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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

Oil & Gas Industry Capex Projecting Uptick For A Change

Always lurking in the background is the question of what higher oil prices mean for global oil demand

We are now in the season of planning for 2018. That means the oilfield service industry, as well as Wall Street, is anxious to know how its customers' managements view the future for their businesses. The recent OPEC and non-OPEC agreement to continue its production cut through the end of 2018 has lifted oil prices, but it also has raised questions about the response that may come from American shale producers as well as other non-OPEC producers now that they are likely to have more cash flow and more profitable prospects. Always lurking in the background is the question of what higher oil prices mean for global oil demand – a challenging analysis given what appears to be the growing synchronization and strengthening of global economic activity, something that has been lacking since the Great Recession of 2009.

The two firms – Evercore ISI and Barclays Capital Inc. – see oilfield spending increasing by about the same amounts next year - roughly increases of 7% and 8%

Two Wall Street investment banks have recently surveyed several hundred oil and gas companies and have compiled a list of their capital spending intentions for next year. The two firms – Evercore ISI and Barclays Capital Inc. – see oilfield spending increasing by about the same amounts next year - roughly increases of 7% and 8%. The difference between the two estimated increases for 2018 amounts to less than $5 billion, so the difference in the percentage growth estimates reflects their different estimates for 2017 spending.

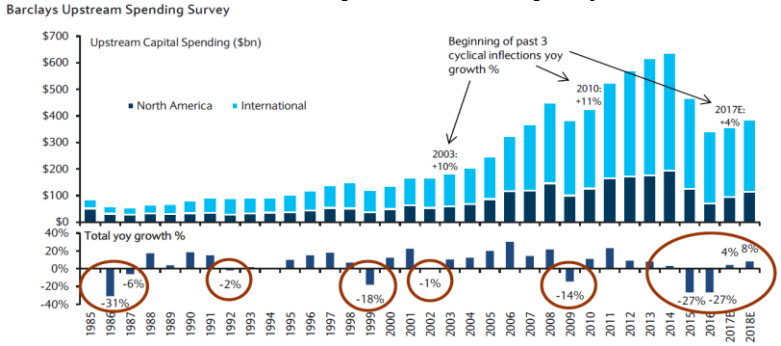
Barclays has conducted its spending survey for 33 years, and they published a chart showing the annual spending totals split between North America and International markets since 1985. This history is interesting and instructive about the possible spending pattern going forward. The 1985 starting point for the survey catches the year in which the oil market changed dramatically, as it did in 2014, when Saudi Arabia elected to stop supporting the then OPEC target price of $27 a barrel, allowing oil prices to fall to $10 per barrel. That price

drop was the final death knell for the global oil industry as it exited the oil price boom that marked the 1970s. That boom was driven by the two price spikes related to major geopolitical events – the 1973 Arab Oil Embargo and the 1979 Iranian Revolution – that highlighted the vulnerability of Western economies to the oil from a handful of Middle East producers.

An outcome from the oil price jump was that western economies began serious efforts to improve their energy efficiency

As Middle East oil producers soon discovered to their chagrin that their 1973 boycott of the United States and certain Western European countries over the countries support for Israel in the Yom Kippur War with Egypt would boomerang on them. The tripling of oil prices between 1973 and 1975 shocked the economies of the Western countries and created a severe multi-year recession. An outcome from the oil price jump was that Western economies began serious efforts to improve their energy efficiency. From smaller, lighter cars that achieved double digit mileage per gallon ratings to increased insulation standards for new homes, all aspects of Western life that involved energy changed. While individuals and governments were addressing the demand side of the energy equation, the oil and gas industry became even more international in their focus as the companies searched for new energy supplies around the world, especially outside of the Middle East and OPEC's member countries. The opening up of the North Sea, West Africa and Mexico eventually enabled the world to replace substantial volumes of Middle East oil, leading to the price collapse and revamping of OPEC pricing in the mid-1980s.

Exhibit 1. A 33 Year History Of Oil Industry Capex



Source: Barclays

The prospect of strong oil demand in the face of triple digit oil prices spurred oil companies to ramp up their spending, which continued until the 2014 oil price collapse

What the capital spending chart also shows is how spending exploded when we entered the early 2000s, as the commodity boom lifted crude oil prices to nearly $150 a barrel shortly before the 2008 financial crisis and resulting recession in 2009 cut oil consumption and choked off liquidity for the oil companies, forcing them to cut back their activity. Once liquidity was restored to the industry, global oil consumption demand growth quickly pushed oil prices back comfortably above $100 a barrel. The prospect of strong oil demand in the face of triple digit oil prices spurred oil companies to ramp up their spending, which continued until the 2014 oil price collapse.

The Barclays analyst noted an interesting trend with the release of his firm's spending survey. In 2017, Barclays estimates that spending will increase by 4% from the amount expended in 2016. In comparing other recoveries, the current year's spending increase is estimated to have been slightly less than half the annual increases recorded in the first year of the two most recent recoveries after declines in spending. The increases in 2003 and 2010 were 10% and 11%, respectively, versus the 4% increase for 2017. Barclays remarked that these more modest spending increases likely reflected exploration and production company managers' more cautious views on the outlook for oil prices, but also a nod to the pressure from investors for greater capital discipline in managing spending of their cash flows.

The Barclays analyst, David Anderson, commented on a call with clients that he has been an energy analyst for 20 years, starting as an E&P analyst and is now his firm's oilfield service analyst. He made the point that every year in his career he has had heard comments about E&P companies exercising greater capital discipline, so he isn't completely believing that talk now, until it is proven by managers' actions.

The meeting was to discuss a common goal of getting those shale companies to make money rather than to promote production growth

The call for greater capital spending discipline is receiving increased attention. *The Wall Street Journal* ran a story earlier this month in which they reported on a meeting during September in New York City involving 12 major shareholders of U.S. shale-oil-and-gas producers. The meeting was to discuss a common goal of getting those shale companies to make money rather than to promote production growth. The article had some telling numbers that reflected the problem for the investors and for the companies. The article's authors wrote:

"Since 2007, shares in an index of U.S. producers have fallen 31%, according to data provider FactSet, while the S&P 500 rose 80%. Energy companies in that time have spent $280 billion more than they generated from operations on shale investments, according to advisory firm Evercore ISI."

