PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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

IMO 2020: Ghost of Christmas Yet To Come Or Next Y2K?

Ebenezer Scrooge cowed before the black hooded phantom in Charles Dickens' A Christmas Carol. The language describing the ghostly midnight figures visiting Mr. Scrooge's bedroom changed at this point in the story. He rails: "Are these the shadows of the things that Will be, or are they shadows of things that May be, only? Why show me this, if I am past all hope! Assure me that I yet may change these shadows you have shown me, by an altered life!"

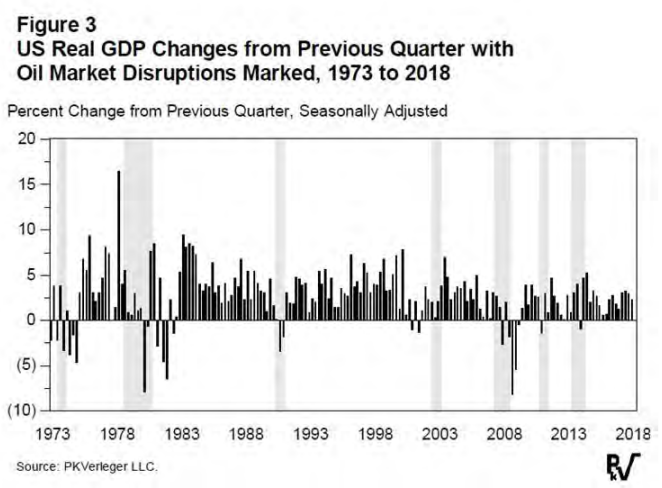
Apocalyptic is the best description of the outcomes being predicting

Oil industry forecasters are acting like Mr. Scrooge when contemplating the impact of the International Maritime Organization's (IMO) mandate that all ships at sea burn low-sulfur fuel oil beginning in 2020. Apocalyptic is the best description of the outcomes being predicting. For example, a $200 a barrel oil price and a global recession in 2020! However, we are reminded of the apocalyptic predictions for New Year's Eve 1999. Midnight, and Y2K, came and went, and the world continued working. Will the world come unhinged on January 1, 2020, when IMO 2020 goes into effect?

The world's oil industry cannot deliver the necessary volumes of low-sulfur fuel to keep the global transportation industry running without disastrous impacts on the cost of goods and the price of oil

When forecasting economic events, one must consider various factors, the impacts of which are neither clear nor predictable. The horror scenarios set forth by some on Wall Street, and in the economic consulting community, suggest that the world's oil industry cannot deliver the necessary volumes of low-sulfur fuel to keep the global transportation industry running without disastrous impacts on the cost of goods and the price of oil, both of which often spike at the start of worldwide economic downturns and are seen as culprits causing the recession.

Exhibit 1. Economies Are Shaken By Oil Market Turmoil



Source: Verleger

Periods of oil market disruptions marked in shaded bars confirm the correlation, although not the causation, of oil market turmoil and economic downturns

Consulting economist Phillip K. Verleger, Jr. has authored a paper titled: "$200 Crude, the Economic Crisis of 2020, and Policies to Prevent Catastrophe." A chart showing quarterly real gross domestic product (GDP) changes from 1973 to 2018 with periods of oil market disruptions marked in shaded bars confirm the correlation, although not the causation, of oil market turmoil and economic downturns. There were two times during that period when the correlation didn't hold - the 1997-1998 oil market turmoil associated with the Asian currency crisis, and the 2001-2003 recession following the 9/11 terror attacks.

Taking off on the proverb, "for the want of a nail, a kingdom was lost," Mr. Verleger likens the lack of low-sulfur fuel oil, or gasoil, as the cause for an economic calamity, which he described thusly:

One or more major US automakers will face bankruptcy, even closure

> "The global economy likely faces an economic crash of horrible proportions in 2020, not for want of a nail but want of low-sulfur diesel fuel. The lack of adequate supplies promises to send the price of this fuel—which is critical to the world's agricultural, trucking, railroad, and shipping industries—to astoundingly high levels. Economic activity will slow and, in some places, grind to a halt. Food costs will climb as farmers, unable to pay for fuel, reduce plantings. Deliveries of goods and materials to factories and stores will slow or stop. Vehicle sales will plummet, especially those of gas-guzzling sport utility vehicles (SUVs). One or more major US automakers will face bankruptcy, even closure. Housing foreclosures will surge in the United States, Europe, and other parts of the world. Millions will join the ranks of the unemployed as they did in 2008."

Hand me the hara-kari knife.

What's going on? Earlier this year, the United Nations' IMO confirmed it would implement a mandatory switch from high-sulfur fuel oil (3.5% sulfur content) to low-sulfur (0.5% sulfur) effective January 1, 2020, for all ships sailing the world's oceans. This is a plan that has been in the works for years and was initially agreed to in 2016, subject to confirmation in the spring of 2018. It is now set to come into effect, and it will impact the estimated 55,000 commercial ships registered around the world in 2016.

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The prospect is that at the start of 2020, the world's ships will stop buying high-sulfur fuel oil (HSFO) and demand low-sulfur fuel oil (LSFO) instead. According to multiple estimates, the world's shipping industry currently consumes 3.4-4.0 million barrels a day (mmb/d) of bunker fuel, all assumed to be HSFO. The switch will add significant incremental demand to the world's roughly 28 mmb/d consumption of diesel/gasoil, which is LSFO. The belief is that the incremental demand will outrun the global refining industry's capacity to produce the fuel, sparking price spikes and depressing economic activity.

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To understand the calamity scenario and what actions may mitigate it, we need to touch on a number of topics – the crude oil market, the refining industry, the shipping industry and the regulatory environment. All four of these are interconnected and changes in one can, and likely will, impact the others. Unfortunately, we can only lightly touch on the topics as an in-depth analysis would create an even more voluminous newsletter than this issue.

The global shipping industry plays a critical role in the economy's functioning. Ships haul every imaginable commodity, semi-finished goods and consumer products from where they are produced to where they are used. Given the amount of cargo carried and the emissions per ton of cargo carried per mile traveled, ships are by far the most energy-efficient form of transportation compared with other modes such as aviation, trucks, and even railways.

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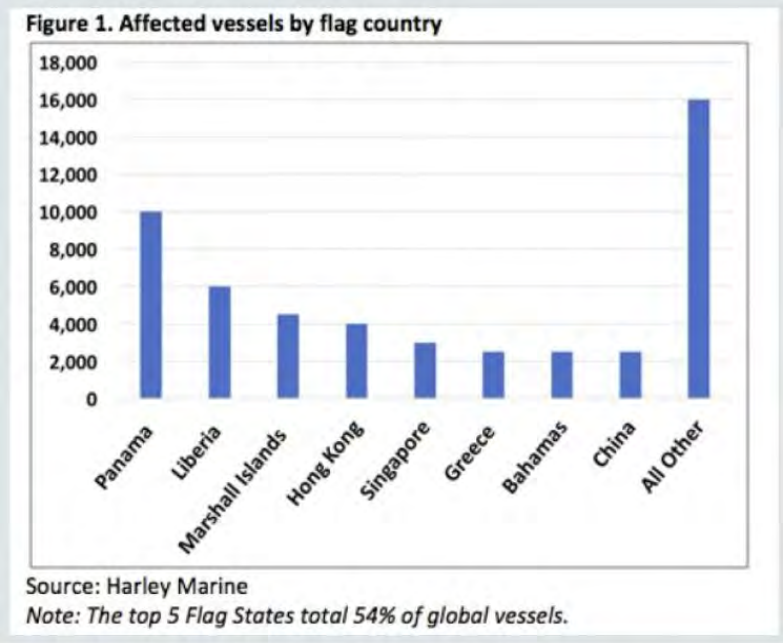
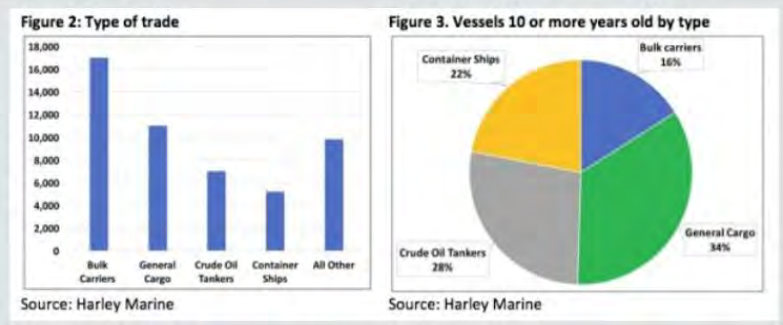
Ships come in all sizes and shapes. The global fleet can be segmented in various ways, such as by flag, trade and age. That segregation is shown in the charts on the next page.

Shipowners have to consider the various options available for complying with the new regulation. These options include:

1. Use LSFO. These can be low-sulfur distillates (LSD), a blend of LSD and high-sulfur residual fuel oil, or low-sulfur residual fuel oil, or some combination. The mixture of high-sulfur fuel oil will probably be limited to a maximum of 20% to have the blend comply with the 0.5% sulfur content specification.

