide bus transportation to the work site to reduce the number of automobiles on the road, address road safety issues, and reduce carbon emissions.

LNG Canada is to be built in Kitimat, British Columbia and will be supplied with natural gas from the province delivered through the 670-km (420 miles), 2.1 Billion cubic feet per day (Bcf/d) Coastal GasLink pipeline to be constructed, operated and owned by

Exhibit 1. Rendering Of LNG Canada Facility

Source: LNG Canada

Each of the companies involved in the project will be responsible for providing its own natural gas supply and will individually offtake and market its share of the LNG

TransCanada Corporation (TRP-NYSE). The pipeline will be built with the capability of being expanded to 5 Bcf/d, and should be in service in 2023. The LNG facility will initially export gas from two processing units (trains) with a combined capacity of 14 million tons (Mt) annually, equal to about 1.9 Bcf/d, with the potential to double its output. Each of the companies involved in the project will be responsible for providing its own natural gas supply and will individually offtake and market its share of the LNG.

Shell Canada Energy, a subsidiary of Royal Dutch Shell, owns 40% of LNG Canada and is the project operator. Earlier this year, Malaysia's national oil company, Petroliaam Nasional Berhad (Petronas), through its Canadian subsidiary, North Montney LNG Limited Partnership (NMLLP), purchased a 25% ownership interest in the project. Other partners include PetroChina Kitimat LNG Partnership, a subsidiary of PetroChina Canada Ltd., which, in turn, is a wholly-owned subsidiary of PetroChina Company Ltd. (PTR-NYSE), who will own 15%. Diamond LNG Canada Ltd., a subsidiary of Mitsubishi Corporation (MSBHY-OTC) owns 15%, and Kogas Canada LNG Ltd., owned by Korean Gas Corporation has 5%.

Shell has been a global leader in the industry since 1964, and with its acquisition of BG Group, now operates about 20% of the world's LNG vessels

Each of the partners in LNG Canada is active in the global natural gas business. Shell has been a global leader in the industry since 1964, and with its acquisition of BG Group, now operates about 20% of the world's LNG vessels and has LNG supply projects either in operation or under constructions in 10 countries. Petronas has long been involved in the Asian natural gas business. It is one of the largest natural gas reserve owners in Canada, and was actively pursuing a separate LNG export project, but rejected it in favor of partnering with LNG Canada. PetroChina is China's largest oil and gas producer and supplier, and has launched three LNG import facilities in China. Mitsubishi Corporation is Japan's largest trading

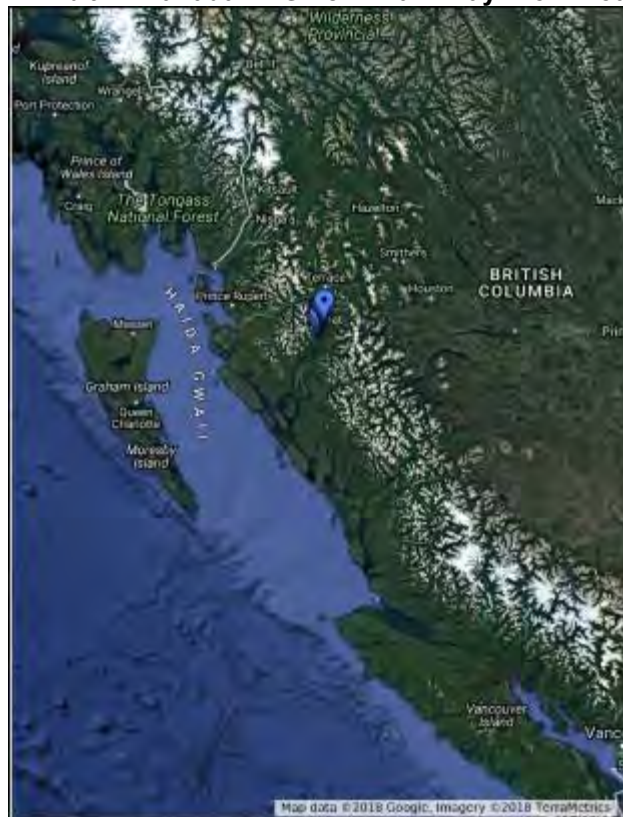
Korea Gas Corporation is the world's largest LNG importing company

company with more than a 50% share of LNG imported into Japan. It has been involved in LNG since 1969 and has an interest in 11 LNG export projects globally. Korea Gas Corporation is the world's largest LNG importing company and South Korea's principal LNG provider, operating four import terminals and a nationwide pipeline network in South Korea and another terminal in Mexico.

Woodfibre has sold all of its first phase output and has financing in place for the project's construction

The extensive industry experience of the participants in LNG Canada, or, in the case of PetroChina, a major player in the soon-to-be-largest LNG importing country, speaks to the blossoming global gas business. In fact, it was only a few weeks after Shell's announcement that Woodfibre LNG, a project in Squamish, British Columbia, backed by Indonesian billionaire Sukanto Tanoto's RGE Group, indicated it would become Canada's second LNG project to move forward. A relatively small project at 2.1 Mt (300 million cubic feet per day) of natural gas, it still has some final hurdles to overcome, but they appear surmountable by yearend, with construction to start in the first quarter of 2019. Importantly, Woodfibre has sold all of its first phase output and has financing in place for the project's construction. It has also secured its gas supply and is working with FortisBC on a 47 km (29 mile) pipeline connection to the plant site.

Exhibit 2. Canada LNG Terminal Away From Coast



Source: Google

It still anticipates being the first to export LNG, as its project has only a four-year construction timeline, putting its first cargo at sea in 2023, while LNG Canada expects to be shipping LNG in 2025

Woodfibre LNG, like LNG Canada, was approved in 2016, but sharply changed natural gas market conditions caused both projects to be delayed. Woodfibre LNG was thought to be the leader in the development of Canada's LNG business. It still anticipates being the first to export LNG, as its project has only a four-year construction timeline, putting its first cargo at sea in 2023, while LNG Canada expects to be shipping LNG in 2025. These two projects may be among the first of a number of new LNG projects that will receive FID approvals in the next year. All of them will be delivering LNG starting in the mid-2020s. LNG Canada is the first new greenfield LNG project to achieve FID status in five years, a reflection of the challenges the petroleum industry has experienced over the past few years with LNG economics.

The world has a huge resource base of natural gas, although we continue to find the large deposits in regions remote from developed economies

October also witnessed the initial shipment from the eighth of nine major Australian LNG projects begun nearly a decade ago as part of a \$200 billion LNG investment boom. In December, Shell is preparing to ship LNG from its offshore floating facility, Prelude, which is the ninth project. We have also seen initial shipments from Russia's expanded Yamal LNG terminal traversing the Arctic Ocean to Asia, shortening the normal delivery time from 30 to 15 days.