Several of the producers made dramatic shifts in their spending, announcing large share repurchases or disclosing plans to sell off non-core assets and returning a portion of the funds raised through dividends or stock buybacks

The investors have been concerned that the managers were being compensated on the basis of how much they grew their company's production and/or its oil and gas reserves, which was skewing capital spending decisions. In other words, the investors, who have looked at their losing investments, would like to see at least a portion of the company's cash flow returned to them in the form of dividends or share buybacks. The article went on to relate meetings between shale producers and some of these investors where the investors delivered their message. Subsequently, several of the producers made dramatic shifts in their spending, announcing large share repurchases or disclosing plans to sell off non-core assets and returning a portion of the funds raised through dividends or stock buybacks. Some of them have also changed the metrics on which

managers' compensation will be based, reflecting greater attention to financial returns over production or asset growth. In several cases, these moves have been greeted with improved share price performance. Interestingly, companies that remain heavily leveraged and haven't gotten the "capital discipline" religion see their share prices continue to languish.

That prayer is: Dear Lord, just give us one more boom and we promise not to screw it up!

While there have been some positive responses to the investors' push for greater capital discipline, one investment manager, Jan Stuart, chief energy strategist for Cornerstone Macro, told the article's authors, "If we do get to $60, it's all guns blazing all over again. There is no such thing as a Texas Wildcatter getting religion." Time will tell whether this judgement proves accurate, but the modest spending surveys don't suggest any boom times for the oil patch in the near term. While we haven't heard the oilfield prayer recited yet, we suspect it is in the backs of many managers' minds. That prayer is: Dear Lord, just give us one more boom and we promise not to screw it up!

Is Oil Facing A Collapse Or Heading For Another Bull Run?

Oil prices are seeking some signal about underlying fundamental industry trends

After roaring ahead in anticipation of an extension of the production cut agreement coming out of the latest OPEC oil ministers' meeting, oil prices have given back some of that advance. Global oil prices seem to be bouncing back and forth from a slightly lower level based on the view of the latest industry news. This signals that oil prices are seeking some signal about underlying fundamental industry trends before regaining their momentum. What form might those signals take?

The market will be closely watching U.S. oil shale output as that may be the ultimate swing factor in how oil prices are set

Compliance with the production cut agreement by OPEC members and their non-OPEC supporters will be a key development. What happens to global oil demand after oil prices have risen by over $10 a barrel since this summer will be critical. The market will pay particular attention to talk by key OPEC officials about how the production cut agreement can/will be unwound, and when it might happen – possibly before the end of 2018? Lastly, the market will be closely watching U.S. oil shale output as that may be the ultimate swing factor in how oil prices are set.

For almost all of 2017, OPEC and non-OPEC compliance with their reduced production targets has been very high. That needs to continue in order for global inventories to contract further. Inventories will be pressured by continued growth of U.S. oil shale output, which is being incented by the higher oil price. As U.S. producers continue to add oil drilling rigs to the working rolls, future output will rise. The latest Short-Term Energy Outlook published by the Energy Information Administration (EIA) last week, stated:

"EIA estimates that U.S. crude oil production averaged 9.7 million barrels per day (b/d) in November, up 360,000 b/d from the October level. Most of the increase was in the Gulf of Mexico, where production was 290,000 b/d higher than in October. Higher production in November reflected oil production platforms returning to operation after being shut in response to Hurricane Nate. EIA forecasts total U.S. crude oil production to average 9.2 million b/d for all of 2017 and 10.0 million b/d in 2018, which would mark the highest annual average production, surpassing the previous record of 9.6 million b/d set in 1970."

If U.S. oil production grows as predicted by the EIA, it will provide a substantial portion of the projected global oil demand increase

If U.S. oil production grows as predicted by the EIA, it will provide a substantial portion of the projected global oil demand increase. At the same time, we should recognize that the higher demand projections are in response to the lower oil prices that existed during the spring and summer. Is it possible that global demand growth slows due to the nearly 20% increase in oil prices since the summer? Is it also possible that U.S. oil production growth will be greater than currently anticipated? That could mean that U.S. shale oil output growth completely satisfies the world's realized increased demand.

In the above scenario, increased attention will be directed to what output comes from a handful of OPEC producers – Iran, Iraq, Libya and Nigeria. At the same time, the ability of Venezuela to sustain its current output, given the horrid shape of its economy and oil business, injects another wildcard into forecasting world oil supply and demand.

Will oil supply be able to keep up with demand growth, or will prices have to rise into the $80-$100 a barrel range and stay there for a few years before beginning to decline?

Given the oil market uncertainty, oil prices in the near-term will be volatile based on news events, such as pipeline disruptions and the number of U.S. oil drilling rigs added or substracted from the working fleet. That is what makes the narrative beginning now about the future course of oil prices so interesting. Will oil supply be able to keep up with demand growth, or will prices have to rise into the $80-$100 a barrel range and stay there for a few years before beginning to decline? Or, will the revolution underway in the transportation sector accelerate the decline in fuel consumption? Both arguments are being made, but interestingly, the difference may be merely about how long before oil demand begins falling, not about its eventual decline.

Dr. Seba is predicting that oil prices will fall to $25 per barrel due to dramatically falling demand by 2030

To examine the most aggressive case for oil's early demise requires us to look to the research by Stanford University economist Tony Seba, and the co-founder of RethinkX, an independent think tank. He is also the author of a book about his research idea titled, Clean Disruption of Energy and Transportation. Dr. Seba is predicting that oil prices will fall to $25 per barrel due to dramatically falling demand by 2030. That is predicated on the mass adoption of TaaS, or Transportation as a Service, that will lead to most people giving up driving and car ownership. The questions are whether this shift will

occur, the extent of the shift, and when it might begin and then when it might accelerate to the point it seriously damages oil consumption.

He believes this shift will move quickly such that 95% of personal transportation needs will be met by people using EVs via the TaaS model by 2030

Dr. Seba's argument is that ride-hailing services such as Uber, Lyft and others will drive the cost of transportation down towards the lowest cost measure, which, in his view, is the cost of transportation via electric vehicles (EVs) using self-driving technology. He believes this shift will move quickly such that 95% of personal transportation needs will be met by people using EVs via the TaaS model by 2030. As a result, Dr. Seba believes people will stop buying their own cars and that most vehicles in the future will be owned by corporate fleets providing TaaS.

