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

Global Coal Market Highlights Green New Deal Problem

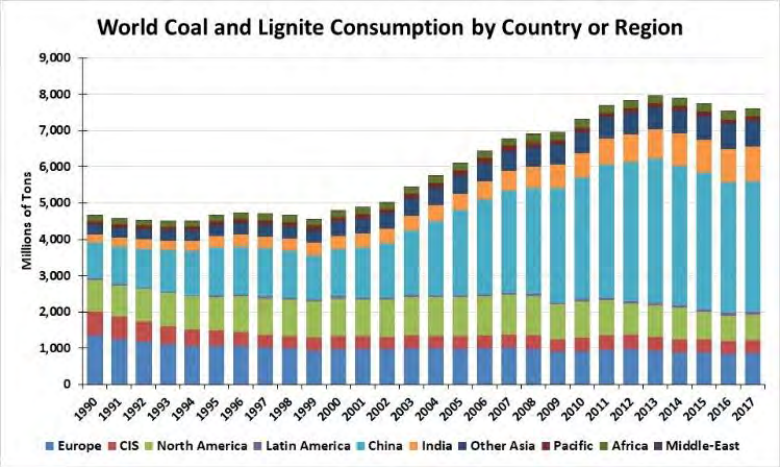
The facts show that outside of the developed economies, the rest of the world is not making a similar commitment

The newly unveiled Democratic Party's Green New Deal to revamp America's energy and economic structures highlights a challenge the effort faces – the rest of the world is not onboard. The core principle of the plan is to "achieve net-zero greenhouse gas emissions and create economic prosperity for all." We will deal with the details of the plan at another time, but suffice it to state that the plan envisions transitioning the United States completely away from fossil fuels of any sort, something that has actually been underway in our electricity generation industry and transportation system. The facts show that outside of the developed economies, the rest of the world is not making a similar commitment. In fact, while the United States is reducing its use of coal to generate electricity, the rapidly growing Asian region is embracing more coal usage – India and China, in particular.

Although coal use in China seemed to have peaked at the same time as North America's consumption, but China's consumption increased in 2017

Since 1990, the consumption of coal and lignite has grown, led by their increased use in the Asian region. As the chart in Exhibit 1 (next page) demonstrates, the use of coal began to climb in 2003, with China's consumption being the main driver. It is interesting to note that since 2013, North American coal consumption has declined, and, more recently, it has fallen in Europe. Although coal use in China seemed to have peaked at the same time as North America's consumption, but China's consumption increased in 2017. More importantly, reports are that China's coal usage grew again last year, despite its commitment under the 2015 Paris Climate Accord to slow, and eventually cut, its carbon emissions, meaning reducing its use of coal.

Exhibit 1. Asia/Oceana Coal Use Drives Emissions

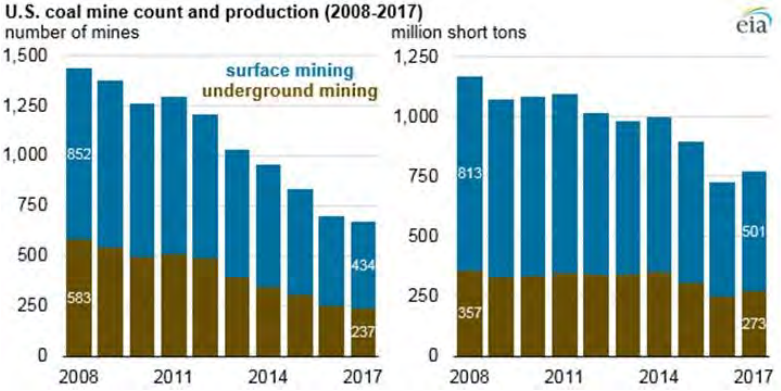


Source: ***Enerdata,*** **PPHB**

Most of the improvement has been due to increased use of coal for steel manufacturing and for export, not much for use in the U.S. power generation market

Now, just as China's coal usage is growing, India's is increasing, too. These increases come as the coal industry in the United States suffers from reduced domestic demand as more and more coal-fired electricity generating plants close. A headline on the Energy Information Administration's "Today in Energy" captured the coal industry's challenge. The headline read: "More Than Half of 2008 Coal Mines Operating in 2008 Have Since Closed." The coal industry in the U.S. has experienced a revival in recent years, but most of the improvement has been due to increased use of coal for steel manufacturing and for export, not much for use in the U.S. power generation market.

Exhibit 2. Contracting U.S. Coal Industry



Source: EIA

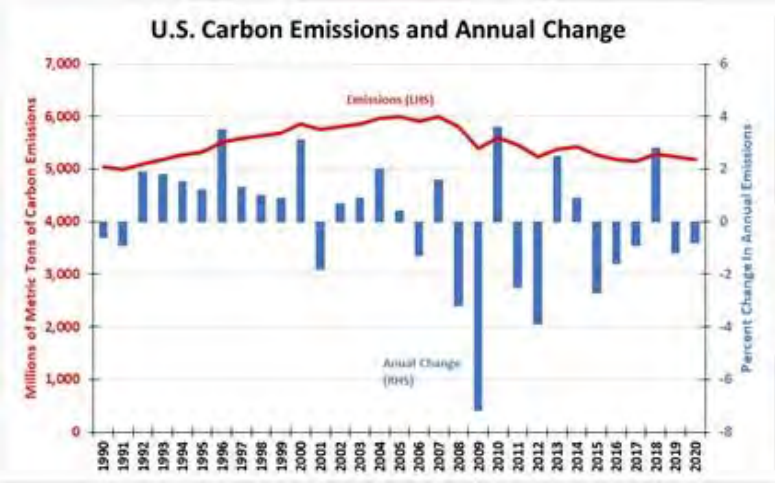
The EIA data shows that during the past decade, the number of mines fell from 1,435 to 671, a 53% decline, at the same time output in the form of millions of short tons fell by 34%. Productivity of mines improved. The number of underground mines declined 59%, but tonnage dropped by only 24%. That contrasts with the 49%

decline in the number of surface mines, but a 38% decline in output. Interestingly, coal employment fell by 37,200 workers, a 43% decline. It is no wonder why mining families in those states where the industry is concentrated are clamoring for help. The loss of coal-mining jobs in the downturn has been a fraction of the job losses experienced by oil and gas workers during the 2014-2016 downturn.

After rising steadily between 1990 and 2006, which coincides with the recent peak in coal output, emissions have been in decline

The decline of the coal industry has corresponded with improvement in United States carbon emissions. Exhibit 3 shows the total volume of carbon emissions for 1990-2020, including forecasts by the EIA for the next two years. After rising steadily between 1990 and 2006, which coincides with the recent peak in coal output, emissions have been in decline. The chart also shows the annual change in total carbon emissions, highlighting how there were only a few years of annual emission declines between 1990 and 2006. Since then, there have only been a few years with emission increases.

Exhibit 3. How Carbon Emissions Are Improving



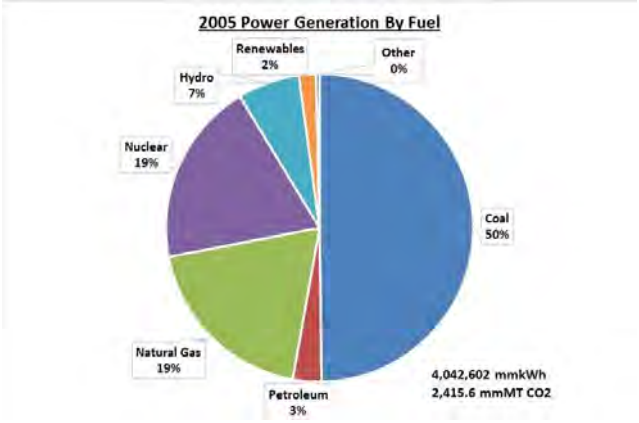
Source: EIA, PPHB

The primary reason for the emissions improvement is the shift in fuel consumption used to generate the country's electricity. Using data for 2005 and 2017, we can see that the total amount of electricity generated barely declined (-0.5%), but carbon emissions fell nearly 38%.