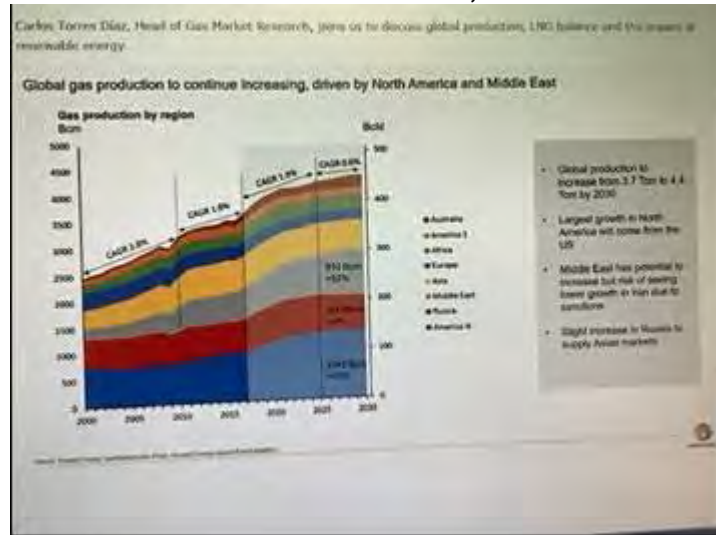
The recent Canadian LNG project announcements showcase the global natural gas industry's entry into a new era

Today, the world is moving toward a lower carbon-intensity energy mix, meaning fueling economies will involve increased use of renewable energy, nuclear power and natural gas, all at the expense of coal usage. Fortunately, the world has a huge resource base of natural gas, although we continue to find the large deposits in regions remote from developed economies and those countries with large populations that need the gas. This means those countries will continue to rely on dirty fuels, hurting their climate and the health of their residents.

Virtually every forecast of the future of the global energy business foresees natural gas playing a larger role. The recent Canadian LNG project announcements showcase the global natural gas industry's entry into a new era. That era will be marked with many new mega LNG projects gaining investment approval in order for the industry to overcome the projected LNG market tightness starting in 2022-2024, and making sure there will be adequate supplies to meet market demand out to 2030.

During a recent webinar by Rystad Energy's Head of Gas Market Research, he showed a forecast calling for global natural gas production to grow from 3.7 trillion cubic meters (Tcm) in 2017, or approximately 358 Bcf/d, to 4.4 Tcm, or 425 Bcf/d, by 2030. Most of the production growth will come from North America, with the Middle East being another major source of additional gas supply. Rystad expects small amounts of additional production coming from Russia and Australia.

Exhibit 3. Global Gas Growth Slows, But Still Grows



Source: Rystad Energy, PPHB

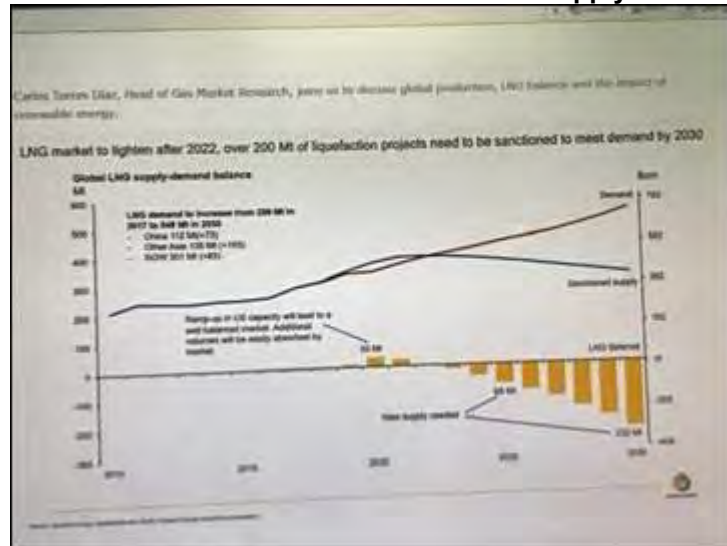
The primary demand driver will be China

The LNG market is projected to grow from 289 Mt in 2017 to 548 Mt in 2030. The primary demand driver will be China, where Rystad sees demand rising by 73 Mt over this time period. By 2030, China’s LNG consumption will account for slightly over 20% of global demand. Gas consumption in the rest of Asia will surpass China’s growth, but it is spread across numerous countries. The same is true for the rest of the world’s gas use, but again no one country matches China’s market share.

The LNG oversupply peaks in 2020, based on the start-up of new export terminals, and then declines, moving into a supply-shortage condition beginning in 2023

Based on the projected demand growth, the global gas market should be in surplus for the next several years, before tightening. Rystad presented a chart of projected global gas supply and demand that shows the market moving from a balanced state into an oversupplied condition during 2019–2022. The LNG oversupply peaks in 2020, based on the start-up of new export terminals, and then declines, moving into a supply-shortage condition beginning in 2023. That shortage grows steadily, reaching 232 Mt by 2030, which indicates the volume of new LNG exporting capacity needing to be developed over the next 5-7 years.

Exhibit 4. When LNG Market Needs More Supply

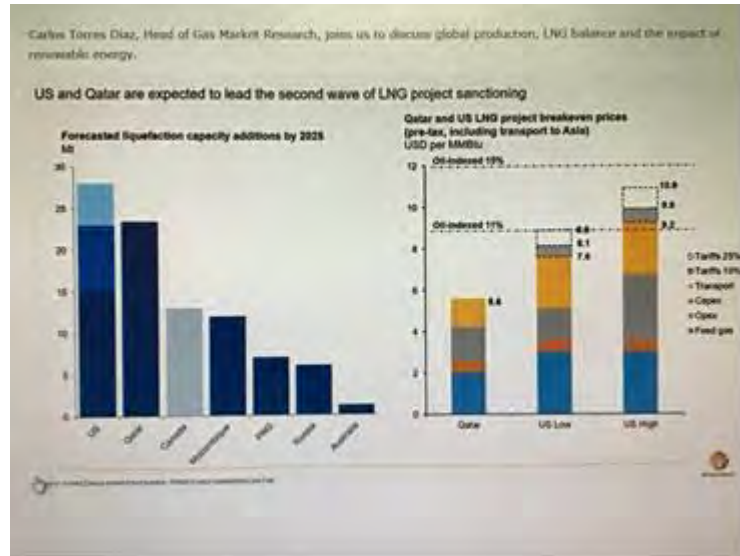


Source: Rystad Energy, PPHB

Of that additional capacity, over 29% will come from the United States, with Qatar adding 26%

Rystad showed potential LNG liquefaction capacity additions growing by 92 Mt by 2025. Of that additional capacity, over 29% will come from the United States, with Qatar adding 26%. With Canada's recent LNG project announcements and potential LNG projects in Mozambique added to those of the U.S. and Qatar, 85% of global capacity additions are accounted for by these four countries. Will all of these projects be constructed? Will the remaining 15% capacity expansion be built? More importantly, will these projects be built in time to meet the projected global demand growth?