Exhibit 2. How World Vessel Fleet Is Characterized





Source: ***shipandbunker.com***

Installing scrubbers that allow the continued use of HSFO involves a number of considerations

2. Use HSFO with exhaust scrubbers. Installing scrubbers that allow the continued use of HSFO involves a number of considerations. Those include: structural compatibility of the ship; cost of installation and operation of the equipment; age of the vessel; trading routes; party responsible for the fuel; type of vessel and trade; availability of equipment and facilities for modifications; and the risk of air quality regulations changing that challenges the long-term viability of exhaust gas scrubbers. This choice becomes an economics exercise, given that installing scrubbers may cost $4-5 million per ship. Older ships, greater than 10 years old, will likely never be able to recoup the investment through higher charter rates, or greater utilization. Sharply lower HSFO prices, however, could help make the investment economics work, but that requires a bet on the long-term trend in fuel prices, a dangerous gamble.

3. Use HSFO with an IMO "waiver" due to unavailability of compliant low-sulfur marine fuel. That will likely be the case in certain parts of the world where no refineries are currently able to produce the complaint fuel.

4. Use alternative fuel sources. Ships using liquefied natural gas (LNG) or methanol are in operation, under construction and being ordered. MSC Cruises, Disney Cruise Lines, Princess Cruise Lines and Carnival Cruises have all ordered LNG-powered ships, or dual fuel vessels. Because these companies deal exclusively with the public, their image of being environmentally responsible is an important consideration in their decisions. Marine forecasters predict that about 5% of the global fleet will eventually be powered by LNG, but their projections assume limited fuel availability. For cruise lines, their predictable routes and regional areas of concentration will incentivize LNG suppliers to establish bunkering facilities.

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5. Use HSFO without a waiver. This option will be a strong factor in markets where the rules are not strictly enforced. (See our discussion on regulation later.)

6. Scrap older vessels that are less efficient and less profitable, despite projected vessel life of 25 years. (See our vessel economics discussion later.)

It is also important to understand that there are currently parts of the world where ships must use even lower sulfur fuel oil. Ships operating in these areas, referred to as emission control areas (ECA), must use 0.1% sulfur content fuel beginning in 2016. In 1997, Annex VI of the MARPOL act established these areas and, starting in 2000, limited sulfur content in fuel to 1.5%. That level was lowered to 1.0% for 2010-2015, after which the level further dropped to 0.1%. The North American ECA also has tighter restrictions on nitrogen oxide and particulate emissions. At one time, a popular thought was that the IMO would merely expand ECA areas to include the Norwegian coast, both the Gulf of Mexico and Pacific Ocean coasts of Mexico, the Mediterranean Sea, all waters surrounding the islands of Japan and New Zealand, and selective portions of the Southeast Asia archipelago, as a way to further limit shipping's carbon emissions.

At one time, a popular thought was that the IMO would merely expand ECA areas

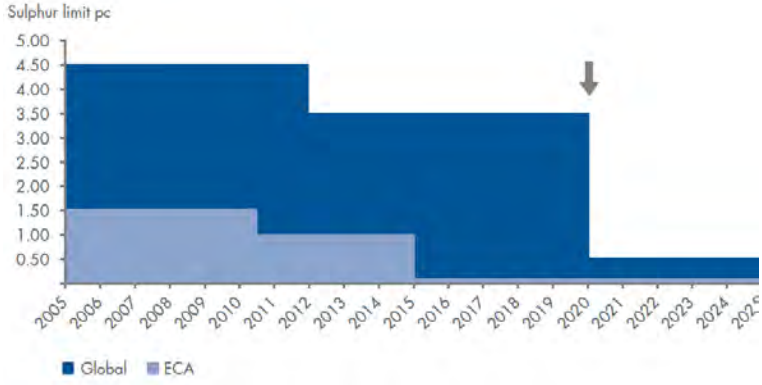
Exhibit 3. Regions With Even Lower Sulfur Restrictions

Source: ***Green4sea.com***

Segments of the global vessel fleet currently must use extremely low sulfur fuel and will not be impacted by the introduction of IMO 2020

While the ECA expansion effort was postponed in deference to a more stringent worldwide fuel regulation, clearly segments of the global vessel fleet currently must use extremely low sulfur fuel and will not be impacted by the introduction of IMO 2020. The chart shows how the limitations on sulfur in shipping fuel have tightened since 2005, and what they will be in 2025.

Exhibit 4. Sulfur Content In Shipping Fuel Market



Source: ***Platts***

We have 17 months before the IMO regulation goes into effect, so both the shipping and refining industries are racing to adjust operations to comply. We have outlined the options shipowners have for compliance, but what is the likelihood of the refining sector being able to ramp up supplies of LSFO?

What the charts show is a significant drop in residual oil's bunker component, estimated at 3 mmb/d

Royal Dutch Shell (RDS.A-NYSE) produced a chart (Exhibit 6, page 8) showing its estimate of what will happen to residual fuel oil demand, which is by definition HSFO, as a result of IMO 2020. Shell also shows a corresponding chart (Exhibit 7, page 9) for the shift in bunker demand. What the charts show is a significant drop in residual oil's bunker component, estimated at 3 mmb/d. At the same time, this component becomes a large part of bunker demand. We

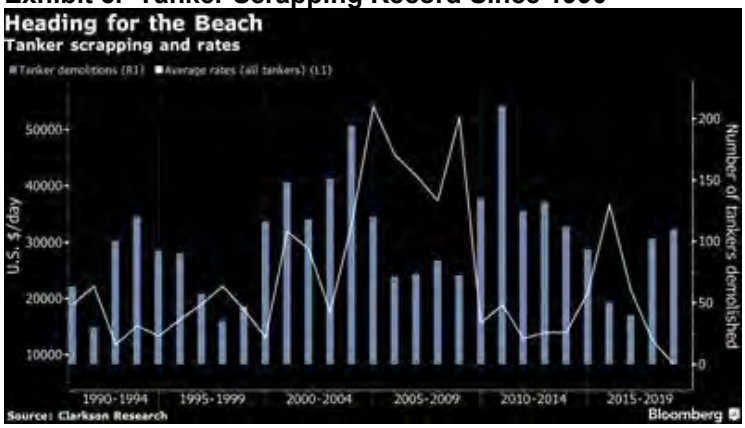
note that both charts show that the most significant market impact occurs in 2020, but then moderates in subsequent years. That moderation reflects the time lag for ships to install exhaust scrubbers and to continue using HSFO. As pointed out above, those scrubber investment decisions reflect shipowners gauging the cost of HSFO and its availability against the cost of investing in making existing vessels compliant with the new rule. Those older vessels that can't justify scrubbers will either be committed to trading in markets where there is no LSFO so the vessels can receive waivers, or operate in violation of IMO 2020. These ships are also the most likely ones heading to scrap yards and replaced by vessels incorporating scrubbers in their design as a cheaper option than retrofitting.

Those scrubber investment decisions reflect shipowners gauging the cost of HSFO and its availability against the cost of investing in making existing vessels compliant with the new rule

At the moment, scrap steel prices are high, so it is an attractive time to send older, inefficient ships to the cut-up yards in India and Southeast Asia. Scrapping of ships always goes on as the cost of periodic inspections mandated by the regulators increase with aging vessels, and the cost to repair them also rises. The older a vessel is, the less time it has to recoup the inspection and repair costs through continued operation. Shipowners now facing the incremental cost of adding scrubbers to older ships may see insurmountable cost recovery challenges.

The older a vessel is, the less time it has to recoup the inspection and repair costs through continued operation

Exhibit 5. Tanker Scrapping Record Since 1990



Source: ***Bloomberg***

As the tanker scrapping chart shows, there has been an upturn in vessels being sent to the cut-up yards in the past two years, partially influenced by the impending IMO fuel decision, but more likely reflecting the sharply lower earnings of large tankers. According to data from Clarkson Research Services Ltd., ships with two-million-barrel capacity (VLCCs) have averaged daily earnings of only $6,159 so far this year. That rate is down from $17,794 in 2017, $41,488 for 2016 and $64,846 in 2015. As the line in the chart shows, average daily earnings and the number of tankers scrapped are inversely related. Today's low vessel earnings may be a more important factor in the scrapping decision than the impending IMO 2020 rule.

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If LSFO prices skyrocket, then the scrubber investment becomes a more feasible alternative

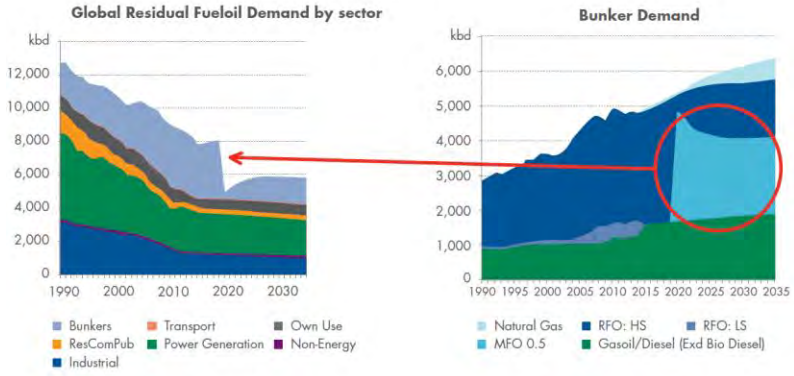
The other side of the equation is whether refiners will be willing to make the necessary investments to produce LSFO, in sufficient volumes as to mitigate a significant fly-up in vessel fuel costs. That would make the fuel switching decision much easier. However, if LSFO prices skyrocket, then the scrubber investment becomes a more feasible alternative. But, there remains the question of whether HSFO will continue to be available in ports. Given the pace of scrubber additions, it appears that shipowners believe HSFO will be available, at least long enough to justify operating vessels with emission controls installed.