Between 2005 and 2017, coal use went from 50% to 30%

The improvement in carbon emissions from the electricity generation sector is due to the significant increase in natural gas, followed by renewables, which are displacing high-emission coal. Between 2005 and 2017, coal use went from 50% to 30%, while at the same time, natural gas use increased from 19% to 33% and renewable power increased from 2% to 9%.

Exhibit 4. Coal Dominated Power Market in 2005



Source: EIA, PPHB

Renewable power is non-dispatchable, meaning it cannot be counted on to be available at all times

The growing share of power generated by renewable fuels – primarily solar and wind – is creating challenges for utility companies for handling the stability of their grids given the variability in renewable energy. Renewable power is non-dispatchable, meaning it cannot be counted on to be available at all times. That is because solar power is only generated when the sun shines. In the case of wind power, although it is plentiful in many locales in the United States, and especially offshore, it can't be counted on to provide electricity all the time. Its failure to deliver power often comes at the most inconvenient times, as power customers unfortunately find out. Wind, contrary to the popular claims by environmentalists, does not always blow somewhere, meaning that it merely needs to be delivered to the right customers at the right time.

Exhibit 5. Natural Gas Gains In Power Fuel Market

Source: EIA, PPHB

The recent bitter cold spell that the Polar Vortex brought to the nation's Midwest and Northeast regions highlighted the growing problem of placing total dependence on renewables for power generation. In Minnesota, in late January, as temperatures fell well

Wind produced only 4% of the electricity generated on the MISO regional power grid

below zero, power data showed that wind produced only 4% of the electricity generated on the MISO regional power grid, of which Minnesota is a part. The wind output represented only 24% of the installed wind generating capacity in the region. Coal generated 45% of MISO's power, while nuclear provided 13% and natural gas accounted for 26%. This energy mix was presented as an argument why Minnesota politicians should rethink their push to double the state's renewable energy mandate to 50% of power by 2030.

Xcel Energy urged its natural gas customers in a number of cities to reduce their thermostat settings

The researchers also pointed out that natural gas not only was supplying a significant amount of electricity in the region, but also was heating 66% of the homes in Minnesota. Xcel Energy urged its natural gas customers in a number of cities to reduce their thermostat settings, initially to 60 degrees, but then to only 63 degrees, to conserve supply and prevent a widespread shortage. This was happening as temperatures remained at -14° F. In one locale, gas customers actually lost their service, but Xcel Energy had reserved rooms for them in nearby hotels.

In an article published on the web site for the Center of the American Experiment, Isaac Orr wrote of the problems encountered by the Polar Vortex cold wave and the lack of wind power and natural gas supply. In his article, he utilized various screen shots from the web site *electricitymap.com* that show how the power in specific regions is being generated at that very moment. At 10:28 am on January 30, the site reported that only 4% of power was being generated by wind on the MISO system. Total renewable energy was 6% of the power output. The power site also showed that at the same time, California had 3% of its electricity coming from wind, while solar was contributing 12%. The site reported that renewable fuels, which includes geothermal, hydro and biomass, along with wind and solar, were generating 32% of California's power. California was also importing 27% of its power from Nevada and Arizona, which means power generated by coal.

The Texas power grid operator is raising power prices during upcoming high demand periods to encourage generators to keep their coal plants operating

While there is a push towards more renewables due to their cleaner, and supposedly cheaper power, the Texas power grid operator is raising power prices during upcoming high demand periods to encourage generators to keep their coal plants operating. The member companies of the Texas Competitive Power Advocates, a group of power plant operators who generate about 60% of the state's electricity, plan to invest over $100 million in existing plants to prepare for the upcoming summer demand. This investment is coming following last month's decision by Texas regulators to raise wholesale power prices during times of peak demand, lifting prices for homeowners and businesses. The rate hikes will boost the revenues earned by these power generators. Without this increase, the generators would have little incentive to build new power plants and renew existing ones in order to meet the state's growing population and demand for energy, in order to avoid power shortages.

Last summer, Calpine opted to run its three natural gas-powered plants continuously instead of idling them at night when the wind blows

As power suppliers have shut down or mothballed coal-fired power plants, the state's power reserve margin is at a record low heading into the summer demand season. The higher rates and increased revenues allow power generating companies to justify the investment in keeping older plants operating. Last summer, Calpine opted to run its three natural gas-powered plants continuously instead of idling them at night when the wind blows. The company lost money at night when strong winds in West and South Texas pushed power prices to zero, but the plants were able to ramp up more easily in the morning as power demand and prices rose.

While these power generators point to the thousands of megawatts of new generating projects they are considering, Ramanan Krishnamoorti, chief energy officer at the University of Houston, questions this investment strategy. He believes that with more megawatts of solar power by 2020, more than a doubling of what was operating in 2017, he believes power prices will not rise as much during the day when the sun is bright and solar can generate its maximum output. Coupled with wind power having cut nighttime power prices, he wonders why anyone would be investing in new natural gas generating plants.

The cost to German electricity customers and the nation's economy will be high

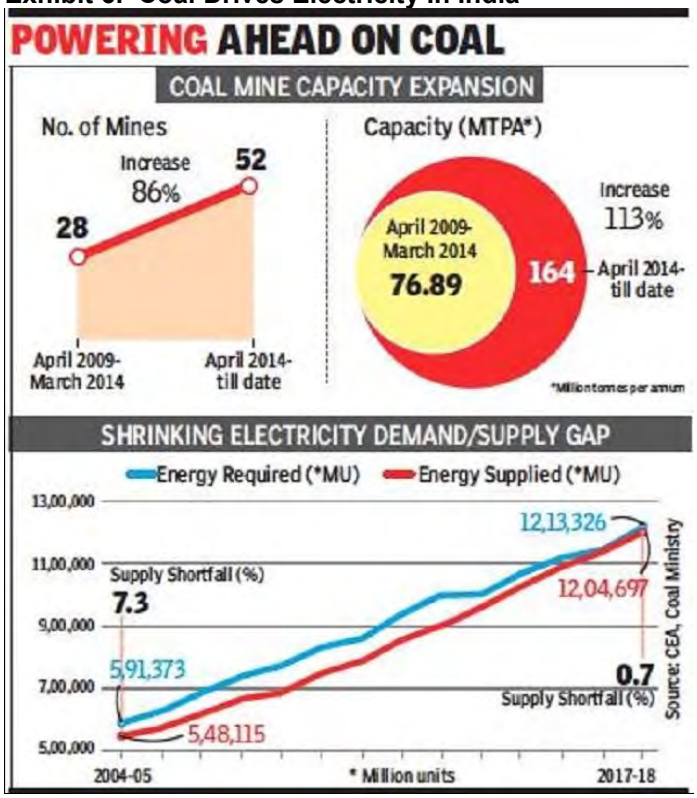
What is happening in the United States through market mechanisms and legal mandates, is being pushed aggressively in Germany where the country is developing a plan to shut down all coal-fired power plants and coal mining operations by 2038. The details of the proposed plan have just been released, and the cost to German electricity customers and the nation's economy will be high. But, as developed economies such as Germany are working to shed their dependence on fossil fuels for power generation, the opposite is happening in India.

The Narendra Modi government recently announced it has opened 52 new coal mines since it came to power in May 2014. These mines represent 86% growth over the number of mines added in the 5-year period 2009-2014, when most projects were hampered by red tape, especially pertaining to environmental and forest clearance permits. The government touted the structural reforms it has made in the cumbersome process for attaining the necessary approvals and permissions from the various statutory authorities to its effort to achieve its village and household electrification programs, a major government social effort.