Exhibit 5. Will Tariffs Derail U.S. LNG Growth?



Source: Rystad Energy, PPHB

A possible shortage of natural gas supply in China is one factor in the wildcard analysis

China may be a wildcard in the demand forecasts. While the government is pushing increased use of natural gas to mitigate the climate problems in many of its largest cities, last winter's weather forced the diversion of gas away from industry to meet heating needs. A possible shortage of natural gas supply in China is one factor in the wildcard analysis. There is also a question of how much of a shortage might be due to LNG issues (construction of import terminals) versus pipeline supply issues. Another ingredient in the LNG supply question is the imposition of Chinese tariffs on U.S. LNG in response to the trade war underway between the two countries. Will that trade war continue? It reportedly was a reason why Shell moved forward with its LNG Canada project rather than push development of another U.S. LNG export terminal.

In a scenario with a low-cost LNG export facility in the U.S. (low capital investment in the terminal), the U.S. project can be competitive even with a 25% Chinese tariff, i.e., a delivered LNG price at or below \$9 per million British thermal units

Rystad showed that although Qatar continues to have the lowest cost LNG, in a scenario with a low-cost LNG export facility in the U.S. (low capital investment in the terminal), the U.S. project can be competitive even with a 25% Chinese tariff, i.e., a delivered LNG price at or below \$9 per million British thermal units, which is in-line with an 11%-return for an oil-linked LNG pricing scheme. A high-cost U.S. project, even with a 25% tariff, would produce a price below that needed for a 15% oil-linked pricing return project. China threatened to implement a 25% tariff on U.S. LNG, but only enacted a 10% tariff. Did they understand what a 25% tariff might do to the economics for new LNG projects targeting the Chinese market? Those economic considerations are important given the current slump in Asian LNG pricing.

According to Reuters, gas traders say there are at least half a dozen tankers caught in this market swoon, each with a cargo worth upwards of \$200 million at current prices

Reuters is reporting that Asian LNG spot prices have fallen to more than a two-month low, due to rising supplies and weak demand. The latest December spot prices have fallen to \$10.20/mmBtu, which are reportedly the lowest they have been since August. A driver for the fall in LNG prices is Japan, which is expecting a warmer than normal winter that will lead to lower demand for LNG for heating. Japan is also in the process of restarting several of its nuclear reactors, potentially further reducing its reliance on LNG imports. The result of the price decline so far is that multiple LNG tankers are stranded in Malaysian and Singaporean waters as their cargoes remain unsold. According to *Reuters*, gas traders say there are at least half a dozen tankers caught in this market swoon, each with a cargo worth upwards of \$200 million at current prices.

At the same time, data and observations show China continuing to aggressively build new coal-fired power plants, especially in the remote provinces of the country. It is actively pushing increased electrification of its transportation sector – electric cars and high-speed rail. Will coal help relieve pressure on the gas demand situation, or only add to the pressure from environmental conditions?

Global gas will become a key market for the petroleum industry for the foreseeable future. If the forecasts for global gas demand prove

accurate, there needs to be a number of new LNG project FIDs approved soon. This is good news for engineering and construction companies, and construction workers, but it may be even better news for the global oilfield service industry that will need to find and develop the additional gas resources to fill the needs of these new LNG terminals.

Snow Globes And The 2015-2018 Energy Market

When the ball is shaken, it is suddenly filled with the snow crystals, creating the illusion of a winter snow white-out obscuring the scene inside

As we attempted to digest the ramifications from the broad sweep of energy news during the past week, we were struck by the image of a snow globe. If you are not familiar with these iconic winter holiday toys, they consist of a ball set on a flat base. Inside the ball is usually a wintery or holiday scene along with artificial snow crystals. When the ball is shaken, it is suddenly filled with the snow crystals, creating the illusion of a winter snow white-out obscuring the scene inside. Slowly, as the snow crystals settle, the scene inside becomes visible, eventually becoming completely clear.

Exhibit 6. A Representative Snow Globe



Source: Amazon

Since late 2014, when the Saudis shook up the energy snow globe, we have struggled to discern the scene inside. Last week's energy news may be a signal that the image is clearing. Although global

In some cases, to achieve the improved financial footing drastic actions, such as bankruptcy, were necessary

crude oil prices have bounced around a lot in recent months, they have been essentially trading in a range that affords profitability for exploration and production companies. We would define the range as between \$50 a barrel on the low end and \$80 on the high. While it is a wide range, it affords sufficient room for extreme volatility at times without forcing executives back to their drawing boards to revamp their plans.

The restructuring efforts over the past three years undertaken by energy companies have put them on firmer financial footing. There has been extreme pain felt throughout the energy sector as a result. In some cases, to achieve the improved financial footing drastic actions, such as bankruptcy, were necessary. The E&P industry is now starting to generate positive cash flows, which affords companies some capital for reinvestment, a badly needed development given the lack of investment during 2015-2017. Increased cash flows have enabled companies to reduce their debt and return cash to shareholders in the form of dividends and share repurchases. The industry's fundamental healing process is proceeding.

It was interesting to hear the CFO of BP plc (BP-NYSE) on the company's recent earnings conference call telling analysts that BP might pay the full \$11 billion cost for the E&P assets of BHP (BPP-NYSE) it is buying in cash. At the time the deal was announced, BP indicated it planned to pay 50% in cash and the other 50% with equity. In a matter of a few quarters, BP is generating sufficient cash flow to enable it to spend an additional \$5.5 billion in cash.

Moody's, recently issued a warning about the amount of debt weighing down the oilfield service industry

While many E&P companies are gaining ground on deleveraging their balance sheets from the era of high oil prices, they also are embracing the mantra of investors and Wall Street analysts to live within their cash flows and return a portion to shareholders. On the other hand, the debt rating agency, Moody's, recently issued a warning about the amount of debt weighing down the oilfield service industry. Their report targeted some of the offshore drilling companies, largely because that sector of the petroleum industry has lagged the recovery the most.