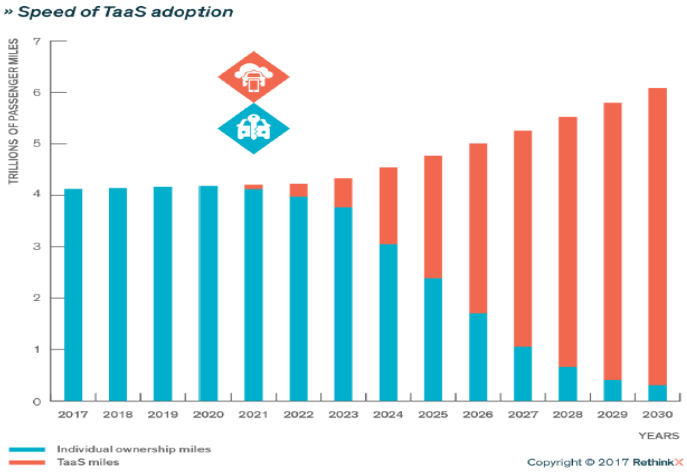
He believes these car owners will make a purely rational financial choice and forego car ownership

The success of this thesis is the belief that the massive disruption will be driven by economic considerations. Dr. Seba relies on the idea that most people would save up to $5,600 per year using TaaS rather than owning their own car. Therefore, he believes these car owners will make a purely rational financial choice and forego car ownership. This is a critical assumption that may be seriously flawed because it calls for a much more radical change in human behavior than is likely to happen. As we have learned from behavioral economics, not all people act in a purely rational economic manner. That said, we may be surprised how quickly some of these changes do come, and the magnitude of their impact on the transportation and energy industries.

The speed of the TaaS adoption will be quick

We have written before about the assumption of many EV forecasters that the public's adoption of the technology will happen much like the speed in which various electronics went from novelties to mainstream. Under Dr. Seba's thesis, the speed of the TaaS adoption will be quick. As a result, its impact on the miles driven by cars owned by people versus those of ride-hailing service will likely take the course set forth in the chart in Exhibit 2.

Exhibit 2. How TaaS Will Revolutionize Transportation

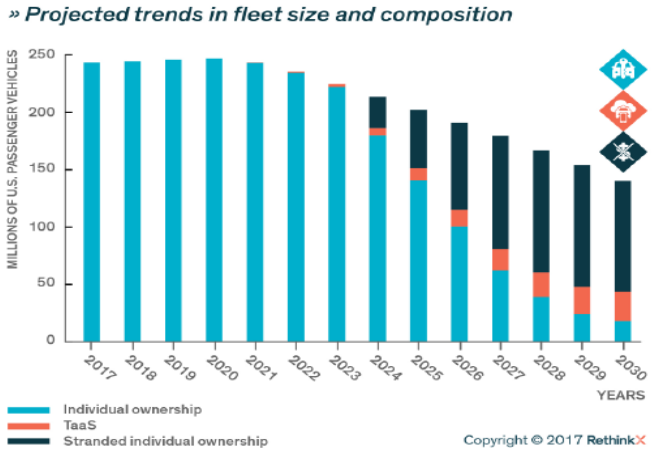


Source: RethinkX

Dr. Seba sees roughly 100 million of stranded individually-owned cars

The bad news for the automobile industry is set forth in the chart in Exhibit 3. As the chart shows, the automobile fleet peaks in 2020 and then begins to slowly decline as TaaS vehicles begin to arrive and reduce people's need for their own car. Between 2020 and 2030, the overall domestic vehicle fleet shrinks from slightly under 250 million cars to 50 million. The 2030 vehicle fleet will be composed of about 30 million TaaS cars and 20 million of individually-owned ones. Importantly, Dr. Seba sees roughly 100 million of stranded individually-owned cars. In Dr. Seba's world, the TaaS vehicle will be doing almost all the driving, and home driveways and city parking lots will become the new auto junk yards.

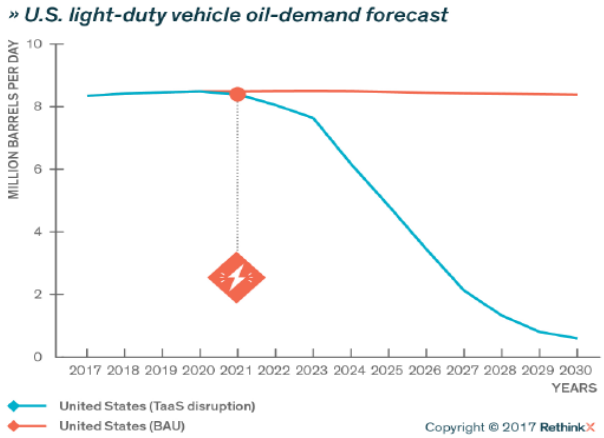
Exhibit 3. Will The U.S. Become A Giant Parking Lot?



Source: RethinkX

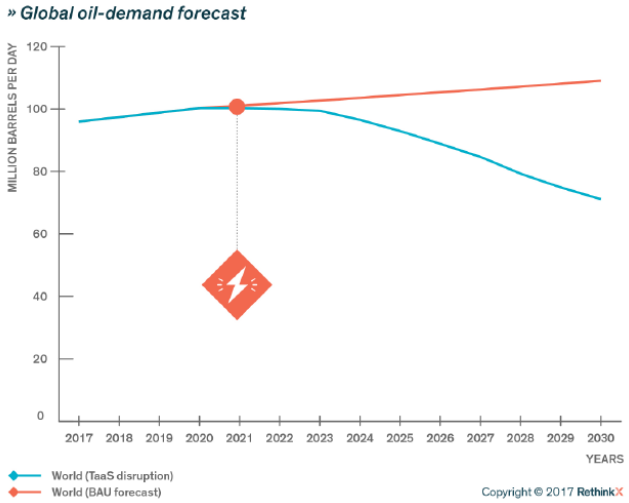
For the oil business, this rapid transformation of the transportation sector will result in a dramatic decline in oil consumption – falling from nearly 8.5 million barrels a day of gasoline to about 0.5 million by 2030.

Exhibit 4. TaaS Destroys U.S. Oil Demand



Source: RethinkX

Exhibit 5. Global Oil Use Will Fall Meaningfully



Source: RethinkX

From a global perspective, Dr. Seba sees oil demand peaking at 100 million barrels a day in 2020, and then declining to 70 million by 2030, which will kill not only demand for fuel but also oil's price. If the United States accounts for eight million barrels a day of the projected decline in overall oil use, then the international oil market will see its demand drop by 22 million barrels a day.