57% of installed capacity as of December 2018 is fired by coal, with renewables accounting for 21%

As the government has worked to provide electricity to India's population, it established a target for power needed to achieve its goal, and against which it can measure its supply achievement. To appreciate how important coal is to the government's electrification plan, one needs to look at the installed generation capacity by fuel. Exhibit 6 (next page) shows that 57% of installed capacity as of December 2018 is fired by coal, with renewables accounting for 21%. Hydro is the third most important power generation fuel

Exhibit 6. Coal Drives Electricity In India

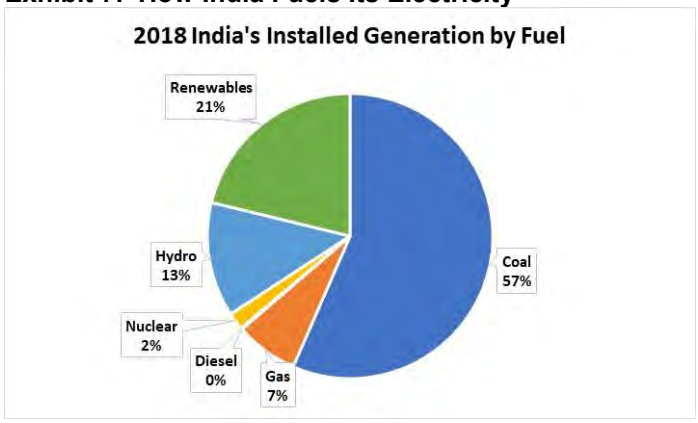


Source: ***India Times***

India is also working to establish a liquefied natural gas import system

source. Neither natural gas or petroleum provide much power, which is largely due to the lack of hydrocarbon resources, although oil and gas discoveries offshore India may help change that situation. India is also working to establish a liquefied natural gas (LNG) import system to help reduce the pollution from the nation's fossil fuel consumption.

Exhibit 7. How India Fuels Its Electricity

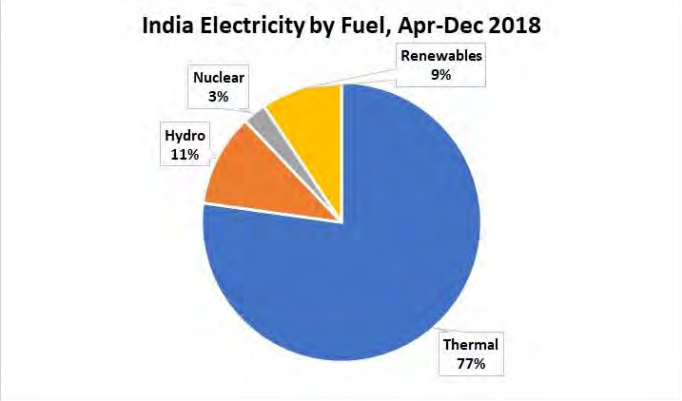


Source: CEA, PPHB

Renewables only supplied 9% of total electricity generated

While renewables account for 21% of installed electricity generation at year-end 2018, when we examine the most recent data for the 2018-19 fiscal year, we find renewables account for a much smaller share of power. According to the April to December power generation statistics from India's Central Electricity Authority, renewables only supplied 9% of total electricity generated.

Exhibit 8. Fossil Fuels And Coal Actually Create Most Power

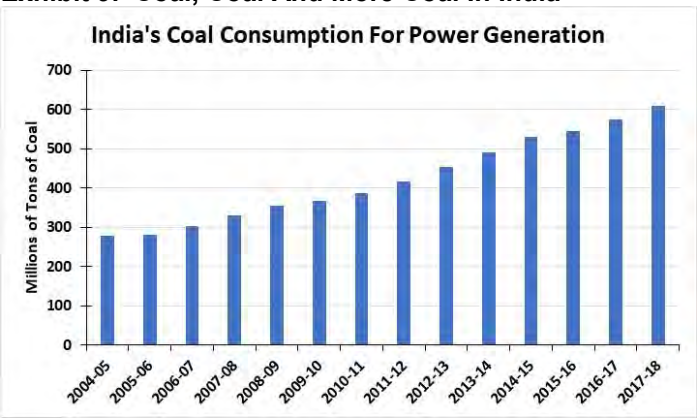


Source: CEA, PPHB

The new mines opened added 164 million tons to India's annual coal production capacity, marking a 113% increase over the amount of coal capacity added during the 2009-2014 period

Natural gas and coal, which accounted for 64% of total installed generating capacity at the end of 2018, were the source of 77% of the nation's electricity produced. The importance of coal for India's power generation program cannot be underestimated. It is why the government is working to make it easier for the opening of additional mines. The new mines opened added 164 million tons to India's annual coal production capacity, marking a 113% increase over the amount of coal capacity added during the 2009-2014 period. This coal production capacity will help India's government rapidly move towards universal electricity access without creating power shortages.

Exhibit 9. Coal, Coal And More Coal In India



Source: CEA. PPHB

The facts are that coal is abundant, relatively easy to extract, and one of the cheapest energy fuels

The reliance on cheap coal for developing economies such as India and China helps explain the challenge for the environmental movement in creating a climate-change initiative designed to eliminate this dirty fuel from the global energy slate. The facts are that coal is abundant, relatively easy to extract, and one of the cheapest energy fuels. This explains why developing countries embrace it for much of their power generation, at least when they are in their initial and accelerating growth phases. The challenge for eliminating coal is highlighted by world's emissions data for the past four years showing annual carbon emission changes for various countries and regions.

Exhibit 10. How China And India Drive Emissions

Source: *Enerdata*, PPHB

In the case of India, whose energy demand is growing at 5% per year, and the government is committed to providing electricity to every home in the nation, getting the country to shift its fuel focus will be extremely difficult

A Green New Deal, if implemented to its fullest extent will achieve little for cleaning up the planet unless countries such as India and China commit to a similar carbon emissions reduction effort. In the case of India, whose energy demand is growing at 5% per year, and the government is committed to providing electricity to every home in the nation, getting the country to shift its fuel focus will be extremely difficult. China has agreed to stop the rise of its carbon emissions by 2030. It also agreed at the Paris Climate Conference in 2015 to grow its renewable fuel share of energy to 20%, reportedly already achieved, although there are often reports of wind farms that are not yet connected to the grid, so they are providing no clean power.

The cheap and abundant coal resources in the world, coupled with developing foreign economies striving to raise the living standards of their people at the least cost, mean that coal will remain a significant fuel source for global energy for a long time. This is a reality that the Green New Deal promoters have yet to face. Eliminating coal will be neither cheap nor quick. Facts often spoil dreams.