The more important point is that these deals are shifting more and more of the offshore industry's high-quality drilling assets into stronger hands

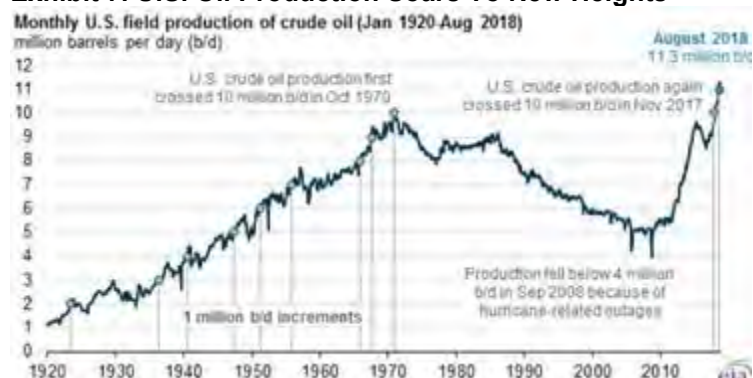
What we have seen in recent months from offshore drillers is several high-profile mergers/acquisitions. Yes, the debt levels of the acquiring companies may be higher than often thought appropriate, but they are generating cash, have debt maturity schedules with sufficient length and covenant terms permitting them to be managed properly. The more important point is that these deals are shifting more and more of the offshore industry's high-quality drilling assets into stronger hands. As a result, the drillers' customers (oil companies) will no longer be able to pit the rigs of multiple companies against each other to drive down contract day rates. Consolidation means fewer bidders. Rig day rates will be held up at higher levels than if some of these rigs were in the hands of

How significant are three major transactions in a matter of days?

financially-distressed owners forced to work them at whatever rate merely to generate cash flow. This is the most fundamental step in the industry's path to recovery.

Last week saw the announcement of a multi-billion-dollar oil and gas company acquisition every day! It started with Penn Virginia Corporation (PVAC-Nasdaq) being bought by Denbury Resources Inc. (DNR-NYSE) for \$1.7 billion. It was followed two days later by Chesapeake Energy Corporation (CHK-NYSE) buying WildHorse Resource Development Corporation (WRD-NYSE) for \$4 billion, and the next morning EnCana Corporation (ECA-NYSE) announced it would buy Newfield Exploration Company (NFX-NYSE) for \$7.7 billion. How significant are three major transactions in a matter of days? Share prices of the sellers are down, and more reflective of the value of the assets owned by the sellers. Cash flows have improved and prospects for further improvement are evident. Debt levels have been reduced. But, possibly more important, the role played by hedge funds proved key. They had purchased large blocks of distressed debt in many of these companies, and then forced financial restructurings, which ensured the funds would end up controlling the companies. Not wanting to be in the business of attempting to run an E&P company, the catalyst for change was present. These conditions spawn deals!

Exhibit 7. U.S. Oil Production Soars To New Heights



Year over year, crude oil production has grown by 2.1 mmb/d, a volume much stronger than imagined

It is also important to note that last week the Energy Information Administration (EIA) announced the latest industry oil and gas production data for August. Surprisingly, crude oil production soared to 11.346 million barrels a day (mmb/d), a 416,000 barrels per day (b/d) increase over the prior month and well above anyone's expectation. Year over year, crude oil production has grown by 2.1 mmb/d, a volume much stronger than imagined. Based on the latest data, HFI Research suggests that year-end production could reach 11.7 to 11.8 mmb/d, or 400,000 to 500,000 b/d higher than the firm's most recent forecast. While production growth should be slowing and then flatten in 2019 due to the oil egress issues in the Permian Basin, currently slowing drilling activity there, the global oil

market may be slightly looser than previously thought. The production data substantiates the oil output power of the United States and the benefits accruing to the domestic economy from the Trump administration's energy policies.

Exhibit 8. How Monthly Gas Output Compares To Weekly



Source: *Seeking Alpha*

On the natural gas front, the production data for August was also positive. The EIA in the “Natural Gas Monthly” for October stated the following:

“In August 2018, for the 16th consecutive month, dry natural gas production increased year to year for the same month a year ago. The preliminary level for dry natural gas production in August 2018 was 2,640 billion cubic feet (Bcf), or 85.2 Bcf/d. This level was 10.5 Bcf/d (14.0%) higher than the August 2017 level of 74.7 Bcf/d. The average daily rate of dry natural gas production for August was the highest for any month since EIA began tracking monthly dry natural gas production in 1973.”

The E&P industry consolidation signals a further cost-reduction wave that will increase cash flow generation capability and provide further strength for the industry to weather downside oil price volatility

The latest crude oil and natural gas production data supports the optimistic view of the opportunities that still exist in the United States for energy companies. The E&P industry consolidation signals a further cost-reduction wave that will increase cash flow generation capability and provide further strength for the industry to weather downside oil price volatility. Three consecutive quarters with the E&P industry living within its cash flow, while also returning cash to shareholders, holds promise that the debt-ravishing growth strategy of the past has been discarded. Solid profitable growth will win back investor interest in the sector.

While the oilfield service sector still has work to do on deleveraging balance sheets, we will not be surprised to see further consolidation in this sector beyond the handful of deals already announced. It may take additional bankruptcies to create the environment for

The snow crystals are settling and the view in the snow globe is one of a healthier energy business

consolidation, but knowing when that process will happen is impossible to forecast. Consolidations and bankruptcies will also lead to healthier balance sheets and profitable growth potential.

The snow crystals are settling and the view in the snow globe is one of a healthier energy business. Oil and gas prices are high enough to promote continued oilfield activity. Companies have streamlined so they are more efficient and have lower costs. Global oil and gas demand will need more U.S. exports providing an outlet for any near-term production gluts in the U.S. All of this suggests that there are still challenges and pitfalls on the road to higher share prices and healthier businesses, but the healing process has progressed. An industry recovery that had been held back by the deleveraging process of the past three years, is now gaining traction.

AVs And MaaS Clash, With City Life Potentially The Big Loser

We call those systems: buses, trains and airplanes

We are treated almost daily to media stories reporting on the maturing of autonomous vehicle (AV) technology and the social benefits of ride-hailing services, also known as Mobility-as-a-Service (MaaS). Most people recognize Lyft and Uber as the most popular MaaS, although others exist, and automobile companies are working to expand the public's choices. These two technologies are being touted as revolutionizing the global personal transportation sector, although the technologies have existed for decades, but just in a different form. We call those systems: buses, trains and airplanes. One could also add ships and ferries to the list. In many cities, taxis are another popular form of AV and MaaS, but they often don't create the most pleasant of transportation experiences. The same can also be said for buses, trains, airplanes and ferries.

These modern personal transportation systems are supposed to be safer – AVs don't have accidents so the public would avoid the estimated 50,000 vehicle deaths per year recorded. The problem of AVs and MaaS is suddenly becoming clear for city planners, and those living and working in the cities – congestion.

Yes, traffic congestion has always been a part of the modern city

Yes, traffic congestion has always been a part of the modern city. At one time, it was caused by the volume of horse-driven carriages, which made the city less desirable due to the piles of manure and gallons of urine covering the streets that pedestrians confronted every day. The advent of the horseless carriage cured that social ill. But it ushered in new ones – pollution and accidents, although the latter existed even with horse-driven carriages.

Congestion is up!

Now, AVs and MaaS will not only offer safer modes of travel, they will presumably do it at a lower per-mile cost than for a person owning and operating their own vehicle. We are now just beginning to see the results of the adoption of AVs and MaaS, although on a limited scale in cities. The results offer up points that might need to be rethought, or at least recalibrated. Congestion is up!