The important qualifier is Regulation 18 of MARPOL Annex VI, which covers both fuel oil availability and quality. This will determine whether vessels operate without scrubbers and purchasing LSFO. On fuel oil availability, the regulation requires each party to "take all reasonable steps to promote the availability of fuel oils which comply with this Annex and inform the Organization [IMO] of the availability of compliant fuel oil in its ports and terminals." The parties are also required to notify IMO when a ship has presented evidence of the non-availability of complaint fuel oil.

The latest figures from IMO show that yearly average sulfur content in the HSFO tested in 2016 was 2.58%, while the worldwide average sulfur content in LSFO was 0.08%

The IMO monitors the sulfur content of fuel oil used by ships. Samples are taken of HSFO commonly used on ships, as well as LSFO, which is commonly used in ECAs that have stricter sulfur emission restrictions. The latest figures from IMO show that yearly average sulfur content in the HSFO tested in 2016 was 2.58%, while the worldwide average sulfur content in LSFO was 0.08%. The average HSFO sulfur content data suggests that some HSFO is lower than the 3.5% figure often cited, meaning that some blending of lower sulfur with higher sulfur fuel oil is already being done.

Exhibit 6. IMO 2020 Will Impact Global Fuel Oil Market

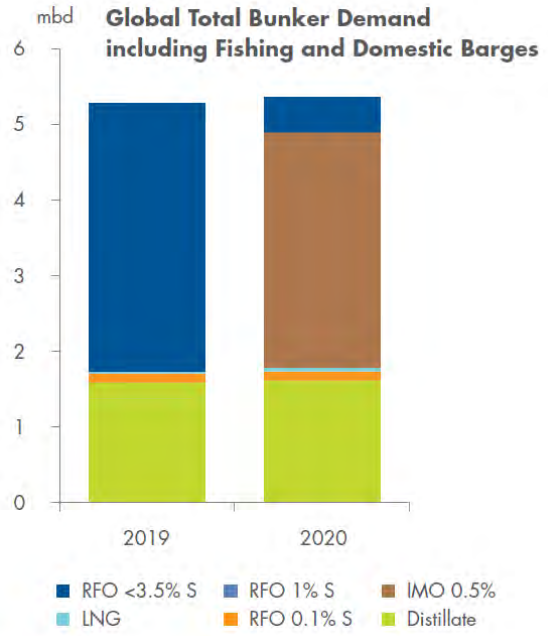


Source: Shell Oil

The Shell report shows how dramatically it expects the fuel mix to change between pre- and post-IMO 2020. Since Shell didn't provide numbers, we have to eyeball the two columns. Total demand increases year to year, with distillate and RFO 0.1% sulfur increasing slightly. The major change is the shift in RFO <3.5%

sulfur to IMO 0.5% sulfur. The question is the ability of the industry to make this shift without disrupting the entire distillate fuel market with sharply higher prices or creating a supply shortage.

Exhibit 7. How Bunker Fuel Market Could Shift



Source: Shell Oil

Only 15% of the world's vessel fleet will have installed onboard scrubbers by 2020

A study by Stillwater Associates estimates that only 15% of the world's vessel fleet will have installed onboard scrubbers by 2020. It also believes that vessels powered by alternative fuels will represent a very small component, so the bulk of the global shipping industry will need LSFO, although there will remain a HSFO market.

Forecasts for scrubbers are all over the map. A *Platts* article says only 400 out of 50,000 registered ships had ordered scrubbers as of February 2018. Another study says that by 2020, 1% of the fleet (500 ships) will have installed scrubbers, which will grow to 25% (12,500 ships) by 2030. A contrasting study puts the numbers at 3,200 (6% of the fleet) now, growing to 22,000 ships (44%) by 2020.

The survey showed that 63% of scrubber orders have been for retrofits with 37% for newbuild installations

A recent survey conducted of Exhaust Gas Cleaning Systems Association members, providers of scrubbers, reports an accelerating ordering rate. Some 71 were ordered in May 2018, alone. At the end of May 2018, there were 983 ships with exhaust gas cleaning systems installed or on order. A number of recent scrubber orders have been placed by major ship operators, including Spliethoff, Frontline, DHT and Star Bulk. The survey showed that 63% of scrubber orders have been for retrofits with 37% for newbuild installations. EGCSA expects shipowners will spend more than $20 billion over the next five years on exhaust gas cleaning systems.

Exhibit 8. How World Scrubber Market Is Evolving

Source: EGCSA

An email exchange with Donald Gregory, director of EGCSA, provided some interesting perspective on the magnitude of the IMO 2020 impact on shipping and, in turn, on how daunting the challenge facing the refining and shipping industries may be. Mr. Gregory wrote:

> "MARPOL Annex VI regulation 14 requires that all ships (certain size criteria) must use fuel with a fuel sulfur content of <0.50%S or have an alternative means of ensuring the exhaust emissions do not contain a SOx emission higher than when burning the prescribed sulfur content fuel. The number of ships to which the regulation applies numbers into the 100,000. However the number of ships that currently burn high sulfur fuel oils and will need to make a change to comply by the 1st January 2020 numbers around 55,000 ships. So with 1,000 using scrubbers there are 54,000 at the moment that will have to switch fuel.
>
> "It is worth noting that around 40% of the fleet (55,000) consume around 60% of the HSFO. These higher fuel consumption ships find the economics of fitting a scrubber more attractive than a ship with low fuel consumption. So it does not need to take the whole fleet to convert to EGCS to make a significant impact on the 0.50%S fuel market."

"It is worth noting that around 40% of the fleet (55,000) consume around 60% of the HSFO"

Mr. Gregory's figures highlight that 22,000 vessels have a disparate impact on the marine fuel market. It is likely that most of these ships are larger and performing the lion's share of the cargo hauling between continents. At the pace at which scrubber orders are being placed, it is possible that upwards of 2,000 additional vessels will be in line for scrubber installations before January 1, 2020, having a minimizing impact on LSFO demand.

Upwards of 2,000 additional vessels will be in line for scrubber installations before January 1, 2020

Ships can sail at much reduced speeds, requiring longer times to make journeys, but also significantly reducing fuel consumption

Another aspect of ship operations impacting fuel demand is slow steaming. Ships can sail at much reduced speeds, requiring longer times to make journeys, but also significantly reducing fuel consumption. That could ease demand for all fuels, but represents an alternative to minimize future demand for HSFO. Potentially the most significant adjustment mechanism for the shipping and refining industries is fuel blending.

Exxon Mobil Corp. (XOM-NYSE) aviation and marine lubricants marketing manager Iain White, speaking at a conference this spring, stated, "Whereas all of the fuel that is supplied into the marine industry today comes from a refinery somewhere, it is very often not the refiner who is selling the finished marine fuel. There is a supply chain with intermediaries along the way." He used Singapore, the world's largest shipping hubs and where more than 40 million tons of fuel oil are sold annually, as an example. He said, "95% of the fuel that is sold in Singapore today is not refined in Singapore. It comes into that market, so there is an awful lot of blending going on there."

Mr. White furthered his argument that blending will become a meaningful solution for meeting IMO 2020 by estimating that blended fuels would cost 10-15% less than straight distillate fuels

According to Mr. White, pricing, availability and access will also play a role in blends beating out distillates. With only 2% of the current fuel market composed of fuels that comply with the 0.5% sulfur cap under IMO 2020 regulations, he expects the decline in price on the 98% of HSFO to boost the likelihood of increased fuel blending. "Come January 2020, if you are a blender of fuel, you will have access to very low-cost HSFO. Sulphur is a linear blend, and if you are blending with a typical distillate – an ECA [emissions control area compliant] fuel at 0.1% sulfur content – it takes about 80–85% high-sulfur fuel to 15% low-sulfur fuel ratio and you can make a compliant fuel out of that." Mr. White furthered his argument that blending will become a meaningful solution for meeting IMO 2020 by estimating that blended fuels would cost 10-15% less than straight distillate fuels.

The new IMO fuel rule will have a much greater impact on international refiners than on U.S. ones

To assess the impact of the IMO rule on refiners, Stillwater points out, based on BP plc (BP-NYSE) statistical data for 2016, that global refinery throughput was 80.6 mmb/d, with fuel oil production at 8.0 mmb/d and distillate production, excluding kerosene and jet fuel, at 27.5 mmb/d. The U.S. Energy Information Administration (EIA) put global marine fuel use in 2016 at 3.9 mmb/d. That year, U.S. refineries produced only 418 thousand barrels per day of residual fuel. About 25% of the U.S. production was fuel oil with less than 1% sulfur content. With U.S. residual fuel representing only 2.6% of crude runs in 2016 compared to a 9.5% share of global refining output excluding the U.S., the new IMO fuel rule will have a much greater impact on international refiners than on U.S. ones.