Winter Highlights A Critical Hurdle For Autonomous Cars

They are unable to figure out how to drive on snow covered roads

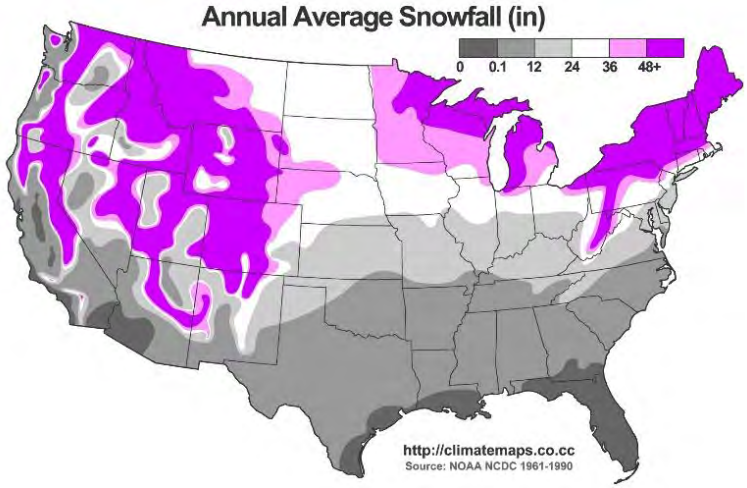
The recent Polar Vortex that brought bone-chilling cold, setting numerous record-low temperature readings for many cities and localities throughout the Midwest and Northeast, following a significant snowstorm that hit these areas, highlighted one of the major challenges for autonomous vehicles (AV). They are unable to figure out how to drive on snow covered roads. Without the ability to

The light beams sent out by the laser sensors that control the vehicle can bounce off snowflakes, making it seem like they are obstacles to be avoided, rather than something the car can drive through

track the lane markers and curbs of roads, AVs do not know where they are or where they are going. In particular, the light beams sent out by the laser sensors that control the vehicle can bounce off snowflakes, making it seem like they are obstacles to be avoided, rather than something the car can drive through. In light of the January storm, executives involved in AV testing in Pittsburgh, Pennsylvania acknowledged to reporters that the idea of AVs being on the public highways in any great numbers is at least a decade away, and possibly multi-decades away if technological breakthroughs aren't made.

While everyone involved in the transportation business hails the long-term benefits that will come from self-driving vehicles, primarily their greater safety, the risks associated with AVs, given the technological challenges of winter-time driving as well as other hurdles, means they will most likely only address niche markets, largely defined by geography and climate. North America and Western Europe are home to cold countries that experience numerous snow storms that will ground AVs unless and until new technology solves their challenge.

Exhibit 11. Historical Data On Regional Snowfalls

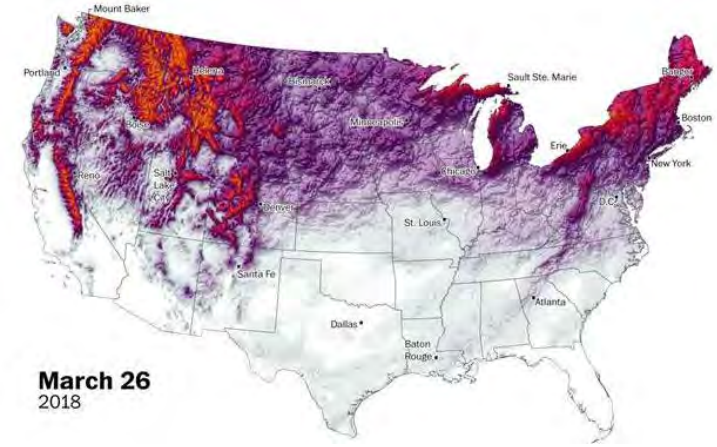


Source: NOAA

AVs will be challenged to operate at times during the winter

Other than the very darkest spots on the U.S. map where the annual average snowfall is between zero and 0.1 inches, AVs will be challenged to operate at times during the winter. The data for the map covers annual snowfall amounts during 1961-1990. In spite of the clamor over global warming and the ending of snowfalls as we know them, the map in Exhibit 12 (next page), which reflects the cumulative snow amounts during the winter of 2017-2018, shows a similar geographic coverage as the earlier one. The gray area on the map reflects cumulative snowfall of between 1" and 24", while the pink is for 24"-48" and the purple covers between 48" and 120", and the bright red, 120"-240".

Exhibit 12. 2017-18 Winter Snowfall Amounts



Source: NOAA

Roadway markings are not uniform and may not even exist

AV software that can differentiate between real obstacles and snowflakes is being developed. However, AVs are also challenged by fog, rain and dust storms that obstruct clear vision of a road's surface. That technology is further challenged by the reality that roadway markings are not uniform and may not even exist. This forces AVs to have to "learn" how to drive in each different city. One issue cited with lane markings is highlighted in Pittsburgh where AVs are being tested. In certain parts of town, the stop markings at intersections are so far back, and neighboring buildings so close, that the AVs cannot "see" traffic from adjacent streets. The cars are having to be taught to begin creeping closer to the physical intersection in order to determine if there are hazards from oncoming vehicles. Once again, the challenge is that not every intersection is the same, so each needs to be programmed separately. Learnings by cars may be just as challenging as learnings by humans.

The software to drive AVs is also challenged by the irrational, as well as traditional interactions of humans with vehicles

The software to drive AVs is also challenged by the irrational, as well as traditional interactions of humans with vehicles. Double parking, walking in front of cars, and cars not stopping before turning right on red lights are merely a few of the instances for which AV software must make adjustments. There are also those times when a driver makes eye contact with another driver to convey a likely move. How AVs interact with cars driven by humans remains a serious issue.

That challenge is further demonstrated in programming for the left turn decision when a green light is not present. Human drivers, facing that challenge, attempt to gauge the flow of traffic before making a left-hand turn. AVs face the same challenge. Companies testing autonomous driving vehicles continue to admit that their cars still have problems at intersections.

The biggest problem for AVs, however, seems to be low consumer acceptance, despite the supposed strong positive qualities associated with self-driving vehicles. The deadly pedestrian

A recent AAA survey found that 73% of American drivers would be too fearful to ride in a fully self-driving vehicle

accident in Phoenix involving an Uber AV test car has left Americans less sold on the technology. A recent AAA survey found that 73% of American drivers would be too fearful to ride in a fully self-driving vehicle. That was up from 63% in a late 2017 survey, and obviously a reflection of the Phoenix accident.

The snow issue suggests that even when AV technology solves some of its challenges, unless it can overcome snow and other bad weather challenges, it will not become a mainstream automobile technology. Data from the National Climatic Data Center of the National Oceanic and Atmospheric Administration showing the average annual snowfall for each state, measured in various locations, highlights where AVs will be only a part-time transportation option.

Exhibit 13. State Average Snowfall Amounts And Days

Days	State	Place	Inches	Centimeters
0.8	Alabama	Birmingham	1.6	4.1
48.0	Alaska	Anchorage	74.5	189.2
0.3	Arizona	Tuscon	0.3	0.8
3.8	Arkansas	Fort Smith	5.2	13.2
0.0	California	San Diego	0.0	0.0
19.1	Colorado	Grannd Junction	19.1	48.5
20.1	Connecticut	Hartford	40.5	102.9
11.8	Delaware	Wilmington	20.2	51.3
0.0	Florida	Tampa	0.0	0.0
0.7	Georgia	Macon	0.7	1.8
0.0	Hawaii	Honolulu	0.0	0.0
19.4	Idaho	Boise	19.2	48.8
19.9	Illinois	Peoria	24.6	62.5
23.5	Indiana	Indianapolis	25.9	65.8
26.2	Iowa	Des Moines	34.9	88.6
10.0	Kansas	Wichita	14.7	37.3
11.6	Kentucky	Louisville	12.5	31.8
0.1	Louisiana	New Orleans	0.0	0.0
27.8	Maine	Portland	61.8	157.0
9.6	Maryland	Baltimore	20.2	51.3
22.4	Massachusetts	Boston	43.8	111.3
44.7	Michigan	Lansing	51.1	129.8
37.3	Minnesota	Minneapolis	54.0	137.2
0.6	Mississippi	Jackson	0.9	2.3
11.5	Missouri	Springfield	17.0	43.2
32.9	Montana	Helena	38.1	96.8
18.3	Nebraska	Reno	21.8	55.4
29.8	New Hampshire	Concord	60.8	154.4
8.7	New Jersey	Atlantic City	16.5	41.9
9.5	New Mexico	Albuquerque	9.6	24.4
66.4	New York	Syracuse	123.8	314.5
3.9	North Carolina	Greensboro	7.6	19.3
45.2	North Dakota	Bismarck	51.2	130.0
30.4	Ohio	Columbus	27.5	69.9
5.6	Oklahoma	Oklahoma City	7.8	19.8
2.2	Oregon	Portland	3.0	7.6
19.4	Pennsylvania	Harrisburg	28.2	71.6
18.7	Rhode Island	Providence	33.8	85.9
0.3	South Carolina	Columbia	0.5	1.3
30.1	South Dakota	Huron	43.9	111.5
6.2	Tennessee	Nashville	6.3	16.0
1.3	Texas	Dallas	1.5	3.8
34.8	Utah	Salt Lake City	56.2	142.7
54.4	Vermont	Burlington	81.2	206.2
6.1	Virginia	Richmond	10.3	26.2
3.0	Washington	Seattle	5.0	12.7
37.7	West Virginia	Beckley	62.0	157.5
38.7	Wisconsin	Madison	50.9	129.3
36.7	Wyoming	Lander	91.4	232.2