A question for the oil industry is: Will the fall in oil's demand ease the pressure on the industry to find new oil supplies to meet projected demand growth in the world's business as usual forecast, in addition to the amount of oil supply lost each year due to existing oil field depletion? Since the oil industry reduced its capital spending on new exploration and development during the past three years, concerns have been raised about the oil industry's inability to find and develop new, high-cost, long-term supply sources such as oil sands and deepwater production.

The key is that in the past two years, the vehicle's sensors are now "seeing" three times farther (about three football fields in distance) at 10% of the cost

How realistic are Dr. Seba's assumptions about TaaS? In our view, they are too optimistic (or pessimistic if you work in the auto or energy industries) and too aggressive. Our conclusion is shaped by our view that this societal shift is too radical to happen as quickly as predicted, especially since the infrastructure needs are not ready and will take years to be ready. To counter our view, Dr. Seba would point to Chandler, Arizona, a suburb of Phoenix. There, Waymo, the autonomous vehicle technology subsidiary of Google's parent, Alphabet (GGO-Nasdaq), is operating a fleet of Chrysler Pacifica minivans in a driverless mode. This follows eight years of development of the self-driving technology and dramatic improvement in sensor technology and cost. The key is that in the past two years, the vehicle's sensors are now "seeing" three times farther (about three football fields in distance) at 10% of the cost. Moreover, the self-driving car is never tired, distracted or drunk.

Waymo CEO John Krafcik announced this new stage of its self-driving technology testing at a technology conference in Lisbon, Portugal, in November.

Exhibit 6. Waymo's Driverless Chrysler Pacifica

Source: Waymo

It also helps that the city's streets are wide and straight, while the area also has predictably nice weather

Chandler is home to a number of high technology companies, including General Motors' (GM-NYSE) 1,100-person driverless-car R&D center. It also helps that the city's streets are wide and straight, while the area also has predictably nice weather. For now, Waymo's cars are restricted from traveling more than 100 miles outside of Chandler. The company will be operating 600 vehicles in Arizona within the next few months, with most of them in Chandler. An interesting benchmark will be when Waymo will allow its cars to travel beyond the 100-mile barrier.

The Arizona Department of Transportation is treating driverless cars just like any other automobile

A recent article about the Waymo experience highlighted the unique position Arizona took with self-driving vehicle regulation. It was among the 41 states and the District of Columbia that have considered legislation for revising rules on vehicle safety and insurance, along with the installation of "kill switches" and driver alerts since 2011 to enable driverless vehicle testing. So far, 21 of them have passed such legislation. In Arizona, they stopped that legislative push after Governor Bill Ducey (Rep) was elected in 2014. He began a review of the existing state laws on motor vehicles and concluded that no new legislation was needed. By issuing an executive order instructing the state's agencies to "undertake any necessary steps to support the testing and operation of self-driving vehicle on public roads," he put in motion the new testing. The agencies established an oversight panel, which has only met twice, and will deal with recommending any new rules and regulations based on real-world experience. The Arizona Department of Transportation is treating driverless cars just like any other automobile. As long as a car such as Waymo's is registered,

insured and operates within current statutes, it will be allowed to drive on Arizona's roads.

The desire to eliminate these deaths is pushing the driverless vehicle effort

The pressure to develop driverless cars is coming from organizations concerned about the growing carnage on America's roads, largely due to distracted driving. According to highway research statistics, 94% of all collisions are caused by human error. In 2016, according to the National Highway Traffic Safety Administration, 37,461 people were killed in 34,436 crashes, an average of 102 per day. The desire to eliminate these deaths is pushing the driverless vehicle effort.

Governments would also lose their traffic ticket revenue

While many people have focused on the impact of driverless cars on the automobile industry, as ride-hailing services can replace car ownership, and the insurance market, as accidents are eliminated. It is also interesting to contemplate other jobs that will be eliminated, or their need reduced. We would list traffic police, emergency room personnel, traffic courts, and personal injury lawyers, to name a few. Governments would also lose their traffic ticket revenue, but hopefully the elimination of jobs would exceed the decline in government revenues.

Driverless cars also will reduce individual freedom

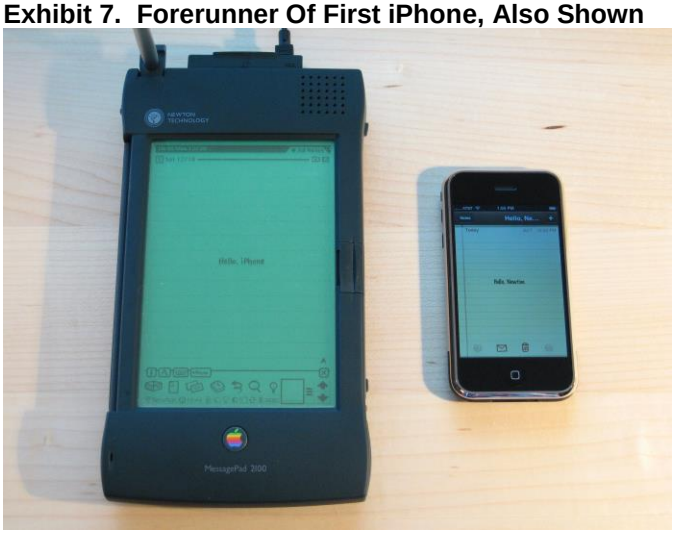
The challenge to self-driving cars, is coming not necessarily from the technology, but rather from its reversal of person autonomy, or freedom. Driverless cars are being sold to the public on the basis of safety and health measures. But, driverless cars also will reduce individual freedom. The automobile has given people the ability to not have to depend on others for their movement. Trains, planes, buses and subways run on their timetables and not when individuals necessarily want them to run. Yes, ride-hailing services can offset that loss of freedom, but driverless cars will require people to have to give information to computers, and potentially to the government. This begs the question about the loss of privacy. We may know how to get to a particular store that we want to visit, but our car does not know how to do it. We need to instruct the car where to go, and the car will need to access the Internet or satellites, and we will probably also have to get permission from our credit card company to enable us to go. The loss of privacy is significant, and with it also comes the possibility of increased danger, especially if people send children alone in driverless cars that could be hacked and re-routed.