Globally, refineries fall into one of three categories, or possibly they may be configured to operate in more than one mode, depending on the owner's processing strategy and the crude oil slate being refined. Crude oil is composed of carbon (84%), hydrogen (14%),

All of the hydrocarbons are mixed together and assembled in different chain lengths, which need to be separated, and that is what refining is all about

sulfur (1-3%) and nitrogen, oxygen, metals and salts, all at less than 1%. Every crude oil produced has its own signature composition, i.e., slight deviations from this traditional breakdown. All of the hydrocarbons are mixed together and assembled in different chain lengths, which need to be separated, and that is what refining is all about. The usual separation method is to apply heat. The different hydrocarbon chain lengths have progressively higher boiling points, meaning that as they reach their boiling points they liquefy and can be pulled from the crude oil stream. Listed below are the products that come from crude oil:

1. Petroleum gas – used for heating, cooking and making plastics. Boiling range less than 104°F.
2. Naptha – intermediate product that will be further processed to make gasoline. Boiling range of 140°-212°F.
3. Gasoline – motor fuel. Boiling range of 104°-401°F.
4. Kerosene – fuel for jet engines and tractors; starting material for making other products. Boiling range of 350°-617°F.
5. Gasoil/distillate – used for diesel fuel and heating oil; starting material for making other products. Boiling range of 482°-662°F.
6. Lubricating oil – used for motor oil, grease, other lubricants. Boiling range of 572°-700°F.
7. Heavy gas or Fuel oil – used for industrial fuel; starting material for making other products. Boiling range of 700°-1112°F.
8. Residuals – coke, asphalt, tar, waxes; starting material for making other products. Boiling range greater than 1112°F.

Understanding the various fuels extracted from crude oil at different temperatures helps with the categorization of refineries. The web site *howstuffworks.com* listed the various steps engineers go through to refine crude oil, which separates refineries into the following categories:

“The oldest and most common way to separate things into various components (called fractions), is to do it using the differences in boiling temperature. This process is called fractional distillation. You basically heat crude oil up, let it vaporize and then condense the vapor.

Chemical processing, for example, can break longer chains into shorter ones

“Newer techniques use Chemical processing on some of the fractions to make others, in a process called conversion. Chemical processing, for example, can break longer chains into shorter ones. This allows a refinery to turn diesel fuel into gasoline depending on the demand for gasoline.

“Refineries must treat the fractions to remove impurities.

“Refineries combine the various fractions (processed, unprocessed) into mixtures to make desired products. For example, different

mixtures of chains can create gasolines with different octane ratings."

If we combine all the types of coking and hydrocracking output, North American has 13.6% capacity while Asia only has 3.2%

The last two points are actually steps done by more sophisticated refineries relying on chemical processing. Other refinery discussions list the three refining types as: topping mode, cracking mode, and full conversion mode. By segregating the refining industry into these categories, we gain an understanding of the lower level of sophistication of the international refining industry compared to the North American industry. From the "2017 Oil and Gas Journal Worldwide Refining Survey" we learn that if we combine all the types of coking and hydrocracking output, North American has 13.6% capacity while Asia only has 3.2%.

The refineries most at risk from the fuel shift are the least sophisticated. Coastal topping refineries are the most at risk unless they can switch to low sulfur crude oil, or if the price of low sulfur crude rises. The cracking refineries will also feel pressure from the new fuel rule. However, they have more flexibility than topping refineries by increasing their gasoil output, asphalt production, lube oil production, and modifying their crude oil slate to permit catalytic cracking of lower sulfur residuals.

The big winners are the full conversion refineries because of the favorable changes in distillate price, sweet/sour crude oil price differentials, and light/heavy crude oil differentials

The big winners are the full conversion refineries because of the favorable changes in distillate price, sweet/sour crude oil price differentials, and light/heavy crude oil differentials. These refineries are able to adjust their crude oil slates and their product mixes to capitalize on these shifting market trends. If HSFO prices fall low enough to replace crude oil as a refinery input, these sophisticated refineries will gain since HSFO feedstock usually contains 30% distillate and 70% residual, increasing the refinery's distillate yield.

Refinery consultant KBC pointed to how a conversion refinery, in this case in the Mediterranean region, could reconfigure its output to produce a greater volume of gasoil (marine diesel/LSFO) in contrast to the amount of HSFO produced. As Mr. White of ExxonMobil pointed out with respect to blending, virtually all of the HSFO output from this refinery could be blended down to provide shippers with IMO 2020 compliant fuel.

KBC explained the significance of adjusting the crude oil slate at more complex refineries on the output of HSFO, which presumably will become less profitable, in favor of more high-value LSFO. Quoting from their presentation:

> "A refinery that processes Mars crude oil can have a yield of HSFO of about 33 percent. Modelling the same refinery for processing a blend of Heavy Louisiana Sweet and Light Louisiana Sweet (50 percent each) shows that production of HSFO could be cut. This highlights the difference that the feedstock grade of crude oil can make.

"Modelling a typical Fluid Catalytic Cracking and Coking conversion refinery, processing a blend of Mars / Maya (50 percent each) heavy crude oils, shows that the yield of HSFO can be lowered to around 2.8 percent. This underlines how the right refinery units can cut the yield of high sulfur fuel oil."

Exhibit 9. Typical Complex Refinery Output Potential

TYPICAL YIELDS OF A CONVERSION REFINERY IN THE MEDITERRANEAN REGION	
Product	**Wt. % Yield**
Light Naphtha	5
Gasoline	14
Jet Kerosene	2.5
Gasoil	40
HSFO*	15

* Current specification (3.5% sulphur content)

Source: KBC

CERI suggests that IMO 2020 will create a serious problem for Canada's bitumen oil due to its high sulfur content

As refineries make such a crude oil slate shift, there will be increased competition for the desired crude oils, which could boost their price at the expense of higher sulfur crudes. A recent report from the Canadian Energy Research Institute (CERI) suggests that IMO 2020 will create a serious problem for Canada's bitumen oil due to its high sulfur content. That status will cause a widening of the discount for Western Canada Select (WCS) crude oil versus West Texas Intermediate, significantly impacting the profitability of WCS. Canadian oil has a number of challenges, in particular the lack of export pipelines, as well as its sulfur content. Helping its marketability, however, is declining supplies of Venezuelan and Mexican heavy crude oils for which WCS is interchangeable. The biggest unknown for high sulfur crude oils is just how much HSFO will continue to be needed for those ships investing in scrubbers rather than counting on purchasing more expensive LSFO.

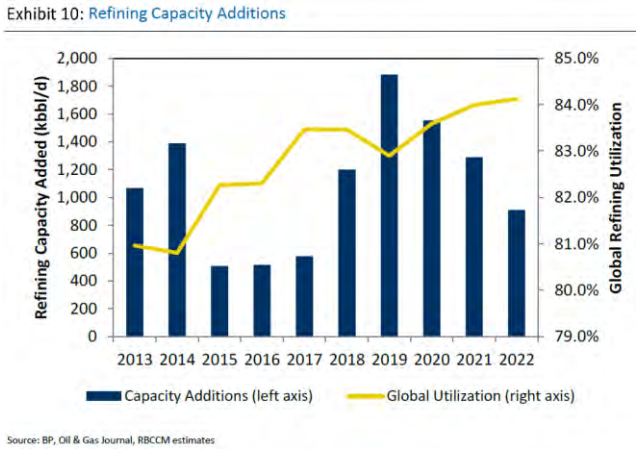
The shift underway in IMO fuel specifications helps explain ExxonMobil's recent decision to invest $1 billion in upgrading and expanding its Singapore refinery to be able to produce 0.5% sulfur fuel oil

The shift underway in IMO fuel specifications helps explain ExxonMobil's recent decision to invest $1 billion in upgrading and expanding its Singapore refinery to be able to produce 0.5% sulfur fuel oil. The company has already completed similar upgrades of its Rotterdam and Antwerp refineries, and has an upgrade underway at its Gulf Coast refining complex. When the Singapore refinery upgrade is complete in 2023, ExxonMobil will be the only major international oil company producing IMO 2020-compliant fuel on three continents, and its refineries will no longer be producing HSFO.

Substantial refining capacity is scheduled to come on stream in 2019 and 2020

Unless a refinery upgrade is already underway, the ability of the refining industry to add LSFO supply to the market is zero by 2020. However, substantial refining capacity is scheduled to come on stream in 2019 and 2020, and presumably those refining additions will be able to provide LSFO, or produce the necessary fuel components for blending fuels that meet IMO 2020 requirements.

Exhibit 10. Refinery Capacity Additions Into 2020



Source: RBC

A 2017 Bain & Associates study contained the following discussion about the global refining industry and its ability to deal with the new fuel regulation.

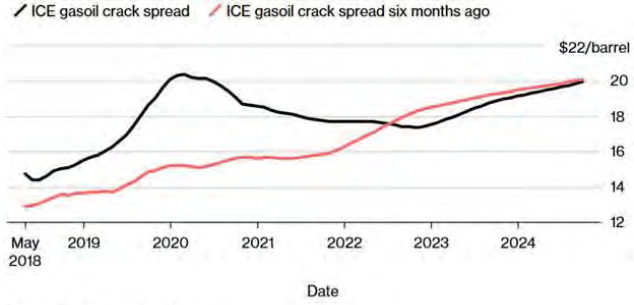
> "Complex refineries with hydrocracking and residue desulfurization units that enable maximizing LSFO and distillates production will be able to navigate the disruption. Asia and the Middle East are home to such refiners. Additionally, refiners with coker units, such as those on the US Gulf Coast, will fare well, as will refiners with access to crude with very low sulfur.
>
> "Simple refiners that produce mostly HSFO (such as the high-sulfur hydroskimming and topping refineries in Russia) and those whose products have low distillate yields (such as the pure-play gasoline refineries that are based in parts of Northwest Europe and on the US East Coast) will find it very difficult to maintain profitability in the new environment."