Source: ***Current Results***

Since AVs are being designed without steering wheels and pedals, they will not be available for manual driving in bad weather, even if the owner felt confident in operating a vehicle in such weather

As we reviewed the data, we were amused because we have been in several of the states and cities cited when the snowfalls were much greater than the annual average estimated and local mobility was shut down. New Orleans, Louisiana was one example. The point of the table is to highlight states and cities where residents contemplating owning AVs may not have unrestricted use. Since AVs are being designed without steering wheels and pedals, they will not be available for manual driving in bad weather, even if the owner felt confident in operating a vehicle in such weather. Will AV owners be entitled to "snow days" like school shutdowns? As the most optimistic assessment for when AVs will overcome the weather challenge is 10 years, we are not factoring them into our assessments of AVs' impact on driving and gasoline demand.

As Tim Cook, the CEO of Apple put it, a self-driving car is the largest artificial intelligence project, which will test technology

It is also instructive to note that some of the self-driving car research efforts are being scaled back, suggesting that maybe not all participants in this market believe they can become successful. Apple Inc. (AAPL-Nasdaq) has reportedly been working on a self-driving car for a number of years. Earlier this year it laid off, or transferred to other operations, about 200 staff from its Titan project. While the company is tight-lipped about new product developments, the fact that self-driving cars face significant regulation, it hasn't been able to hide everything. As of last year, Apple had 70 vehicles approved for self-driving testing in California, one of, if not the largest test vehicle fleets. Speculation following the staff layoff is that Apple has shifted from focusing on a vehicle to developing the software to drive vehicles, which could be used by its partners such as Volkswagen. As Tim Cook, the CEO of Apple put it, a self-driving car is the largest artificial intelligence project, which will test technology. Cracking that technology challenge could open up other applications that might be more feasible for Apple from a future product point of view. The direction change, however, points to a shift in emphasis and timing of AVs, not inconsistent with others comments about the timing being a decade or more away from being road-worthy.

Could Auto Market Help Mitigate IMO 2020 Compliance?

The global high-sulfur fuel oil market is estimated at between 3-4 million barrels per day of consumption

One of the great concerns about the health of the future oil market is the impact from the United Nation's International Maritime Organization's rule mandating all ships switch from burning fuel oil with a 3.5% sulfur content to fuel oil with only 0.5% sulfur content. The switch to low-sulfur oil, mandated to occur on January 1, 2020, is expected to cause shipping costs to rise sharply as low-sulfur fuel oil (diesel/gasoil) is expected to be in short supply. Ships would be bidding against traditional diesel consumers – autos, trucks and rail locomotives – at the same time refiners will be aggressively seeking low-sulfur crude oils to boost their refinery output of the compliant low-sulfur fuel oil. The global high-sulfur fuel oil market is estimated at between 3-4 million barrels per day of consumption. If all this demand shifts to low-sulfur oil, oil markets will experience turmoil.

Initial analyses called for significant disruption with the potential for oil prices soaring as high as $250 per barrel to satisfy demand

Will that turmoil be experienced, and if so, how disruptive might it be for the global oil market? Initial analyses called for significant disruption with the potential for oil prices soaring as high as $250 per barrel to satisfy demand. We have always believed these analyses failed to take into account the multiple ways in which shippers, and the refining industry, may mitigate outright market disaster, something $250 per barrel oil prices would create.

Capital investments will require analyses of expected fuel availabilities and future costs, as they will impact the payback-time of the modification relative to the ultimate remaining life of the vessel

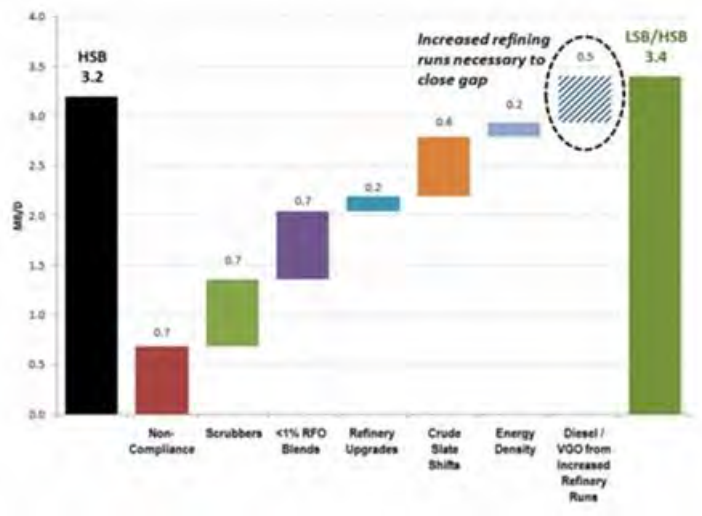
What are the options for shippers? Briefly, they can switch to low-sulfur fuel even if it is more expensive. They can install engine exhaust scrubbers onboard the ship that capture the sulfur emissions after the fuel is burned. They can use a blended low-sulfur fuel oil created by mixing low-sulfur diesel and high-sulfur fuel oil. They can modify their ship's power system to burn LNG, as well as install a gas storage system onboard. They can apply for an exemption from IMO while operating in areas where no low-sulfur fuel oil is available. Lastly, they can fail to comply. All the options, with the exception of the last two, require the ship's owner to make either a capital investment in the vessel or absorb higher operating costs. The shipowner's choice may depend on the vessel's contract status: long-term charters traditionally shift the fuel cost to the charter. Capital investments will require analyses of expected fuel availabilities and future costs, as they will impact the payback-time of the modification relative to the ultimate remaining life of the vessel. Look for an uptick in vessel retirements as a result of higher fuel costs and capital investment decisions.

A final option for a ship's owner responsible for the fuel cost is to "slow-steam" to limit the amount of fuel burned on trips. A variation on this theme was recently presented at a shipping conference where a consultant offered the prospect that very large container ships, currently using the Panama Canal to reach Gulf and East Coast ports, might opt to deliver their cargos to West Coast ports to reduce the length of the trips, and the amount of fuel they would burn. This adjustment might limit the rise in cargo rates. Whichever option is elected, shippers face higher costs.

More sophisticated refineries are capable of producing higher volumes of low-sulfur petroleum products, but it requires substantial capital investment, and time, to reconfigure less sophisticated plants

Refineries will also be impacted. They will be competing for low-sulfur crude oils to ease the stress of producing more low-sulfur compliant fuel. More sophisticated refineries are capable of producing higher volumes of low-sulfur petroleum products, but it requires substantial capital investment, and time, to reconfigure less sophisticated plants. Global integrated oil companies are most likely to own and operate sophisticated refineries, and thus most likely to invest in upgrading their plants. They are very interested in being able to meet the fuel needs of their global customers anywhere in the world. These are the refinery owners who are making the capital investments in upgrading their plants. There is also the prospect that the global refining industry operates at a higher utilization rate than normal for a brief period of time at the beginning of IMO 2020 enforcement.