People who want their freedom and privacy will still want the ability to transport themselves when and where they want

According to several psychologists, autonomy is one of the five core emotional needs of all people. People who want their freedom and privacy will still want the ability to transport themselves when and where they want. That doesn't mean that they won't welcome the benefits of ride-hailing services, but it may argue that people might just want to own their own autonomous vehicle to reduce the stress of driving, but retain their privacy. Clearly, driverless or autonomous cars open up the opportunity for the elderly and handicapped to secure transportation services on their own, rather than having to depend on others. Therefore, we find it hard to see the rapid

transition of the transportation sector as proposed by Dr. Seba. This also suggests that the demise of oil's use is overstated, at least in the timeframe proposed by Dr. Seba.

Exhibit 7. Forerunner Of First iPhone, Also Shown



Source: Apple

Is the current driverless automobile technology the equivalent of the 1973 mobile phone, the 1990s phone, the first iPhone, or today's Smart Phone?

Could all of this happen by 2040 rather than 2030? Possibly, especially given demographic shifts and the need for increased perfection of the technology. Remember, the first cell phone debuted in 1973, weighing two pounds, was the size of a small box, provided 30 minutes of talk time, and needed 10 hours to recharge. Digital cell phone technology was introduced in 1990, and improved in the early 2000s, which set the stage for the cell phone revolution. But it wasn't until Apple (AAPL-Nasdaq) introduced the iPhone in 2007 that the mass adoption of cell phones began. Is the current driverless automobile technology the equivalent of the 1973 mobile phone, the 1990s phone, the first iPhone, or today's Smart Phone? If it the first generation, then we are possibly 40 years from mass adoption. If it is the equivalent of the iPhone, then we are only a decade away. If we had to guess, we would suggest that current driverless technology is where the cell phone was at the turn of the century. We probably have nearly 20 more years before driverless cars become ubiquitous.

The Cleaner Air Of California Comes From Nature Not Policy

He was touting the progress California has made in reducing its carbon emissions

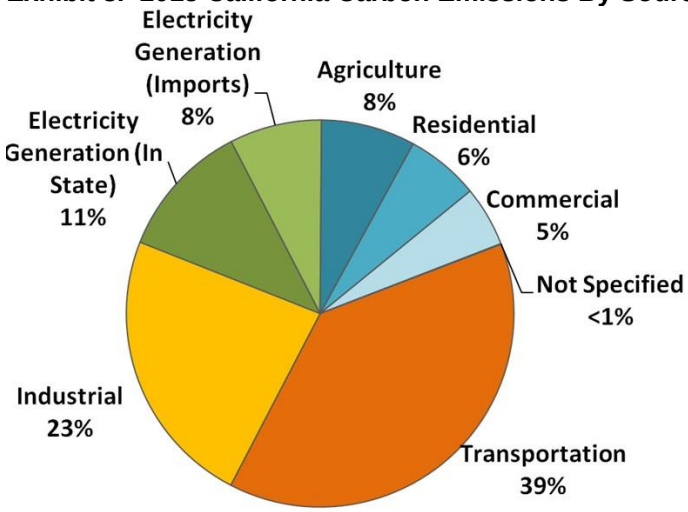
California Governor Jerry Brown (Dem) was featured on CBS' *Sixty Minutes* news show a week ago. In his interview with Bill Whittaker, he was touting the progress California has made in reducing its carbon emissions and why his state was the model for the future and one that all other states should be copying. Gov. Brown spent two weeks in November, at the time of the COP23 meeting in Brussels, traveling across Europe extolling the virtues of California's energy

economy, which has been established and is run by government dictate. Of course, Europe is a receptive audience for government energy dictates in the name of preventing an Armageddon for the planet due to climate change. Part of Gov. Brown's ammunition in backing up his claims of the "energy nirvana" in place in his home state was the recent report from the California Air Resources Board (CARB). That report provided a detailed analysis of the 2016 carbon emissions from facilities that are subject to California's "cap-and-trade" program.

The report highlighted that companies, subject to the state's cap-and-trade system for regulating and pricing carbon emissions, had experienced a fall of about 5% in their 2016 carbon emissions

The report highlighted that companies, subject to the state's cap-and-trade system for regulating and pricing carbon emissions, had experienced a fall of about 5% in their 2016 carbon emissions. Gov. Brown was instrumental in getting the cap-and-trade program extended this year, something he was very willing to promote as a successful policy when lecturing people during his European environmental tour. The initiative for that tour was to promote the fact that numerous states and cities in the United States were still fully-committed to fighting climate change, despite President Donald Trump's decision to take the nation out of the Paris agreement.

Exhibit 8. 2015 California Carbon Emissions By Source



Source: CARB

It was the winter rains and heavy snow storms that enabled California's utilities to rely less on power generated from fossil fuels and more from hydroelectric power

A reporter for *CALmatters*, Julie Cart, covered Gov. Brown's European trip. She also did some research into the CARB report and discovered some interesting facts. "Emissions from in-state electricity generation decreased more than 19 percent last year, and emissions from imported electricity dropped nearly 23 percent," she wrote. The detailed analysis highlighted that it wasn't the cap-and-trade program, or any state government action that resulted in the reduced carbon emissions. Rather, it was the winter rains and heavy snow storms that enabled California's utilities to rely less on power generated from fossil fuels and more from hydroelectric power.

California utilities are under a legal mandate to shift their electricity generation from coal, natural gas and other carbon-based fuels to carbon-free "renewable" portfolios. The mandate is for the switch to reach 33% of the power supplied by 2020 and 50% by 2030. The 33% requirement was put in place with the passage of the original legislation in 2011. In 2015, under the leadership of California's Senate President Pro Tem Kevin de León, a strong backer of Gov. Brown's environmental activism, the 50% mandate was instituted.

The state's definition of renewable sources specifically excludes hydroelectric power produced by major dams

The state's definition of renewable sources specifically excludes hydroelectric power produced by major dams such as Shasta, Oroville and Folsom. It turns out that this power was the primary reason carbon emissions dropped so dramatically in 2016. The 2011 legislation that established the 33% target for 2020 defines acceptable renewable power as coming from "biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal, or tidal current."

Mr. de León's 2015 bill, while increasing the renewable portfolio mandate to 50%, tightened the use of "small hydroelectric generation" to achieve it. According to the CARB web site, these small hydroelectric power plants must be "certified" for their net megawatt-hours (MWh) to count as part of the renewable energy portfolio standard. To understand the significance of this distinction, in 2016, according to the text of the report from CARB, there was a net of 28,977 gigawatt-hours (GWh) of hydropower generated, which accounted for 14.6% of the state's total power supply. There are 267 hydropower facilities in California, with the 71 large ones producing 24,410 GWh of electricity, while the 196 small ones generated a net of 4,557 GWh (number discrepancy exists on CARB web site).