One of the most at-risk refining sectors is that of Russia, which has a preponderance of simple refineries

One of the most at-risk refining sectors is that of Russia, which has a preponderance of simple refineries. Will Russia become the leading supplier of HSFO for those ships that decide to use scrubbers to meet the IMO 2020 rule? There is also the issue of state-owned refineries where there is a lack of money to invest in their upgrading. A prime example is Venezuela where the government's financial position makes any expenditure on its oil business impossible to undertake.

Other people focused on the refining industry's challenge in dealing with the IMO 2020 rule comment on crack spreads and how they are changing heading into 2020. Exhibits 11 and 12 show crack spreads. In the case of gasoil, note how the crack spread has increased heading into 2020, but then shows it declining by a third in the second half of 2020, and retreats by 50% by 2023.

Exhibit 11. Gasoil/Distillate Crack Spreads

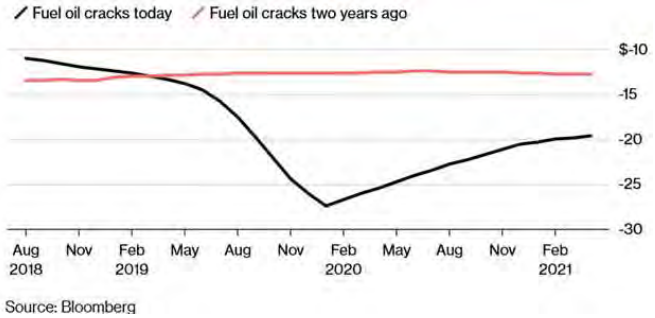


Source: Bloomberg Fair Value
Source: *Bloomberg*

The market anticipates dislocations during the transition to the new fuel standard, but anticipates a fairly rapid market recovery in the early months after the fuel shift

In the case of fuel oil, the crack spread turns significantly negative during the final two-thirds of 2019, bottoming in January 2020. The negative spread recovers half of the 2019 decline by the end of 2020. This suggests the market anticipates dislocations during the transition to the new fuel standard, but anticipates a fairly rapid market recovery in the early months after the fuel shift. This certainly doesn't mean people won't face fuel availability challenges, and/or that fuel costs won't rise impacting shipping rates and cargo transportation costs, but the financial impact may prove to be more moderate than some forecasters are currently projecting.

Exhibit 12. Fuel Oil Crack Spreads



Source: Bloomberg
Source: *Bloomberg*

The market anticipates dislocations during the transition to the new fuel standard, but anticipates a fairly rapid market recovery in the early months after the fuel shift

In one of the early assessments of what the IMO 2020 fuel regulation could mean to shipping costs, oil industry consultant Wood Mackenzie estimated it might add $60 billion to the shipping industry's bill based on how it expected gasoil prices to rise and HSFO prices to collapse. We later reviewed two studies – one predicting the cost impact would total $100 billion, while the other projected it to be twice that amount. A third, and more recent study,

believes the fuel cost impact will be in the range of $24 to $60 billion annually. Given all the variables in play, and one we haven't explained yet, it is easy to see how extreme the estimates have become. We always remember that the most outrageous forecasts are the ones that receive the greatest attention, yet often bear little resemblance to the eventual reality.

The IMO is a United Nations-sponsored organization, but it lacks enforcement powers

One of the great unknowns is how many vessels will elect to not comply with the IMO rule in 2020. The IMO is a United Nations-sponsored organization, but it lacks enforcement powers. It has to rely on the flag states where vessels are registered for any enforcement actions. The experience of what happened with the creation of the ECA zones and enforcement violations is illustrative. According to comments by Dea Forchhammer, senior business development manager at Maersk Oil Trading, at a *Platts* shipping conference, in 2015, ECA zone non-compliance rates in port inspections conducted were 3% in the Baltic Sea and 9% in the North Sea. She said, "Only 30% of violations were sanctioned, which is just silly… In some countries, fines are as low as $1,500, compared to savings of $100,000 per trip, per ship, in the current ECA zones [from using non-compliant fuel]. There are very few detentions, [and] very few cases of legal action."

Exhibit 13. Penalties For IMO Fuel Non-compliance

PENALTIES FOR NON-COMPLIANCE TO SO_x REGULATIONS IN SELECTED COUNTRIES WITHING SECAs

Country	Maximum financial penalty
Belgium	Eur 6 million
Canada	CAD 25,000
Denmark	No maximum
Finland	Eur 800,000
France	Eur 200,000
Germany	Eur 22,000
Latvia	Eur 2,900
Lithuania	Eur 14,481
Netherlands	Eur 81,000 + gains
Norway	No maximum
Sweden	SEK 10 million
UK	GBP 3 million
USA	USD 25,000/d

Source: Trident Alliance

Source: *Platts*

There is currently no failsafe detection measure for use on the open seas

Because sulfur compliance is left to the individual port states, enforcement is conducted by verification of bunker fuel sulfur levels in port and monitoring of vessel smokestack emissions at sea using airplanes and drones, as well as electronic "sniffers" on ship bridges. However, there is currently no failsafe detection measure for use on the open seas. As Ms. Forchhammer put it, "How do you put something on a vessel that the people on the vessel can't tamper with, that's the question. We need a black box on every ship to measure what it is emitting."

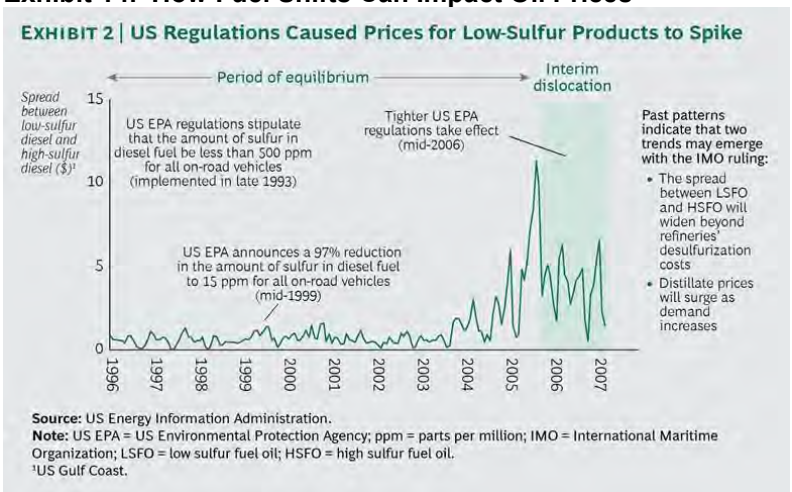
It is this non-compliance in ECAs that lies behind the organization of the Trident Alliance, including many of the leading shipowners. They see compliance as proper from an environmental perspective,

but also from a competitive position. In any region where IMO 2020 is not enforced, shipowners who operate their vessels outside of compliance reduces operating costs relative to complying ships. Whether this cost differential is likely to shift cargos to non-compliant shippers is debatable, but could be a competitive advantage in the early phase of the IMO 2020 implementation.

For short-term disruptions, price hikes and administrative actions are likely the way markets and participants will deal with it

There is little doubt that IMO 2020 will disrupt the marine fuel market, and likely the global distillate market, too. That would be in keeping with the history of the introduction of new fuel regulations. The question is just how bad the disruption may be, and importantly, how long it might last. For short-term disruptions, price hikes and administrative actions are likely the way markets and participants will deal with it. While the IMO has said there will not be a postponement of the rule's implementation, the number of government protestors suggests an overall delay, or various exemptions might still be allowed as we draw closer to 2020. IMO has argued that the organization's process for postponing the rule cannot be done with less than 22 months of time prior to implementation, a time span that has passed. A temporary holiday for the rule's enforcement is possible, but likely it would be done through granting waivers, a process that already exists. If we assume the rule is upheld and that everyone attempts to comply, then we can look at past history of fuel shifts for a perspective on the impact on fuel markets.

Exhibit 14. How Fuel Shifts Can Impact Oil Prices



Source: BCG

The spread widened by as much as 10-fold, initially, but then settled out at an average of a 5-fold increase when the rule was actually in place

A Boston Consulting Group chart showing the price spread between low-sulfur and high-sulfur diesel when the U.S. imposed a reduction in mid-2006 offers a possible perspective. The spread widened by as much as 10-fold, initially, but then settled out at an average of a 5-fold increase when the rule was actually in place. That experience suggests a significant price spike for LSFO in those regions where the fuel is not currently mandated, but then easing as time enables

the refining and shipping industries to adjust. That scenario is consistent with how Shell sees the demand shift in bunker fuels shown earlier.

The Iranian Revolution in 1979 produced the largest price spike, but the second least impact on GDP

Another consideration is the broad implications for the global economy from such a price spike for transportation fuels. Mr. Verleger's paper contained some discussion of this topic. One chart he showed was the impact on overall consumption as a percent of GDP in episodes of oil market disruptions. His chart also shows the oil price increase and the corresponding decline in GDP. Interestingly, the Iranian Revolution in 1979 produced the largest price spike, but the second least impact on GDP.