Exhibit 14. How IMO 2020 Demand May Be Met



Source: RBN Energy

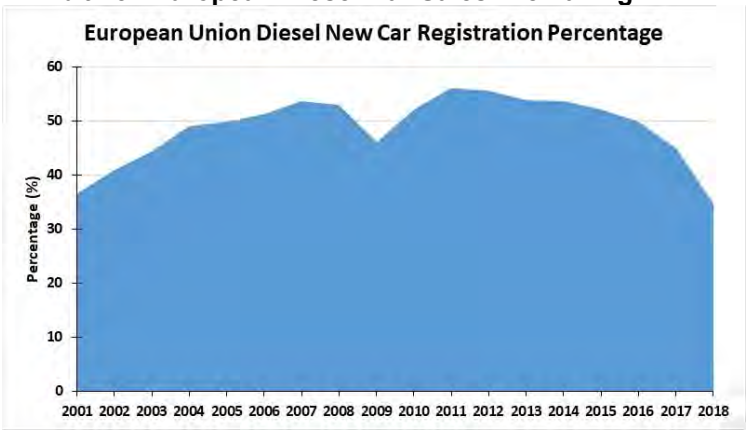
For many years, diesel cars were favored by drivers for their increased fuel-efficiency, less polluting nature and cheaper fuel due to government subsidies

An analysis of the impact of "IMO 2020," as it is called, by consultants Baker & O'Brien, suggests a number of fuel transition steps that reflect the multitude of options for shippers and refiners that were outlined above. Those steps and their estimated magnitude are shown in Exhibit 14. Another consideration for meeting the potential low-sulfur fuel shortfall, but one we have yet to see mentioned anywhere, is the decline in auto diesel fuel in Europe in response to collapsing diesel car sales. For many years, diesel cars were favored by drivers for their increased fuel-efficiency, less polluting nature and cheaper fuel due to government subsidies. That favored position existed up until 2015 when "Dieselgate," as the emissions cheating scandal promoted by German car manufacturer Volkswagen along with other German car brands, exposed the fallacy of diesel cars being environmentally friendly. That discovery shocked not only prospective diesel car buyers, but also current diesel car owners. Governments also reacted to the discovery in ways diesel car owners were not happy about – higher fuel prices and proposals to ban driving diesel cars in many European central cities. Those prospects are leading to lower resale values for existing diesel vehicles. The municipal bans are seen as the only way to address the carbon emissions building up in urban areas, since diesel cars have now proven not to be a realistic solution. With the anti-fossil fuel movement cheering, European governments also moved to ban the sale of internal combustion engine (ICE) cars, with plans to eventually eliminate all operating ICE vehicles.

As a result of the bans, new diesel car sales in Europe have crashed. The fall in diesel car sales will reduce fuel demand – initially diesel fuel and then gasoline. These market forces are also causing governments to eliminate diesel fuel subsidies, making the fuel much more expensive and further pressuring vehicle sales in

Europe. New diesel car registrations in 2018 fell to a near-term low of under 35%, down from the peak in 2011 of over 56%. Although electric vehicles are gaining market share, most of the market shift has been toward ICE cars.

Exhibit 15. European Diesel Car Sales Are Falling

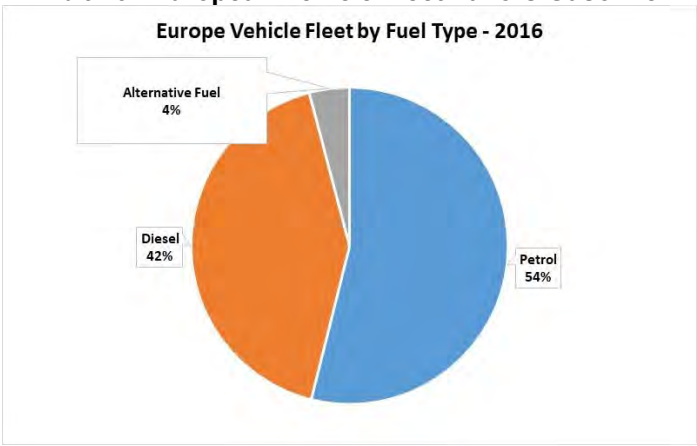


Source: ACEA, PPHB

The fleet mix in the European Union is weighted toward ICE cars, but not by a substantial margin (54% vs. 42%)

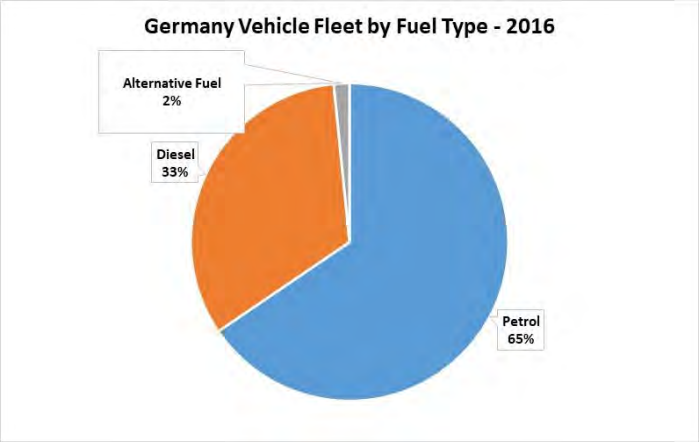
This fleet shift away from new diesel car sales will correspondingly create a mix shift for the overall fleet. The most recent fleet data is for 2016 from the European Automobile Manufacturers Association. It shows that the fleet mix in the European Union is weighted toward ICE cars, but not by a substantial margin (54% vs. 42%). When we focus on two of the largest car markets on the European continent, we see a substantial difference in fleet mix, which reflects the heavy subsidization of diesel fuel in France, making it much cheaper than regular gasoline, compared to Germany.

Exhibit 16. European Vehicle Fleet Favors Gasoline



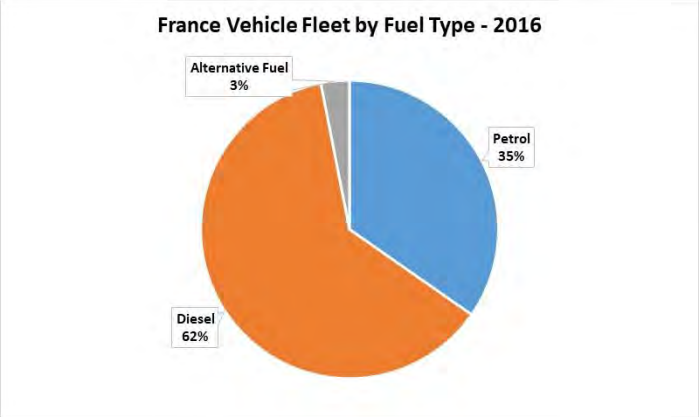
Source: ACEA

Exhibit 17. Germany's Fleet Heavily Favors Gasoline



Source: ACEA

Exhibit 18. France Vehicle Fleet Favors Diesel Power



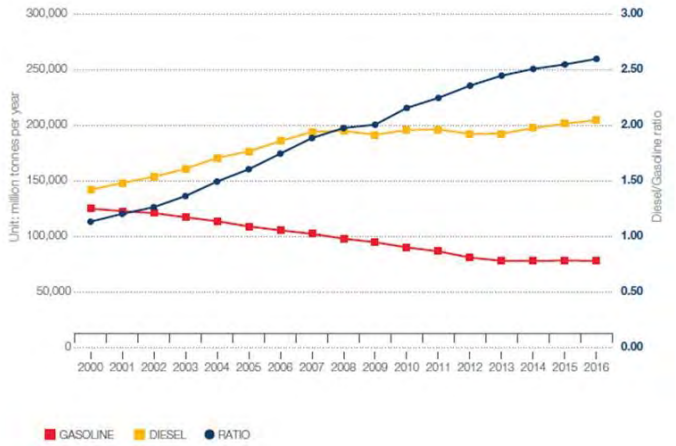
Source: ACEA

The diesel fuel market is not only impacted by the attitude of governments and their citizens to this fuel versus gasoline and ultimately electric vehicles (EV), there is also an issue with how the vehicles are driven. In Norway, for instance, many families have an EV for commuting and driving around town because of their favored treatment – no tolls, free parking, and access to HOVs. The families use ICE vehicles for their long trips due to the range issue with EVs.