Lyft and Uber have accounted for 50% of the increase in the city's traffic between 2010 and 2016

According to the San Francisco Transportation Authority, Lyft and Uber have accounted for 50% of the increase in the city's traffic between 2010 and 2016. Investment firm ARK Investment Management LLC projects that autonomous taxi fleet networks could exacerbate the trend, boosting global traffic three-fold by 2030! What downsides does that trend bring? Likely, it means longer travel times, greater pollution, dirtier streets, and possibly less healthy residents. We already know, from surveys conducted in relation to the introduction of MaaS in certain cities in the United States, that people have given up walking and riding mass transit due to the ease and comfort of MaaS.

The MaaS trip growth rate was faster than the pace of decline in taxi trips

The ARK people pointed to recent transportation statistics for New York City, derived from data collected by the taxi regulatory agency, that showed how MaaS daily trips had surged over the past several years. Examining the daily data by type of service – MaaS and taxis – we found several very interesting trends. As shown in Exhibit 9, by the end of 2016, MaaS daily trips had overtaken the number of trips provided by taxis. From that point forward, the MaaS trip growth rate was faster than the pace of decline in taxi trips – in other words, total trips increased, meaning greater congestion.

Exhibit 9. How Ride-Hailing Has Added To NYC Congestion



Source: NY Taxi Authority, PPHB

In two and a half years, New York City saw taxi and MaaS rides grow from slightly over 500,000 per day to nearly 1.1 million

We calculated that between January 1, 2016, and June 30, 2018, the total number of daily trips provided by taxis and MaaS grew by 86%. However, if we measure the change up to the spring 2018 peak, there was essentially a 100% increase. That meant that in two and a half years, New York City saw taxi and MaaS rides grow from slightly over 500,000 per day to nearly 1.1 million. This analysis does not include the rides provided by luxury limos or green taxis, which primarily operate in the outlying boroughs of the city, but which do enter the core of the city. This magnitude of daily trips points to the growing congestion gripping New York City, leading to frustration for riders and pedestrians alike.

“One thing is certain: zero- or single-occupant vehicles are a bad thing”

If the AVs are used in the same way that today’s vehicles are – carrying a single person – they will lead to more congestion

To appreciate the impact of MaaS, note that from the beginning to the end of the two-and-a-half-year span, taxis went from accounting for 65% of the trips to only 28%. Clearly, the MaaS alternative has been received very positively, meaning the service quality, price and optionality have been well received. This also helps explain why the value of a taxi license (medallion), which at one time was worth \$1 million, and at times was more valuable than a seat on the New York Stock Exchange, has collapsed in value.

Work done by Peter Calthorpe, an urban planner based in Berkeley, California, who promotes mixed-use, walkable neighborhoods, challenges the assumptions behind the push for AVs and MaaS. He and transportation planner Jerry Walters wrote in an article in *Urban Land* in 2017 that “one thing is certain: zero- or single-occupant vehicles are a bad thing.” The reasons why they are bad is because “they cause congestion, eat up energy, exacerbate sprawl and emit more carbon per passenger-mile.” Therein lies the heart of the issue – the solo car trip.

AVs, as envisioned, can actually lead to more solo car trips and greater congestion. Why won’t people send an AV to pick up their groceries and dry cleaning while they stay at home doing other, potentially more important, or enjoyable, tasks? The result is that total vehicle miles traveled will increase, as well as there being more vehicles on the road.

Mr. Calthorpe acknowledges the popular claims for AVs – they will be safer than human-driven vehicles, but they will also lead to fewer cars, faster commutes and a radical rethinking of cities where parking is no longer a priority. Citing a number of transportation studies, Mr. Calthorpe has developed a computer model that can simulate the impact of AVs in urban settings. If the AVs are used in the same way that today’s vehicles are – carrying a single person – they will lead to more congestion. The key according to both Mr. Calthorpe and Mr. Walters is to increase the number of people per vehicle. While we haven’t seen any reference to the concept that AVs will open up personal transportation to people currently without access – the elderly, youths and people with disabilities – unless they have someone with them, their addition to the transportation system will definitely add to the vehicle miles traveled. Without achieving the goal of boosting the number of passengers per vehicle, AVs will merely increase congestion. The San Francisco and New York City taxi data suggest that the critics are on to something. Possibly AVs will not become as ubiquitous as their sponsors suggest, but rather they will become a solution for niche applications.

Pace Of EV Sales Up, Lifting Forecasts For Future Growth

Third quarter sales of electric vehicles (EVs) were strong. For the first nine months of 2018, the industry delivered 232,500 plug-in

The sales in the third quarter were helped by the strong deliveries of Tesla Model 3s

vehicles, an increase of 63% compared to the same period of 2017. Battery EVs (BEVs) accounted for a 63% market share, with the remaining 37% being plug-in hybrid EVs. The sales in the third quarter were helped by the strong deliveries of Tesla (TSLA-Nasdaq) Model 3s. Overall, EVs accounted for 1.8% of total light vehicle sales year-to-date, up from 1.2% in 2017.

Exhibit 10. U.S. EV Sales Soared In Q3



Source: EV Volumes.com

Close watchers of the EV market are projecting EV sales reaching a 3.5% market share in December, and 2.1% for all of 2018

Close watchers of the EV market are projecting EV sales reaching a 3.5% market share in December, and 2.1% for all of 2018. That forecast suggests 2028 EV sales of 365,000 units, an 82% increase over 2017. With a 2.1% market share, EVs in the United States are beginning to approach market shares achieved in other automobile markets.

The significance of Tesla cannot be underestimated. For the full year, Tesla may account for half of all EV sales in the United States. Counting only BEVs, Tesla cars could represent three of every four units sold this year. What will happen as Tesla is forced to live in a market with its investment tax credit for EV sales disappearing? There is also a question about the competitive landscape when other luxury car manufacturers – Audi, Mercedes and BMW – begin to deliver and expanded the array of EV models?

Exhibit 11. Without Tesla Where Would EVs Be?

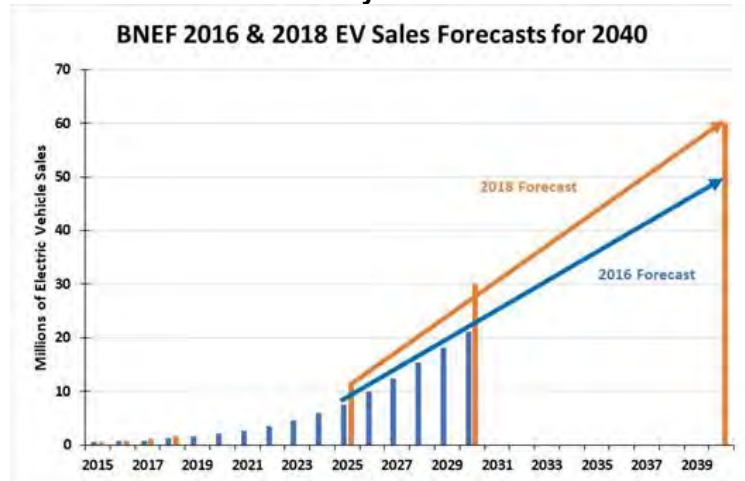


Source: EV Volumes.com

The increased acceptance of EVs, plus the continued push by politicians to tilt the playing field in favor of EVs over traditional internal combustion engine (ICE) vehicles, has forced increases in the projections

The increased acceptance of EVs, plus the continued push by politicians to tilt the playing field in favor of EVs over traditional internal combustion engine (ICE) vehicles, has forced increases in the projections of the penetration rate for EVs into the automobile market. We have seen sharply increased projections from traditional clean energy forecasters such as the Bloomberg New Energy Finance (BNEF) group and even the Organization of Petroleum Exporting Countries (OPEC). We will not be surprised to see these organizations further raise their forecasts when they release future projections.