Exhibit 15. Oil Event Impact On Prices And GDP

Table 5. Total US Consumption Loss as a % of GDP During Four Crude Oil Spike Episodes

Episode	Episode Year	Consumption Loss on All Items except Energy as a % of GDP	Oil Price Increase (%)	GDP Decline (%)
Arab Embargo	1973	0.48	61.9	1.6
Fall of Shah of Iran	1979	0.77	102.4	0.8
Invasion of Iraq	1990	0.38	32.2	0.0
2007/08 Price Increase	2007	0.77	79.9	2.5

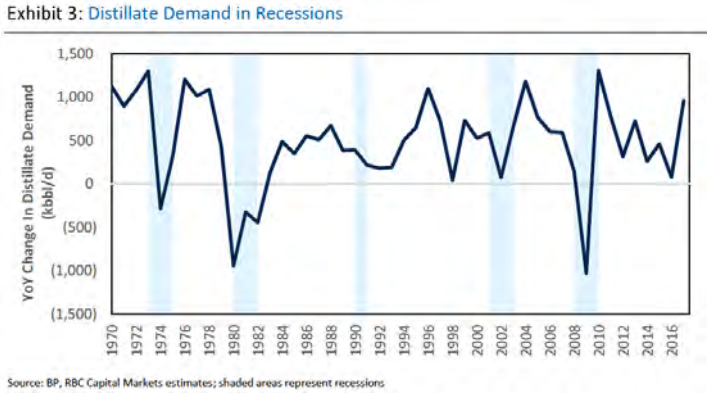
Source: PKVerleger LLC.

Source: Verleger

Note that in 1979 and 2008, distillate demand fell by one million barrels a day, which is a third of the current HSFO consumption of the shipping industry

A chart from an RBC commodity report discussing the IMO 2020 rule's potential impact on the oil market shows how much distillate demand has declined during the most disruptive market and economic events. Whenever the economy collapses rapidly, whether due to oil price spikes or financial calamities, business activity contracts, producing a disproportionate impact on distillate consumption. Note that in 1979 and 2008, distillate demand fell by one million barrels a day, which is a third of the current HSFO consumption of the shipping industry. Shipping, too, will see demand fall as global trade contracts during a recession. If, as some are speculating, the IMO 2020 rule and its disruption to the distillate market creates a severe global recession, the projected fuel market tightness might ease materially.

Exhibit 16. Distillate Demand Falls In Recessions



Source: RBC

We tend to believe the impact from this event will be closer to that of YK2 than the apocalyptical outcomes predicted

While the world as we know it might end on January 1, 2020, when the IMO low-sulfur rule for ships goes into effect, after researching the issue, we tend to believe the impact from this event will be closer to that of YK2 than the apocalyptical outcomes predicted. Much 'sturm und drang' has been introduced into the IMO 2020 issue, but sensationalism always receives more attention than the mundane. Will the world actually lose 3-4 million barrels a day of fuel oil supply due to the shift from HSFO to LSFO?

For marine vessel operators, there will be shortages of LSFO, but this provides the perfect case for seeking waivers from the rule, which will have to be granted

Refined product prices will rise and refining crack spreads will widen, or, in the case of HSFO, decline sharply. That is how markets adjust and send signals to refiners and customers about how best to invest to capitalize on the transitioned fuel oil market. Transportation customers will have to adjust to higher costs, and they will, whenever possible, pass those costs on to consumers contributing to higher inflation. For marine vessel operators, there will be shortages of LSFO, but this provides the perfect case for seeking waivers from the rule, which will have to be granted. The problem will be if ports abandon supplying HSFO as implementation of IMO 2020 begins. We seriously doubt fuel suppliers will execute that strategy without more evidence of exactly how the shipping industry is likely to comply with the rule. The growth of scrubber installations suggests bunker fuel suppliers shouldn't abandon any revenue sources without clear evidence that a market is completely disappearing.

This issue is much more nuanced than many are willing to acknowledge

Given all the variables in assessing how IMO 2020 will impact the global oil market, the fuel oil and distillate segments, transportation companies and consumer inflation, there is no clear answer. This issue is much more nuanced than many are willing to acknowledge. Therefore, is IMO 2020 something to be concerned about? Certainly. To be worried about? Possibly. To freak out about? No.

Trying To Sort Out The Reality Of Electric Vehicle Forecasts

All this activity is in response to forecasts about how large the EV market will eventually become

It seems like every day there is a new revelation about automobile company efforts to boost their electric vehicle (EV) prominence. New EV models are being introduced and dates when customers can begin ordering them are being announced. Companies are building new plants, or repurposing existing assembly plants. New battery lines are being constructed to meet the needs of increased EV output. All this activity is in response to forecasts about how large the EV market will eventually become and, importantly, when it will reach significant size. For energy executives, these developments will have an impact on oil demand, but no one knows by how much or when.

On the web site *wattev2buy.com*, there is a selection tool that enables someone to find the ideal EV model based on answers to a series of questions about planned vehicle use and characteristics

important to the buyer. This section begins with a brief description about "range anxiety," which is known to be a major concern for many buyers, causing them to decide against buying an EV. The term describes fears of consumers that the EV they buy will lose its charge sooner than desired, or needed. That fear is used by uneducated or unscrupulous auto salesmen to push buyers into buying internal combustion engine (ICE) vehicles. While addressing the range anxiety issue, the web site also opines on the impact EVs will have on global oil demand. Quoting from the site:

That fear is used by uneducated or unscrupulous auto salesmen to push buyers into buying ICE vehicles

> "A recent study by MIT proves that around 90% of all personal driving requirements can be met by electric vehicles, and we believe that this figure will improve to 100% by the turn of the decade. In 10 years from now, range anxiety will be synonymous with gas guzzlers. Remember when "Big Coal" disregarded solar power as a threat; that was barely ten years ago. "Big Oil" will suffer the same consequences in the next decade."

How likely is that prediction? A recent study by Marianne Kah, the former economist for ConocoPhillips (COP-NYSE), sponsored by Columbia University's Center on Global Energy Policy, explored why forecasts for EVs and their impact on oil demand differ so significantly, with some very interesting observations. Her study concluded by highlighting those mobility trends requiring more study in order to help improve EV and oil demand forecasts.

Her study concluded by highlighting those mobility trends requiring more study in order to help improve EV and oil demand forecasts

Ms. Kah wrote, "To determine whether the enthusiasm around the potential for EVs to reduce fossil fuel consumption is warranted" surveys need to be examined in greater detail. In her effort to conduct that due diligence, she found that each study was based on different assumptions and employed different methodologies. This meant they could not effectively be compared. Therefore, she selected 15 studies from governments, think tanks, consultants, investment banks, and oil companies in which she sought, on a confidential basis, to obtain comparable data along with the underlying assumptions from their authors.

As Ms. Kah concluded, none of the passenger vehicle forecasts call for much oil consumption growth over the next 25 years. While a few forecasts, especially those calling for limiting carbon emissions to the extent that global temperatures will not rise by more than 2°C by 2100, project a significant decline in fuel consumption by 2040, they do not see demand declining before 2020, and then not much of a decline by 2030. She also pointed out that any oil demand reduction in the transportation sector is also potentially offset by oil demand growth from the petrochemical, aviation and/or freight transport sectors, since they have fewer and more costly substitutes. The key conclusion from her study is that by having a better understanding of the future pace of oil demand growth, oil companies and policy makers will recognize the need for more

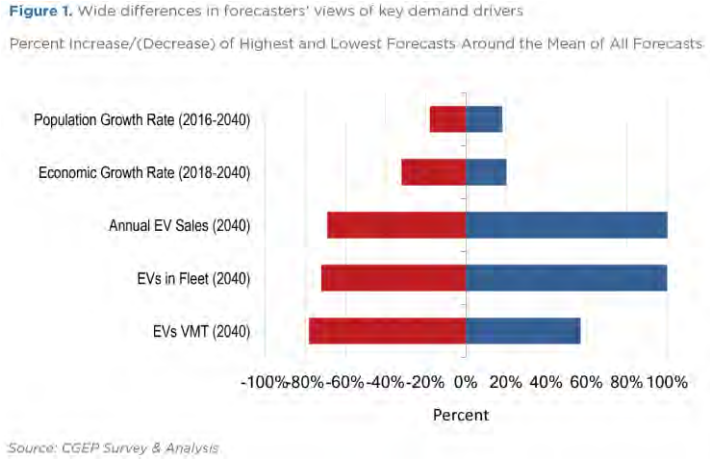
None of the passenger vehicle forecasts call for much oil consumption growth over the next 25 years

investment in new oil supplies to avoid a supply shortage and the accompanying oil price spike likely to be the outcome.

More stringent carbon emissions scenarios may reflect what 'needs' to happen rather than 'what is most likely to occur'

The review showed that there are widely disparate views among the forecasts of the underlying forces driving oil demand growth. The most stringent carbon emissions reduction scenarios assumed significantly lower population growth and higher EV sales and usage than the other scenarios. Ms. Kah suggested that the more stringent carbon emissions scenarios may reflect what 'needs' to happen rather than 'what is most likely to occur.' That difference is significant and can lead to materially different policy actions.