The amount of hydropower generated in 2016 was slightly more than twice the amount generated in 2015

The amount of hydropower generated in 2016 was slightly more than twice the amount generated in 2015. Importantly, 2016's hydropower was twice the annual average of 14,236 GWh generated over 1983-2016. The 2016 hydropower volume was consistent with the amounts reported for 2012 and 2013, but considerably below the recent record amount of 42,731 GWh generated in 2011. In 2006, the state's electricity from hydropower sources reached over 48,000 GWh, and it was even more in earlier years.

The reason why hydropower is not considered a renewable energy source, except for the smallest facilities, is because the environmental movement dislikes dams

The reason why hydropower is not considered a renewable energy source, except for the smallest facilities, is because the environmental movement dislikes dams. Shouldn't these artificial water retention ponds be favored by environmentalists if they truly believe that climate change will bring drier summers and less rain and snowfall during winters? One would expect them to favor any resource that would reduce the need to burn more hydrocarbons. At

the present time, there is only one coal-fired electric generating plant operating in California, although the state's utilities often import power from plants that do burn coal. That supply is being reduced by more hydropower being available both in California and in nearby states from which the power can be imported.

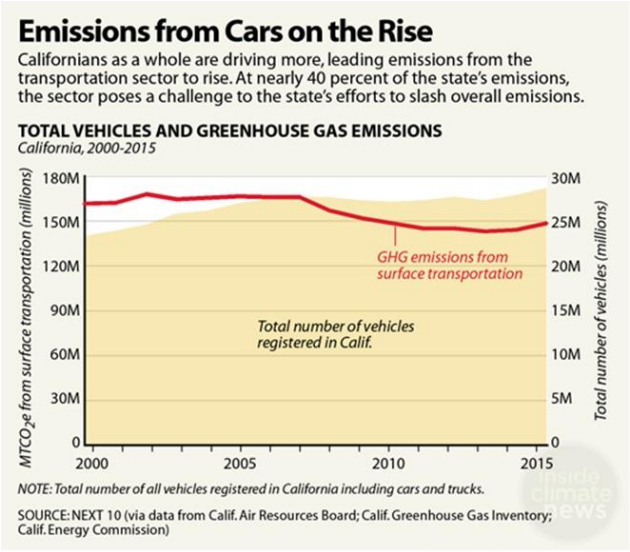
Environmentalists also fight nuclear power plants

Besides hydroelectric plants, environmentalists also fight nuclear power plants, which happen to be the only power source that can provide guaranteed base-load power with no carbon emissions. In California, this opposition has led to the closure of the San Onofre atomic power plant in Southern California, as well as the planned closure of the Diablo Canyon plant hear San Luis Obispo.

The explanation for the higher transportation sector carbon emissions, despite the state's aggressive push for cleaner cars and zero-emission vehicles, is that lower gasoline prices encouraged drivers to drive more

While California made progress in reducing its carbon emissions overall, it was largely due to the increased supply of hydroelectric power, with assistance from reduced purchases of power from coal-fired plants and imported into the state. Electricity importers were also able to bring in more hydroelectric power from the Hoover Dam. Electricity importers reduced carbon emissions by about 10 million metric tons of CO2 equivalent (MMt CO2e). At the same time, in-state electricity generation facilities reduced emissions by about 7 MMt CO2e. Combined, the cleaner power led to a 2016 carbon emissions reduction of 17 MMt CO2e, compared to an overall greenhouse gas emissions reduction, as reported by CARB, of 16 MMt CO2e, meaning that the transportation sector added about 1 MMt CO2e. The explanation for the higher transportation sector carbon emissions, despite the state's aggressive push for cleaner cars and zero-emission vehicles, is that lower gasoline prices encouraged drivers to drive more. Note in Exhibit 9 that vehicle emissions started to rise in 2014 and went higher in 2015. We now

Exhibit 9. California's CO2 Emissions On The Rise



Source: ***Inside Climate News***

know that they increased again in 2016. This period did coincide with lower global oil prices, and lower gasoline and diesel pump prices.

The high cost of housing has forced people to live further from their jobs, adding to their commuting distances

Another explanation for the increase in vehicle carbon emissions, but not a politically-popular one, is that the high cost of housing has forced people to live further from their jobs, adding to their commuting distances. It is much easier to blame cheap gasoline for the issue, which is a reason why the state hiked its gasoline fuel tax, than to acknowledge problems in the state's economy – high housing costs.

The wildfires in the Los Angeles area are reported to have released as much carbon as a year's worth of vehicle emissions

While Gov. Brown is getting significant air time for his environmental message, the reality is that absent a rainy and snowy 2016, California might not have been able to report lower carbon emissions. In that event, his message would still be that California is the role model and everyone should follow it. This year will be a significant challenge for the governor, but we assume the explanation is already being written. The wildfires in the Los Angeles area are reported to have released as much carbon as a year's worth of vehicle emissions. We fully expect that if California experiences an increase in its total carbon emissions for 2017, it will be blamed on climate change causing the wildfires. Fires such as these have been experienced in the past, as recently as in the 1960s. The growth in the region will make the fires' cost that much higher than in the past, but the lack of proper forest land management, encouraged by the Obama administration, also played a role.

The cost of achieving this shift is beginning to be felt by Californians, leading to businesses and residents fleeing to other, low-cost states, often merely across the state line

California has often been a leader of trends in America. In most cases, these were social trends such as hippies, free speech, music, marijuana, same-sex marriage, surfing, and even the car craze. Now, the state wants to lead in revamping its, and the world's, energy structure. The cost of achieving this shift is beginning to be felt by Californians, leading to businesses and residents fleeing to other, low-cost states, often merely across the state line. The record for reducing the state's carbon emissions is being built on forcing people to abandon dirty fuels and switching to less-polluting ones. The case was bolstered in 2016 by passing off a benign carbon fuel – hydropower – as a fossil fuel, and then claiming that government emissions programs were the reason for the emissions reduction. Eventually, the truth will prevail.