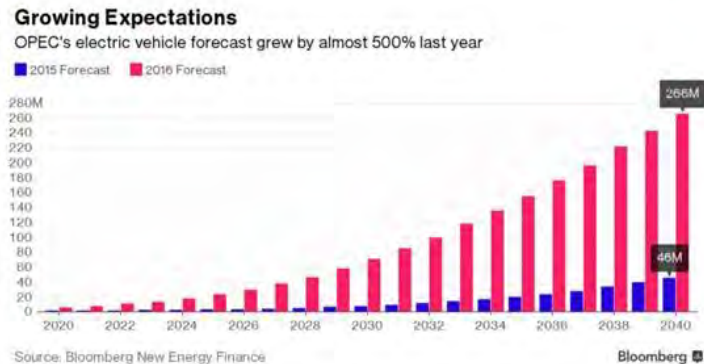
Exhibit 12. BNEF Sees Many More EVs In The Future



Source: BNEF, PPHB

With respect to the BNEF forecast increase between 2018 and 2016, it had the impact of increasing the slope of EV sales growth. We would note that the 2018 projected growth trend to the 2040 sales estimate actually falls below the number of units projected to be sold in 2030. Thus, the near-term growth trend is higher than that for the 2030-2040 period.

Exhibit 13. Even OPEC Is More Optimistic On EV Success



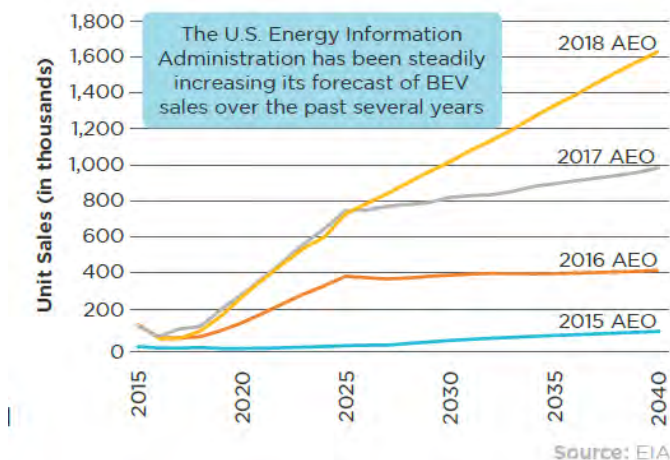
Source: BNEF

There were numerous changes in government policies regarding EVs that could not have been anticipated, such as the German diesel emissions scandal

With respect to the OPEC forecast, BNEF was emphasizing the change in the sales projections between 2015 and 2016. While one could suggest that the market was growing much faster than OPEC forecasters had previously assumed, but there were numerous changes in government policies regarding EVs that could not have been anticipated, such as the German diesel emissions scandal. That prompted a significant outrage, leading to many European cities and governments enacting plans to limit or outright ban ICE cars from their roads. As forecasters must incorporate the latest government regulations into their models, that regulatory shift may explain a substantial portion of the 500% increase touted by BNEF in its chart. In other words, without government actions would the world be clamoring for so many new EVs?

A more recent examination of forecast changes regarding EV growth was displayed in a chart showing how the Annual Energy Outlook base case projections prepared each year by the U.S. Energy Information Administration (EIA) has increased between 2015 and 2018. Over that time span, the number of EVs anticipated to be sold in the United States in 2040 rose from 100,000 units to 1.6 million.

Exhibit 14. How EV Forecasts Have Climbed Recently



Source: EIA

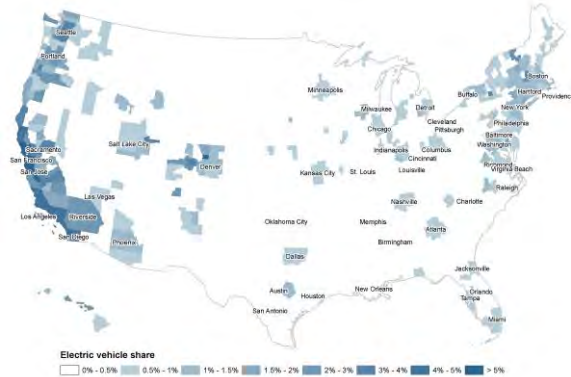
It was not surprising that the concentration in new EV registrations was concentrated on the East and West Coasts

A white paper published in late summer by the International Council on Clean Transportation focused on “The continued transition to electric vehicles in U.S. cities,” and highlighted a map showing the EV share of 2017 new vehicle registrations by the top 50 metropolitan areas. It was not surprising that the concentration in new EV registrations was concentrated on the East and West Coasts. These are not only the most highly urbanized markets, but also home to the most aggressive environmental movements. In particular, California stood out for its high concentration of new EV registrations, but given the local and state incentives, on top of the federal tax credit, that should not be a surprise.

According to the data, the San Jose area had the highest market share at 13%, followed by other California areas with 5% to 8%

According to the data, the San Jose area had the highest market share at 13%, followed by other California areas with 5% to 8% market shares. The other top markets in Colorado, New Hampshire, New York and Washington had market shares of 3% to 5%. A key point the authors of the white paper made was that for the 50 metropolitan markets, the EV share at 1.6% was 2.5 times greater than for the rest of the United States.