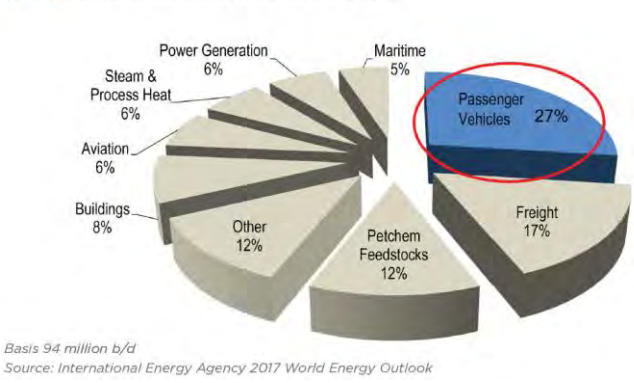
Exhibit 17. Global Oil Market And EV Factors



Source: Marianne Kah

As Ms. Kah points out, when one has such wide differences in the impact of the drivers for oil demand growth, including population growth, economic activity, and EV sales, the forecast outcomes will be wildly divergent. How to reconcile these outcomes is critical for oil executives.

Exhibit 18. Why Cars Are Important To Oil Market

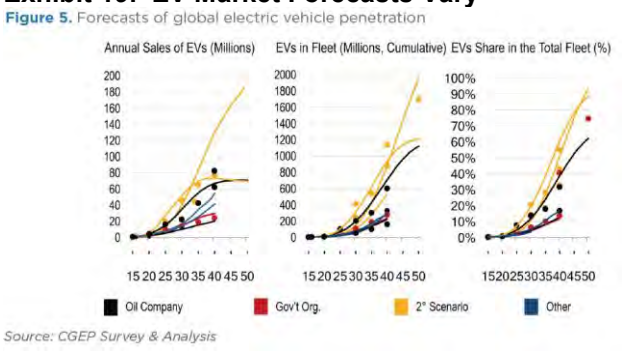


Source: Marianne Kah

It is important for the oil industry to understand how much of that 27% demand share may evaporate with the rise of EVs

The fact that passenger vehicles represent the largest share of global oil demand has been why environmentalists have targeted this sector so aggressively in recent years. It is important for the oil industry to understand how much of that 27% demand share may evaporate with the rise of EVs. On the other hand, we must acknowledge that a major restraint on oil demand growth in this sector has been the improvement in vehicle fleet fuel efficiency. That improvement will continue, with or without the impact of EVs, as more efficient vehicles come to account for an ever-growing share of the world vehicle fleet.

Exhibit 19. EV Market Forecasts Vary

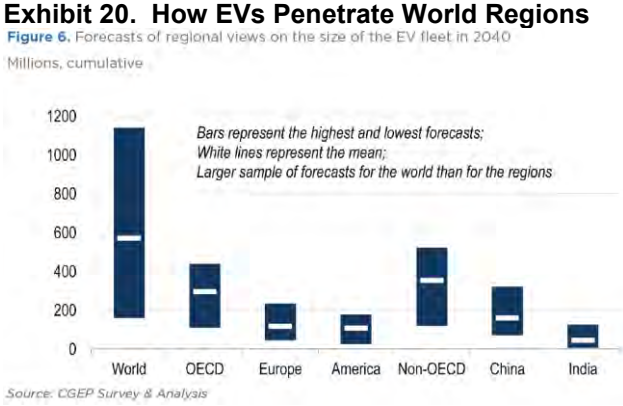


Source: Marianne Kah

Several scenarios see a sharp ramping up in sales beginning in 2020 and ending in 2035

The chart showing differences in EV sales and fleet penetration rates is extremely illuminating. The first of the three charts shows annual EV sales. It provides an interesting perspective on the fleet, in that, other than the lone outlier forecast, the rest of the forecasts range between 20 million on the low side to 80 million on the upper end in 2040. What may be more illustrative of the challenge in understanding the impact of these forecasts on oil demand is the shape of the annual sales' curve heading toward 2040. Several scenarios see a sharp ramping up in sales beginning in 2020 and ending in 2035. On the other hand, numerous forecasts see a steadily increasing growth rate in annual EV sales. The differences

Exhibit 20. How EVs Penetrate World Regions



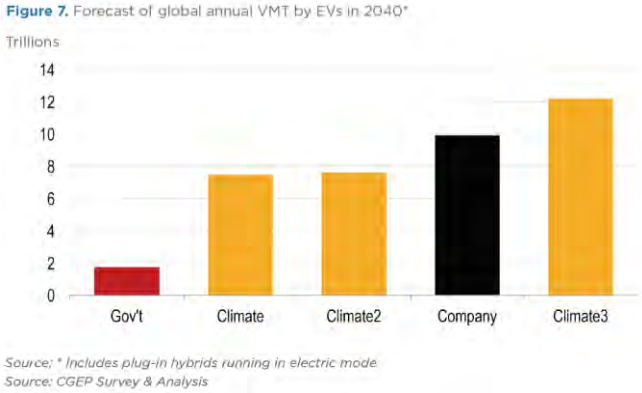
Source: Marianne Kah

in the shape of those sales' forecasts helps explain why total EVs in the fleet grows to higher levels in more scenarios. The timing differences highlighted here is a reason why oil companies must understand more completely the assumptions underlying those rapid EV growth scenarios in order to better prepare for the impact on future oil consumption.

What happens to oil demand and EV sales if attitudes toward EVs change in India and the forecasts prove low?

We found the chart of regional EV markets fascinating. While most media attention on EV sales and market growth focus on the U.S. and Europe, the China and non-OECD markets are much more important to understanding the impact on overall oil demand. The India data in the chart is eye-opening, as it is destined to become a more populous country than China. What happens to oil demand and EV sales if attitudes toward EVs change in India and the forecasts prove low? Is that a risk not being properly assessed by all players in the EV market?

Exhibit 21. VMT Can Vary Even With Few EVs



Source: Marianne Kah

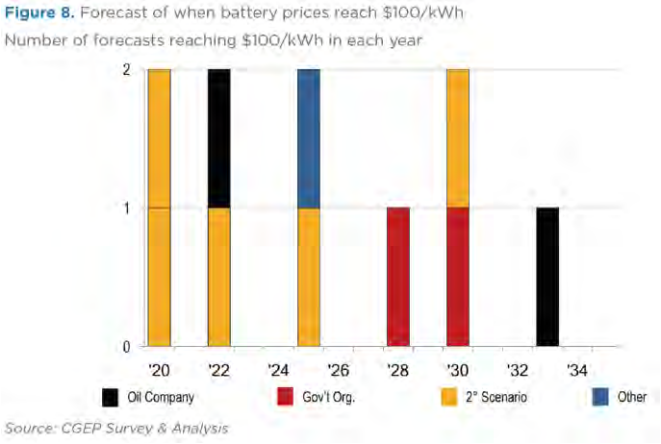
The greatest VMT growth forecast (Climate 3) assumes that by 2040, over half of the passenger vehicle fleet is EVs

The chart showing forecasts of vehicle miles traveled (VMT) highlights an area of little research, but importantly, offering a potential pothole for oil demand. Ms. Kah points to the two forecasts with the largest annual VMT growth as an example why there needs to be more disclosure by forecasters of their assumptions, because of the different impact on oil demand. The greatest VMT growth forecast (Climate 3) assumes that by 2040, over half of the passenger vehicle fleet is EVs. As a result, a substantial share of total VMT is done by EVs. That means a huge negative impact on oil demand. On the other hand, the second highest VMT forecast was prepared by an oil company who believes that EVs won't be a large portion of the global vehicle fleet. Their forecast, however, reflects the oil company's belief that there will be a new mobility model, or transportation as a service (TaaS). In that scenario, autonomous EV fleets provide transportation on demand in urban areas and therefore become responsible for an extremely large share of total VMT. Once again, there will be a disproportionate impact on oil demand.

Personal transportation is undergoing a transformation that will impact VMT, vehicle-of-choice decisions, and oil consumption

So far, however, the growth in mobility as a service, or ride-hailing, has contributed to increased road congestion, dropping average urban highway speed, vehicle fuel efficiency and increasing carbon emissions. The recent announcement by autonomous vehicle software developer Waymo that it is teaming up with Walmart, Inc. (WMT-NYSE) to offer its customers grocery shopping online at a discount, and then having autonomous cars bringing the customers to the store to pick-up their groceries, is an example of how TaaS may reshape travel and the vehicle-of-choice decision. Walmart is reportedly paying for this new service. Waymo also announced an extension of its agreements with AutoNation, Inc. (AN-NYSE) and Avis Budget Group, Inc. (CAR-Nasdaq) to provide temporary transportation for customers when their vehicles are being repaired and for final mile transportation for rental car customers. Personal transportation is undergoing a transformation that will impact VMT, vehicle-of-choice decisions, and oil consumption. What is unknown is the speed in which these new services emerge and how impactful they will be on oil demand.