Climate Change No Longer A National Security Risk

Will remove climate change as a national security risk

In an article last Friday, Mollie Ziegler Hemingway, a senior editor at *The Federalist*, wrote that a late draft of the National Security Strategy of the Trump administration, due to be released yesterday, will remove climate change as a national security risk. According to the draft, it will say, "Climate policies will continue to shape the global energy system. U.S. leadership is indispensable to

countering an anti-growth, energy agenda that is detrimental to U.S. economic and energy security interests. Given future global energy demand, much of the developing world will require fossil fuels, as well as other forms of energy, to power their economies and lift their people out of poverty."

President Barack Obama had made climate change, and its necessary regulations, his administration's focus starting with his National Security Strategy in 2015

This will be a sharp reversal from the policies of the Obama administration, and is consistent with President Donald J. Trump's decision to exit from the Paris climate change agreement. President Barack Obama had made climate change, and its necessary regulations, his administration's focus starting with his National Security Strategy in 2015. At the Paris conference in 2015, President Obama told the audience: "In some ways, [climate change] is akin to the problem of terrorism and ISIL." He furthered that point during a weekly address when he said "Today, there is no greater threat to our planet than climate change."

All of these issues resulted in increased regulations, which some economists believe may have restrained the economy's growth

In September 2016, President Obama released a memorandum requiring federal agencies to consider the effects of climate change in the development of national security-related doctrine, policies, and plans. This focus on climate change impacts and how to deal with them led to spending on developing alternative fuels, as well as planning for how to mitigate rising sea levels and extreme weather events. All of these issues resulted in increased regulations, which some economists believe may have restrained the economy's growth.

The new Trump National Security Strategy will focus on conventional and immediate national security risks. With respect to climate change, the draft says, "The United States will remain a global leader in reducing traditional pollution, as well as greenhouse gases, while growing its economy. This achievement, which can serve as model to other countries, flows from innovation, technology breakthroughs, and energy efficiency gains –not from onerous regulation."

Last week President Trump signed an executive order to further get rid of onerous regulations on businesses. The energy industry has been a beneficiary of some of those changes, signaling better days ahead, especially with higher crude oil prices.

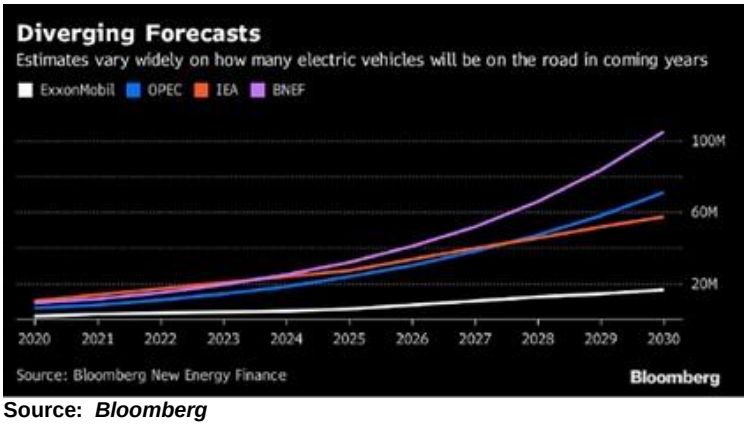
Electric Vehicles, Rare Metals And Electric Demand

The differences arise from the very different assumptions about the take-up rate for new EVs that underlies each forecast

As we have written about a number of times, there is a wide range in the estimates of how many electric vehicles (EV) will be on the nation's and world's highways in the future. The differences arise from the very different assumptions about the take-up rate for new EVs that underlies each forecast. The rate is subject to several economic issues including the continuation of the rate of decline in battery costs and the potential extension of government tax incentives for the purchase of EVs. Besides those factors, there is

also the issue of government actions banning the sale or use of internal combustion engine (ICE) powered cars on the roads. At the core of these issues is the belief that ending the use of fossil fuels in the world's transportation sector is needed in order to help limit the rise in carbon emissions and their possible impact on global warming and climate change trends.

Exhibit 10. Forecasts For Electric Vehicle Fleet Growth



Source: ***Bloomberg***

The two middle estimates reflect the latest EV forecasts from OPEC and its counterparty, the IEA

The chart in Exhibit 10 shows the future number of EVs expected to be on the roads in 2030 based on four separate projections. The lowest number comes from the world's largest oil company, Exxon Mobil Corp. (XOM-NYSE). The highest EV estimate was made by Bloomberg New Energy Finance, a consulting firm in the Michael Bloomberg media empire. The two middle estimates reflect the latest EV forecasts from OPEC and its counterparty, the International Energy Agency (IEA). The most recent OPEC forecast has been revised sharply higher in response to the increasing governmental activism for banning ICE cars from the nation's roads.

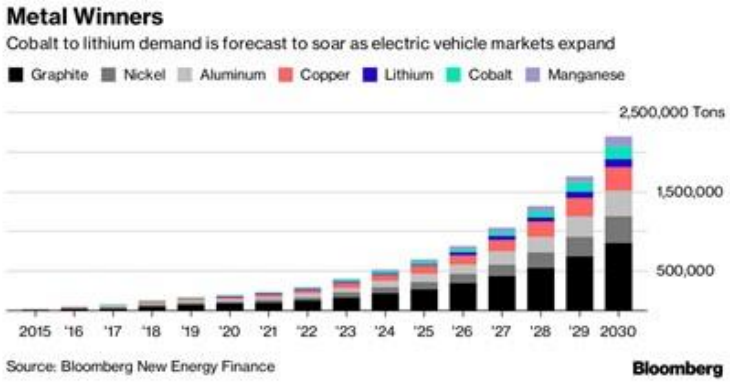
As one writer recently put it: It doesn't matter what you believe about climate change; governments have decided and are acting on that belief

Which forecast should readers believe? Traditionally, the nod would go to the people most intimate with the energy business – ExxonMobil and OPEC. Until this year, the OPEC forecast for EVs was more in keeping with that of ExxonMobil and its fellow major international oil companies, suggesting a modest EV penetration rate. While OPEC's members represent oil producers from around the world, with a particular concentration in the Middle East, the organization is headquartered in Vienna. That exposes OPEC's staff and its economists to the influences of the environment in which they live, which means the actions of European countries. Those continental governments have become extremely vocal about the need to restrict ICE vehicles given their carbon emissions. As a result, they have initiated programs to ban ICE cars, without insuring that their countries and citizens are prepared for the cost of this shift. The impact of those actions is being reflected in the new OPEC, and IEA forecasts. As one writer recently put it: It doesn't matter what you believe about climate change; governments have decided and are acting on that belief.