Between 2000 and 2013, gasoline volumes declined steadily, which would seem to be reflective of the trend of rising new diesel vehicle registrations

The variable use factor appears to be reflected in the fuel use growth trend data. As Exhibit 19 (next page) shows, diesel fuel volumes rose steadily from 2000 to 2006, and then went sideways until 2014, at which time they started rising again. That was before Dieselgate and the recent rejection of diesel cars. Interestingly, between 2000 and 2013, gasoline volumes declined steadily, which would seem to be reflective of the trend of rising new diesel vehicle registrations.

Exhibit 19. Europe Diesel Fuel Volumes Slowing

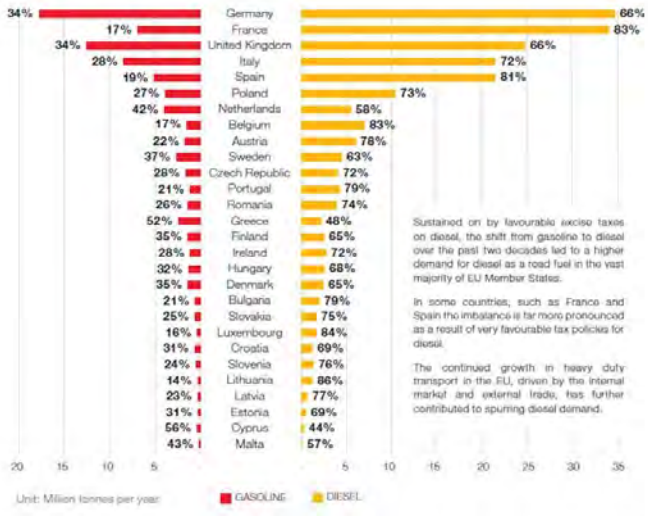


Source: Wood Mackenzie

The two largest EU diesel fuel markets are Germany and France

Another interesting chart is the ranking of the EU countries by their vehicle fuel consumption shares. The two largest EU diesel fuel markets are Germany and France. Given the significant number of diesel vehicles relative to ICE ones, it is not surprising that fuel volumes are heavily skewed in favor of diesel.

Exhibit 20. EU Vehicle Fuel Market By Country



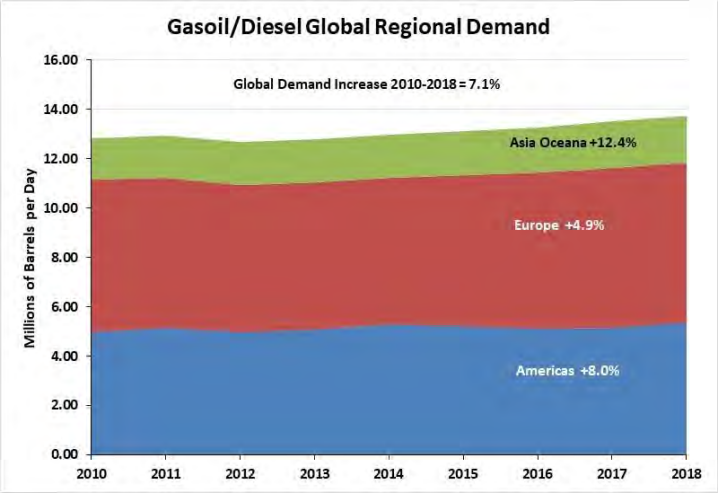
Source: Wood Mackenzie

With recent quarterly sales rates dropping by 30% or more in Germany, the United Kingdom and Brussels, for example, the likelihood is that diesel fuel demand in the EU will decline. A recent article in *The Wall Street Journal* discussed Germany posing a risk to the oil market because of falling oil demand in the last three-quarters of 2018. We expect an examination of detailed fuel data will show a fall in diesel consumption.

The EU represents over six million barrels a day of diesel demand, making it the world's largest regional market

The EU represents over six million barrels a day of diesel demand, making it the world's largest regional market. Exhibit 21 shows diesel demand data from the International Energy Agency for 2010 through 2018. Over that period, global diesel demand increased by 7.1%, with European demand rising by 4.9%. Although only a small market, the Asia/Oceana region experienced the greatest growth over the period at 12.4%.

Exhibit 21. Europe Is World's Largest Diesel Fuel Market



Source: IEA, PPHB

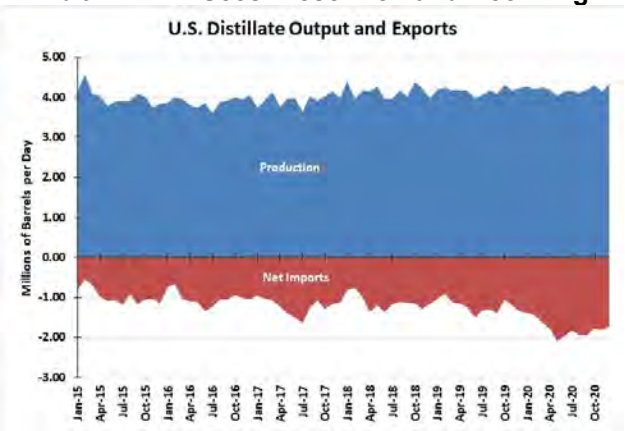
According to the IEA, both Germany and France each used roughly one million barrels per day of diesel fuel in 2018. Some of this supply will become available for other global markets, and in particular for use in the shipping industry either directly or possibly as a blending component with high-sulfur fuel oil to produce an IMO 2020 compliant fuel.

Diesel output is projected to remain essentially flat through the forecast period, but net imports are expected to increase by between 600,000 and 800,000 /d in 2020

In the United States, the diesel fuel market is also changing. When we examine the EIA's data on diesel fuel use and net imports, we see that the U.S. is a net exporter of roughly one million barrels per day (b/d). Traditionally, this volume flowed to Europe, where their refineries produced more gasoline than the EU needed, so that excess was traded to North America. We now understand that surplus diesel volumes are heading to South America. Exhibit 22 (next page) shows the history of U.S. diesel fuel production and net imports from 2015 through 2018 along with the agency's forecast through 2020. What we see is that diesel output is projected to remain essentially flat through the forecast period, but net imports are expected to increase by between 600,000 and 800,000 /d in 2020. The increase reflects declining diesel consumption, likely due to fewer diesel cars and trucks being sold, especially as diesel fuel now sells at a premium to gasoline compared to a few years ago when it was priced at a discount. An increase in exports of diesel fuel from the United States will also help the global shipping industry

in its dealings with IMO 2020. In fact, the projected U.S. diesel export volume would equal or exceed the estimated increase in refinery runs to produce more low-sulfur fuel oil estimated by Baker & O'Brien (Exhibit 14, page 15). Again, we caution that given all the moving parts of the refining industry, oil production and shipping's fuel needs, geographically, we fully expect some disruptions and likely higher fuel costs. What we don't feel comfortable with is the overly bearish (sharply higher) oil price outlook due to the implementation of IMO 2020.