Exhibit 15. EVs Are Most Successful On Coasts

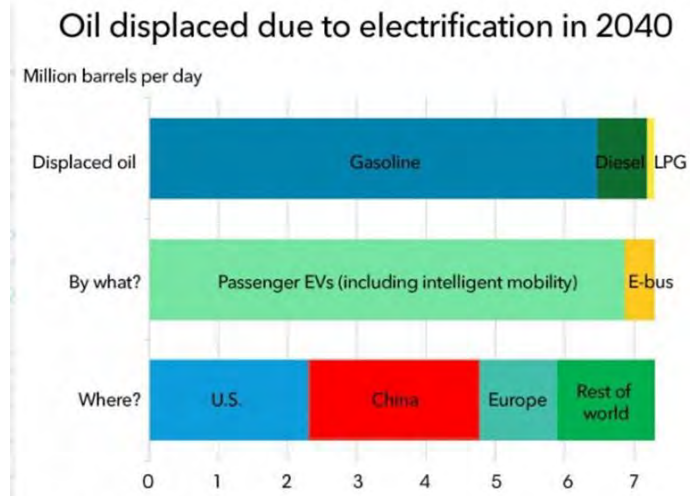


Source: International Council on Clean Transportation

A new report by BNEF suggesting that EV sales will increase tenfold by 2025 and reach 55% of new car sales worldwide by 2040

Given the seemingly strong momentum of EV sales, we were not surprised to see details of a new report by BNEF suggesting that EV sales will increase tenfold by 2025 and reach 55% of new car sales worldwide by 2040. From 1.1 million worldwide EV sales in 2017, BNEF projects 11 million will be sold in 2025 and 30 million in 2030. EV sales will begin to bite into sales of ICE vehicles starting in the mid-2020s, they predict.

Exhibit 16. How Gasoline Will Be Impacted By EVs



Source: Bloomberg New Energy Finance

Source: BNEF

BNEF expects EVs to displace approximately 6.9 million barrels per day of transportation fuel, or about 7% of global consumption

In 2040, when 55% of vehicle sales are expected to be EVs, BNEF anticipates nearly one-third of all vehicles on the road will be electric. At that point, the oil industry will have seen nearly seven million barrels a day of gasoline, diesel and LPG demand from the transportation sector vanish. Electric buses will have a minor impact on the decline in fuel sales.

BNEF projects battery costs will fall to \$70/kWh in 2030, below the theoretical \$100/kWh price that makes EVs cost-competitive with ICE vehicles

Much of the EV growth is taking place in China, especially in the six large cities that have restricted sales of ICE vehicles. Those cities represent a little more than 20% of the EV market today, says BNEF. Thus, it is not surprising that BNEF expects EVs to displace approximately 6.9 million barrels per day (mmb/d) of transportation fuel, or about 7% of global consumption. Roughly 2.4 mmb/d of reduced transportation fuel will be due to Chinese EV sales, followed by about 2.3 mmb/d due to U.S. sales. The remaining 2.2 mmb/d of vanishing fuel demand will be accounted for by Europe and the rest of the world's EV sales.

The EV market growth projected by BNEF is dependent on the continued decline in battery costs and continued increase in battery efficiency. That will enable auto manufacturers to install fewer batteries to achieve the same vehicle range as now, but at lower overall costs. From \$1,000 per kilowatt-hour (kWh) in 2010, battery costs fell to \$209/kWh in 2017. BNEF projects battery costs will fall to \$70/kWh in 2030, below the theoretical \$100/kWh price that makes EVs cost-competitive with ICE vehicles. If that projection falls short of reality, the BNEF forecast could easily prove to be too optimistic. On the other hand, even if battery costs don't fall sufficiently to make EVs truly competitive with ICE vehicles, regulatory measures may make the issue moot.

An EV in Germany would take more than 10 years to break even with an efficient ICE's emissions

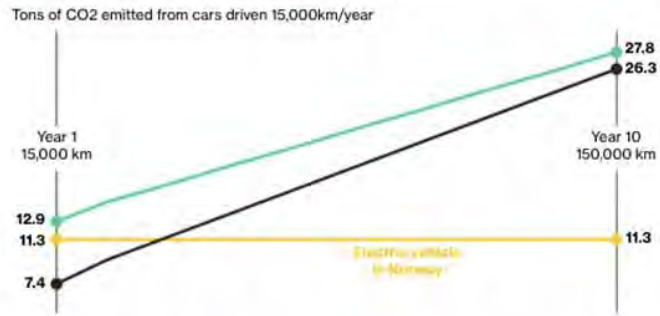
In considering other issues impacting the EV market, we found two recent reports highlighting other challenges that could impede the rapid growth of EVs. The first report was from German automobile consulting firm Berylls Strategy Advisors showing that an EV in Germany would take more than 10 years to break even with an efficient ICE's emissions. That is due to the amount of legacy emissions created during the battery and vehicle manufacturing process, especially since batteries are made in countries that rely heavily on fossil fuels for their power generation.

According to Berylls' findings, to build a car battery for a sport-utility vehicle (1,100 pounds) would emit up to 74% more CO₂ than producing an efficient ICE vehicle if it's made in a factory powered by fossil fuels in a place like Germany. Regulators have yet to set out guidelines on acceptable carbon emissions over the life-cycle of EVs. According to Henrik Fisker, CEO and chairman of Fisker, Inc., a California-based developer of EVs, "It will come down to where is the battery made, how is it made, and even where do we get our electric power from."

Exhibit 17. Legacy CO2 Emissions Are A Problem

Not So Green?

An **electric vehicle in Germany** would take more than 10 years to break even with an **efficient combustion engine's** emissions



Year 1 includes manufacturing-stage emissions. Predictions based on carbon tailpipe emissions and energy mix in 2017.

Source: Berylls Strategy Advisors

Source: **Bloomberg**

Manufacturing an EV results in more CO2 being released than when manufacturing an ICE car, which releases 20% of its lifetime emissions at that stage

Electric cars aren't as clean as they should be. Manufacturing an EV results in more CO₂ being released than when manufacturing an ICE car, which releases 20% of its lifetime emissions at that stage, according to estimates from Mercedes-Benz's electric drive system integration department. Ola Kallenius, Daimler AG (DMLRY-OTC) board member and incoming CEO, was quoted at the Paris Motor Show last month saying, "Life-cycle emissions in electric vehicles depend on how much the car is driven in order to get to a point of crossover on diesels."

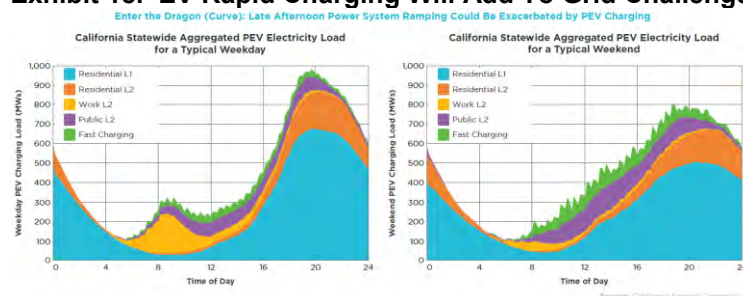
Data from lobbying group Transport & Environment Brussels showed that merely switching to renewable energy for manufacturing EVs could cut their carbon emissions by up to 65%. In Norway, where hydropower supplies virtually the entire grid, Berylls showed that EVs generate nearly 60% less CO₂ over their lifetime compared with even the most efficient ICE vehicles.