Exhibit 22. Wide Range Of EV Battery Target Dates



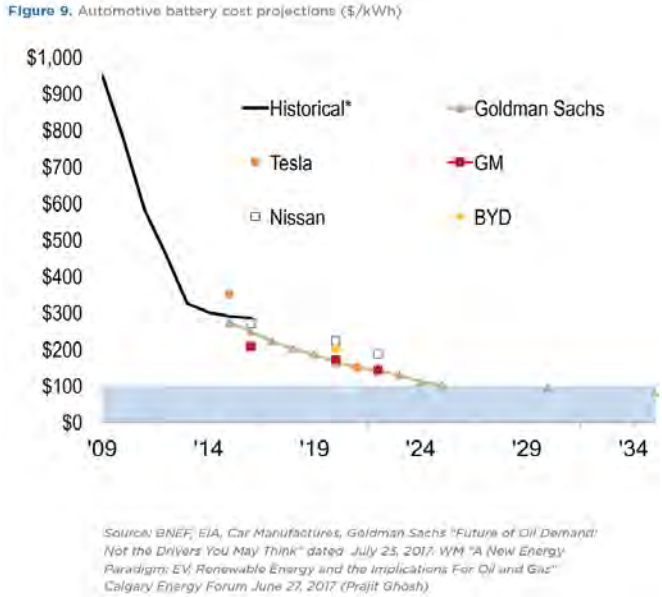
Source: Marianne Kah

A sub-issue is the role of rare earth materials in battery technology and what their availability and cost will mean for battery economics

The critical variable for the success of EVs in displacing traditional ICE vehicles is the cost of batteries. A sub-issue is the role of rare earth materials in battery technology and what their availability and cost will mean for battery economics. Almost none of the EV forecasts addresses these questions, so it is possible that the more optimistic EV sales forecasts overstate their ability to become reality. The two battery charts show when forecasters expect battery costs to reach $100 per kilowatt of capacity as well as what many forecasters project for the battery cost curve.

For oil company managements, the most important outcome from studying the assumptions and methodologies of EV forecasts is how they predict their impact on oil demand. Ms. Kah produced two charts on oil demand – one showing oil consumption in the passenger transportation segment and the other, the impact on total

Exhibit 23. Will Battery Costs Continue Downward Trend?

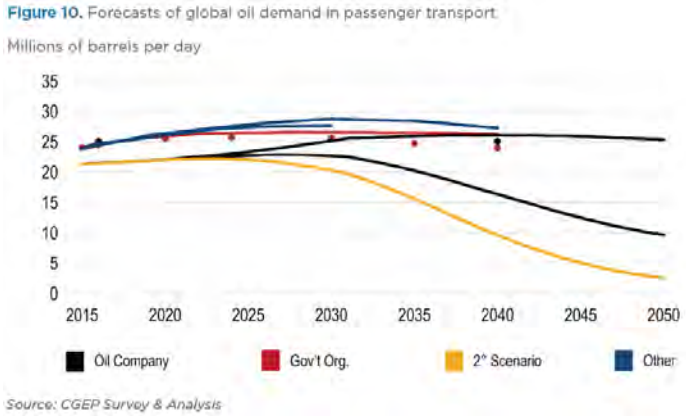


Source: Marianne Kah

It seems that only in the most extreme carbon emission restriction scenarios does oil consumption decline materially, but then not before 2030

global oil demand. In the first case, it was interesting to note the difference in starting points for the various forecasts – nearly a 10% difference. In all cases, there was actually an increase in oil consumption out to 2025, and in some forecasts even longer, before growth flattened and then declined. It seems that only in the most extreme carbon emission restriction scenarios does oil consumption decline materially, but then not before 2030. If those forecasts are truly unattainable, then oil companies need to get back to work finding and developing more oil resources, something that will upset environmentalists. The activity and spending increases will likely force the environmental movement to become more active in ways to disrupt that growth.

Exhibit 24. Passenger Car Oil Demand Forecasts

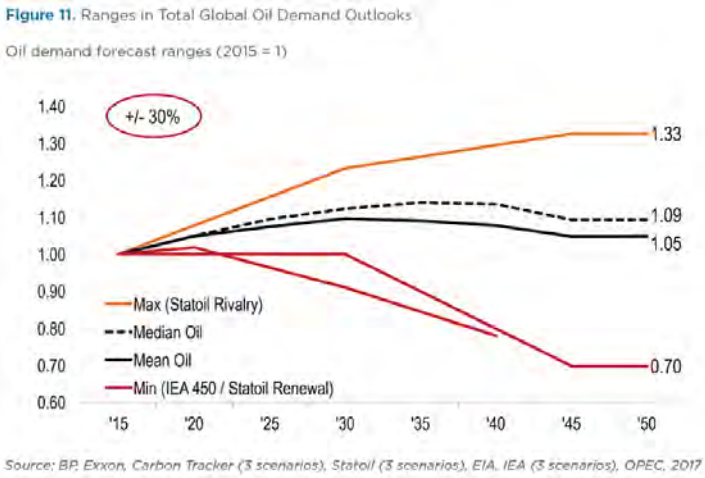


Source: Marianne Kah

With a plus or minus 30% change in oil demand from 2015's starting point, what's an oil company executive to do?

Another startling outcome from Ms. Kah's study is the range in oil demand forecasts by 2050. With a plus or minus 30% change in oil demand from 2015's starting point, what's an oil company executive to do? Seek more insight, which is exactly what Ms. Kah was trying to do. Her effort is not surprising given her 25-year career as the economist for a major oil company.

Exhibit 25. How Widely Oil Demand Forecasts Deviate



Source: Marianne Kah

Will that energy be electric or fossil fuels?

As the study highlights, there is much about the changing transportation market that needs additional research to assess the importance, and how the sector could change. That knowledge would help give greater confidence for oil demand forecasts. The key issues are the growth in autonomous vehicles and new mobility services. Lowering the cost and expanding the convenience of driving will impact VMT and energy use. Will that energy be electric or fossil fuels? The answer to that question may rest on a better understanding of the future trend in battery costs, as well as the role rare earth minerals may play in that equation. A slow expansion of mines could impact the pace of EV growth.

Unless the world moves rapidly toward the low-carbon-emissions scenario, it will be decades before oil demand is impacted by any meaningful degree

Lastly, unless the world moves rapidly toward the low-carbon-emissions scenario, it will be decades before oil demand is impacted by any meaningful degree. The possibility of that scenario becoming a reality likely depends on the actions of governments, which oftentimes are motivated by popular sentiment rather than a rational examination of the reality of technology and the economic cost of such a fuel shift. More insight into these issues and how they impact oil demand is needed, and sooner rather than later.

Lawsuits Over Oil Industry Hiding Climate Risk Roll On

Not long after Rhode Island filed its lawsuit against 100+ oil companies for their continued sale of oil and petroleum products

The Baltimore lawsuit was filed on July 20, one day after a federal district judge dismissed a similar suit by New York City

when they knew of the impact they would have on future sea level increases and damage to the state's coastline, Baltimore launched a similar suit against 26 oil companies. The Baltimore lawsuit was filed on July 20, one day after a federal district judge dismissed a similar suit by New York City. The judge ruled that the issue of climate change needed to be addressed through federal regulation and foreign policy because the issue is global in scope. New York City is considering refiling its suit in state court, hoping it will receive a more favorable (home court) treatment.

The Baltimore suit, as well as the Rhode Island case, have been filed in state courts. Royal Dutch Shell (RDS.A-NYSE) filed a response to the Rhode Island suit requesting that the case be moved to federal court, as it argued that the issue involves interstate commerce and, therefore, is a federal issue. Other cases filed this spring include Boulder, Boulder County and San Miguel County in Colorado against Exxon Mobil Corp. (XOM-NYSE) and Suncor Corp. (SU-NYSE), as well as King County Washington, home to Seattle, who sued five oil companies.

The record of climate change suits filed in federal courts is virtually all in favor of the oil industry

The record of climate change suits filed in federal courts is virtually all in favor of the oil industry. Judges have correctly noted that the issues raised in the lawsuits are of a broader scope than state nuisance laws allow. Even those cases filed in federal court must confront the reality that climate change issues and the policies to address them are legitimately the responsibility of the executive and legislative branches and not that of the judiciary. The grandstanding of these state lawsuits is more important than addressing the legal principles involved.

These developing countries are demanding to know where their money is, and are holding up the progress in writing these rules

One has to wonder how much more money lawyers will make in filing and arguing climate change lawsuits in the one major nation in the world that has a record of significant reduction in its carbon emissions. It is all about money, something we have seen with all the U.S. lawsuits, and even with the issue of countries developing the ground rules for implementing the Paris Climate Accord. In that case, the developing countries were promised $100 billion a year in "reparations" from developed economies for agreeing to use less energy. These developing countries are demanding to know where their money is, and are holding up the progress in writing these rules. The only climate change lawsuit we are familiar with that didn't request money is one in the Netherlands by environmental groups demanding action by Royal Dutch Shell (RDS.A-NYSE) rather than cash payments. We guess those environmentalists don't need the cash as do the states and cities.

New Renewable Technology Effort Derailed By Economics

Public utility commissions are having second thoughts about their approval for rates associated with some of the latest renewable technology efforts. In Maine, the Public Utility Commission has

The PUC indicated that the energy term sheets would add between $172 million and $187 million to customer bills over the 20-year term of the contract compared to today's electricity cost

unanimously voted to review the terms for the Maine Aqua Ventus (MAV) offshore wind project, citing a significant decline in power prices since the contract for its electricity output was approved more than four years ago. The MAV wind project involved utilizing two six-megawatt turbines on VolturnUS, a floating concrete semi-submersible hull designed by the University of Maine. The project has received almost $11 million from the Department of Energy and could receive $40 million in additional funding if it meets certain milestones, although the PUC's decision puts those at risk. The PUC indicated that the energy term sheets would add between $172 million and $187 million to customer bills over the 20-year term of the contract compared to today's electricity cost. That would be a huge burden on Maine electricity ratepayers and worthy of another look.

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