Exhibit 22. EIA Sees Diesel Demand Declining



Source: EIA, PPHB

With more shipping industry forecasts suggesting that IMO 2020 non-compliance (seeking waivers) in the early years will be about 15% of demand, it is possible that with auto diesel supply becoming available, there may not be any significant upward pressure on global oil prices

IMO 2020 continues to be hailed as the most significant oil market development on the horizon, and one that could significantly disrupt the market within the next 12 months. As we have not seen any analysis on the demand changes underway in the global diesel fuel market from the fallout of Dieselgate and the potential from bans on diesel vehicle use in Europe, we believe there may be sufficient slack in this fuel segment that may relieve pressure in the global oil market from the banning of high-sulfur fuel oil from the shipping industry. With more shipping industry forecasts suggesting that IMO 2020 non-compliance (seeking waivers) in the early years will be about 15% of demand, it is possible that with auto diesel supply becoming available, there may not be any significant upward pressure on global oil prices.

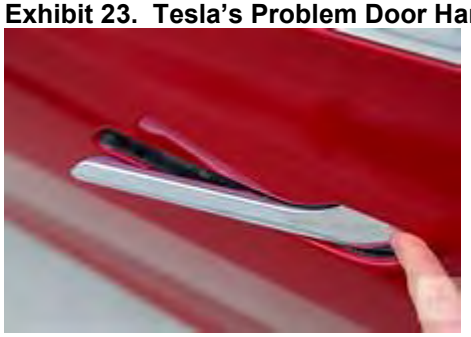
So, What Did EV Drivers Not Know About Cold Weather?

Owners often were frustrated because they could not warm the door handle sufficiently to enable them to be opened

The reports started with Tesla (TSLA-Nasdaq) owners who couldn't get their cars unlocked due to the Polar Vortex winter storm. It started with frozen door handles on the Model 3 electric vehicle (EV), which is imbedded in the side of the door, as well as the doors over the plug-in battery connection, preventing recharging operations. Owners often were frustrated because they could not warm the door handle sufficiently to enable them to be opened, even if they used the option to pre-heat the interior of the vehicle. Owners

reported they tried for between 30 and 60 minutes to free the handles so they could drive the cars, but were forced to give up their efforts.

Exhibit 23. Tesla's Problem Door Handle



Source: Tesla

One owner reported he was able to open his Model 3 doors, but then couldn't get them to close, making his vehicle useless

When the door handle area looked like the picture in Exhibit 24, Tesla owners began complaining about the stylish, but seemingly impractical design for winter weather. Owners employed many tactics to try to pry open the handles. Given that warming them from the inside failed, owners often resorted to pounding on the handle with the flat of their fists to knock off the ice, holding one's hand on the door handle to warm it up, or using disposable hand warmers to accomplish the warming. One owner reported he was able to open his Model 3 doors, but then couldn't get them to close, making his vehicle useless. There was one owner who complained: "I shouldn't have to plant my feet and shove a broomstick into the door handle to pop it open in 28-degree weather. Not everybody lives in California."

Exhibit 24. Winter Ice And A Tesla Model 3

Source: Andrea Falcone

AAA found that when they tested EVs when the temperature drops to 20o F, the car's range fell by an average of 41%

Tesla Model 3 owners, as well as owners of a Chevy Bolt, BMW i3, Nissan Leaf and Volkswagen e-Golf, living in typical winter regions found that their EVs did not have the same range as during warm weather months. AAA conducted a study on the performance of EVs in cold temperatures. The results were not encouraging. AAA found that when they tested EVs when the temperature drops to 20° F, the car's range fell by an average of 41%. According to Greg Brannon, AAA's director of automotive engineering, "We found that the impact of temperature on EVs is significantly more than we expected."

The results of the study are not helpful for EV manufacturers who are attempting to build enthusiasm for these new models as they gear up manufacturing plants to produce thousands of them. AAA found several surprises in the study's outcome. First, the impact on range was pretty much uniform across the five EV models tested. That indicates this will be an industry-wide issue and not a problem for a particular auto maker. It indicates that all battery chemistries, at least those presently being utilized, have a cold-weather problem. Maybe new chemistry will help solve the problem.

Simply turning on an EV in 20o temperatures can result in a 12% loss in range

A second surprise was that simply turning on an EV in 20° temperatures can result in a 12% loss in range. That loss is not overly severe. However, it assumes that the driver elects not to turn on the vehicle's climate control systems – cabin heat and seat heaters. When climate control is used, the range dipped by an average of 41%. As AAA pointed out, for the Chevy Bolt, which the Environmental Protection Agency awards a range of 238 miles per charge, starting it up drops its range down to 209 miles. When the climate control for the vehicle cabin is used, the Bolt's range falls to 140 miles per charge. For those EV owners who opted for smaller battery sizes to reduce their vehicle's purchase price, they would be facing even shorter travel distances, potentially so short that they may need to repeatedly charge their vehicles after going only very short distances.

Many EV owners were unable to drive their vehicles out of their basement garages because the ramp angle required more power than the car could deliver

The battery problems can also result in EVs not being able to generate sufficient power to climb hills. That was a theme of criticism of EVs by owners in Beijing the winter before last. Many EV owners were unable to drive their vehicles out of their basement garages because the ramp angle required more power than the car could deliver. One driver also became stuck on a highway overpass when his car could not generate sufficient power to complete the trip, and then did not have enough power to even back down the overpass ramp. The experiences of these EV owners were reported in Beijing's English language newspaper, as they told reporters they were trading in their EVs for traditional internal combustion engine cars. That was a surprising move as EVs are favored when seeking to obtain a permit for a vehicle to drive in Beijing.

Range is also further reduced when the driver elects to use the air conditioner to keep cool

Another issue EV owners are learning, if they didn't know it before, was that hot temperatures also reduce EV range. And that range is also further reduced when the driver elects to use the air conditioner to keep cool. We also are aware that driving techniques will drain the battery, reducing the vehicle's range. Thus, driving at very high speeds on highways can cut the distance an EV can travel on a single charge. All of these range-sapping issues are addressed by the car manufacturers either installing larger batteries or getting buyers to elect larger batteries, increasing the purchase price.

The advice for EV owners is to adjust their routines to compensate for these battery-draining issues, especially in winter

At the heart of the problem is that the chemistry of EV batteries – those using lithium-ion – leads to increased resistance that limits how much power they can hold, as well as how fast a battery pack can be charged or discharged. The advice for EV owners is to adjust their routines to compensate for these battery-draining issues, especially in winter. They should keep their EVs parked in garages overnight when temperatures fall to very low levels, and it helps if the garage is warmed. It is also possible to keep the car plugged in over-night as they have systems to prevent the battery from overcharging. By plugging in, the battery draws grid power to keep the battery pack warm, reducing the drain when the EV is started.

Another recommendation is to pre-heat the vehicle while it is plugged in, again helping to offset the battery drain from the cabin warming process. This can often be done by utilizing a smart-phone app that allows the driver to switch on the cabin heat remotely while the EV is still plugged in. Cars may also be pre-programmed to start warming at a particular time of the day. Remember that an EV does not have the opportunity to warm its cabin by drawing excess heat generated by an internal combustion engine.

Cold weather has a greater negative impact on battery performance than hot weather

We found it interesting that based on the AAA study, cold weather has a greater negative impact on battery performance than hot weather. An implication for global warming? AAA found that at 95^{o}, an EV's range fell by about 4%, compared to about a 10% reduction in range lost due to cold temperatures. On a hot day, setting the cabin climate control to 70^{o} will drop the EV's range by 17%.

Essentially everything about driving an EV will impact its range. That means not only how the vehicle is driven – acceleration speed and overall traveling speed – but also creature comforts such as the cabin temperature. Using the radio will use battery power, as well as having the headlights on at night. Additionally, the aging of the EV will result in reduced range as the battery gradually degrades. That is why EV manufacturers are considering when it will be appropriate to begin recycling EV batteries. The most likely alternative use for these vehicle batteries is as part of a home battery power storage system, to provide backup power for renewable energy systems. So far, the renewable power business hasn't figured out how to convince EV buyers of a twofer – one for an EV and used ones for backup solar power at the house.

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