In a world of autonomous EVs in a MaaS model and powered by renewables, the time to overcome the legacy emissions buildup would be much less than a decade. It all depends on how many miles the clean vehicle drives, and the AV/MaaS model is based on the concept of extensive annual mileage per vehicle.

The other challenge is the one faced by electric utility companies. It relates to how they will manage when EVs are charged. So far, experience has shown them being charged at the end of the work day, or in the early evening hours. In California, where EVs have the greatest concentration, the state is pushing utilities to switch to renewable fuels for generating power for the grid. Data has shown what is often described as the "duck curve" where dispatchable power (generated from nuclear, hydro or fossil fuels) is displaced

during daylight hours when solar contributes extensively. The hourly graph of the respective amounts of dispatchable and non-dispatchable power create a shape that looks like a duck's body. The body narrows as dusk approaches and solar power disappears. At that point, dispatchable power must ramp up sharply. Managing this process is a significant challenge for grid operators since they are never exactly sure when the dispatchable power is needed, nor exactly how much is needed at any point in time.

Exhibit 18. EV Rapid Charging Will Add To Grid Challenges



Source: ScottMadden

The duck curve is now morphing into the “dragon curve” as a result of the volatility of power needs created by EV fast-charging

With the addition of EV recharging needs, which will often fluctuate during the afternoon and evening hours, a new demand is being made on the grid. The duck curve is now morphing into the “dragon curve” as a result of the volatility of power needs created by EV fast-charging. This demand pattern creates something that looks like how a dragon’s tail is envisioned. Learning how to manage this new variable power load will be an issue. Many forecasters expect utilities to develop variable power pricing schemes that will encourage EV owners to charge their vehicles during the lowest power demand hours of the day – the middle of the night! Timers to control EV charging units may be a solution, but no one knows whether that will work, or if people will embrace variable pricing.

Interestingly, 18% of the clean car enthusiasts suggested: “not for a long time”

We were intrigued recently to read about a Twitter-survey of the readers of *Green Car Reports* on when EVs would rule the automobile world. With forecasts for how soon EVs would dominate new vehicle sales ranging from 50% by 2030 to only 25% by 2050, *Green Car Reports* elected to conduct an unscientific survey. It asked its Twitter followers to tell when they anticipated 100% of new car sales to be EVs. That meant all models – cars, SUVs, pickup trucks, etc. The survey of EV enthusiasts who follow this news service was interesting. Total EV sales by 2020 was predicted by 6% of the respondents, suggesting an unrealistic scenario since most world markets are barely at 2%, and the target date is only two years away. Nearly half the respondents (48%) said it would happen by 2030, with 28% targeting 2040. Interestingly, 18% of the clean car enthusiasts suggested: “not for a long time.” If nearly one in five EV enthusiasts doesn’t expect a complete takeover of the vehicle market by EVs within the next 22 years, maybe all the aggressive market share gain forecasts are too optimistic.

IMO 2020 Will Not Be Delayed; Possibly Disappointing Shippers

While this learning-period delay was rejected, the IMO continues to assert there will be adequate low-sulfur vessel fuel available when the transition occurs and that there will be no market dislocations

A recent meeting of the International Maritime Organization (IMO), the arm of the United Nations that oversees the operation of the global maritime industry, confirmed that the sulfur reduction regulatory plan previously approved would not be delayed. The prospect of a delay was prompted by the request from the United States, along with several other countries, for a three-month period for the shipping industry to gain practical data about the challenges of implementing the mandated reduction in the sulfur content of vessel fuel from 3.5% to 0.5% on January 1, 2020. While this learning-period delay was rejected, the IMO continues to assert there will be adequate low-sulfur vessel fuel available when the transition occurs and that there will be no market dislocations.

In the past, we wrote about the IMO 2020 issue. The article was prompted by claims from some oil industry consultants and analysts that IMO 2020's impact in the fuel market could drive oil prices to \$150-\$200 a barrel. Those forecasts were tied to the dislocations in the diesel fuel market and the global trucking industry, as well as a potential shortage of low-sulfur fuel and a glut of high-sulfur oil, all of which would prompt the refining industry to aggressively bid up low-sulfur crude fuel. On the other hand, this dislocation would also drive down the price of heavy crude oils, with high sulfur content, and oil sands output.

An alternative to switching fuels for shipowners is to install exhaust gas scrubbers that remove the sulfur emissions

An alternative to switching fuels for shipowners is to install exhaust gas scrubbers that remove the sulfur emissions. While a costly step, it is a viable option for existing ships. Newly-constructed ships could use alternative fuels such as LNG to deal with the low-sulfur rule. Another option seldom discussed are non-compliance waivers for ship voyages. Most non-compliance comments focus on shipowners declining to comply with their fuel use and hoping not to get caught. First, it is important to understand that the IMO has no policing power to enforce fines on shipowners for violating IMO 2020. It must rely on the flag countries in which the ships are registered to enforce any penalties. In most cases, the financial penalties are quite low, and the flag registry countries may not want to "bite" the hand that feeds the government with registration fees.

Another aspect is to seek waivers, which is a legitimate action under IMO rules

Another aspect is to seek waivers, which is a legitimate action under IMO rules. If a shipowner can show that no compliant fuel is available, which is likely to happen in areas of the world where all the refineries are unsophisticated and cannot produce the required low-sulfur fuel, the ship can sail using high-sulfur fuel and a waiver.

We were intrigued to see a press release from tanker operator Frontline Ltd. (FRO-NYSE) about the IMO 2020 issue. The release quoted Robert Hvide Macleod, CEO of Frontline Management stating:

"Backed by the ongoing commitment and support from Frontline's largest shareholder, we have taken significant steps to modernize our fleet, decreasing the average age of our owned vessels to 4.7 years. Following the committed installations, over 40% of our owned fleet will be equipped with scrubbers. Notably, the majority of these installations will be performed prior to 2020, when new sulfur emissions compliance requirements go into effect. Further installations will be considered, and we are uniquely positioned to access scrubber capacity from Feen Marine. We believe our actions will position the Company to generate significant earnings for our shareholders."

ExxonMobil is positioned to supply low-sulfur fuel to most geographic markets by 2019, while other refiners are behind

With Exxon Mobil Corp. (XOM-NYSE) working on finishing upgrading its refineries around the world to be able to produce low-sulfur fuel, we expect others will soon follow. ExxonMobil is positioned to supply low-sulfur fuel to most geographic markets by 2019, while other refiners are behind. Scrubber sales and installations are growing. There still remains the waiver option for those regions of the world that will be challenged to supply the fuel given the lack refinery capability due to the cost and time necessary to upgrade them. Non-compliance and hoping not to get caught may be a strategy for some small, less professionally-managed shipping companies, but it is not an option for respected shipowners. The outcome of IMO 2020 will be higher fuel costs and higher transportation costs. Could this be sufficient weight on global trade in 2020 to create economic weakness? It is an issue to be watched, but probably not feared, at least at the present time.

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