Those issues include the development of an adequate battery recharging network and insuring that there will be sufficient rare earth minerals

While the momentum for EVs is building (manifested by the upwardly revised EV forecasts), there are several technical issues that could create problems for the aggressive goals of the environmental movement being reached. Those issues include the development of an adequate battery recharging network and insuring that there will be sufficient rare earth minerals available for creating batteries at a reasonable cost.

Exhibit 11. How Rare Earth Minerals Demand Grows

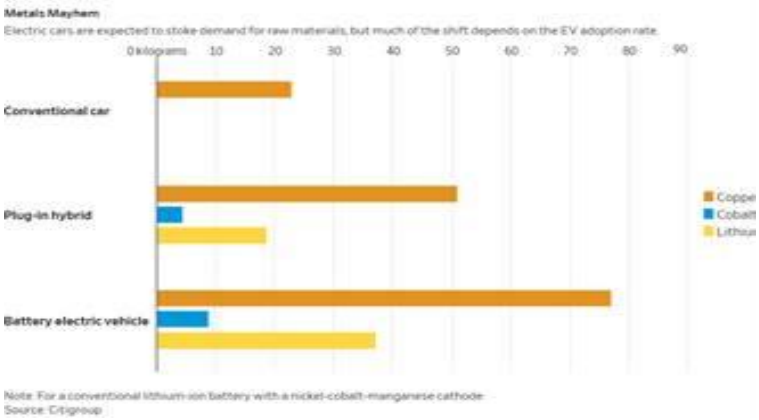


Source: ***Bloomberg***

The high mineral commodity prices will likely produce additional supply, but the unanswered question is how long it will take to expand mines and open new ones

The current price action in commodity markets is focused on the projected mushrooming demand for rare earth minerals given the magnitude of EVs projected to be sold in the future. In some cases, the minerals needed for making EV batteries are by-products of mining other commodities that may not be in the same demand. For cobalt, much of the supply comes from the Democratic Republic of the Congo, where a substantial amount is mined by children in defiance of global humanitarian child labor laws, raising questions about its future supply. The high mineral commodity prices will likely produce additional supply, but the unanswered question is how long it will take to expand mines and open new ones.

Exhibit 12. Rare Minerals Used By Vehicle Type

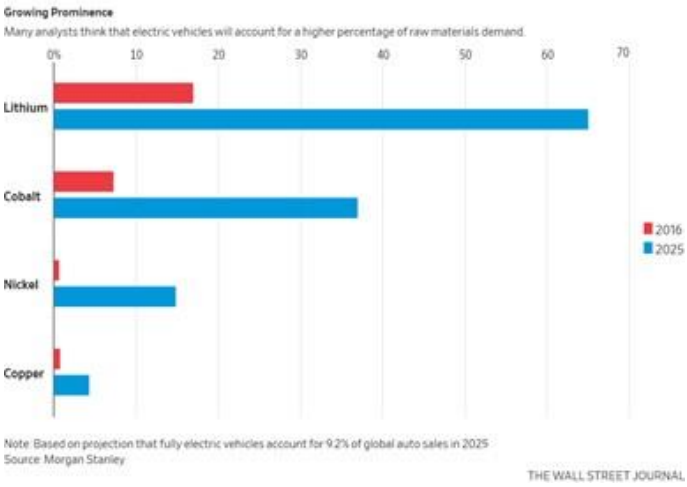


Source: ***The Wall Street Journal***

There is always the possibility that the chemistry of batteries will change

The amount of these minerals needed in EVs is markedly greater than for conventional cars, as shown in Exhibit 12 (prior page). Considerably more of all key metals are used in battery electric vehicles (BEV) than in plug-in hybrid (PHEV) cars. Given the view that the electrification of the future vehicle fleet will primarily involve BEVs rather than PHEVs, it means even more mineral consumption. Of course, there is always the possibility that the chemistry of batteries will change due to shortages and the escalating expense of some of these rare minerals for batteries. Assuming that the mineral composition of batteries doesn't change, Exhibit 13 provides an estimate of the demand growth between now and 2025 for key battery minerals.

Exhibit 13. Future Demand For Battery Minerals



Source: ***The Wall Street Journal***

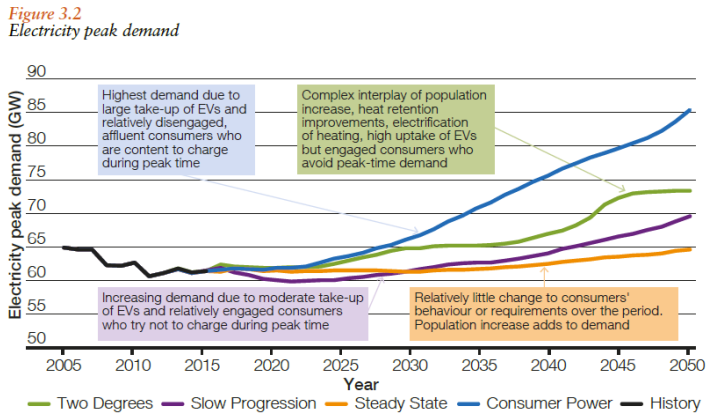
The power increase would be the equivalent of six of the Hinkley Point nuclear power plant that is currently under construction

The minerals involved in battery recharging is only one aspect of the impact EVs will have on electricity demand. The bigger question is how much additional electricity will be needed if we are to completely electrify the vehicle fleet, and where will the power come from. In the UK, the primary electric utility, National Grid (NGG-NYSE), has examined the issue and developed several scenarios of how consumers will adopt EVs and recharge them. Their study concluded that in the worst case – fully embraced EVs with no mitigation of expense in recharging them - the country could see 18 gigawatts (GW) of incremental power consumption by 2050. That worst-case scenario assumes that EV sales would account for more than 90% of all cars in the UK by 2050, with one million on Britain's roads by the early 2020s, and as many as nine million EVs by 2030. The power increase would be the equivalent of six of the Hinkley Point nuclear power plant that is currently under construction.

In the case of a moderate increase in EVs and consumers becoming disciplined to only recharge during non-peak demand times, the incremental peak electricity demand would be about five GW, or the

equivalent of one and half Hinkley Point plants. National Grid also pointed out that in every case, the application of smart charging technology could move the power demand to non-peak times, thereby reducing, in one case, an estimated eight GW increase to 3.5 GW.

Exhibit 14. How EV Recharging Can Impact Power Demand



Source: National Grid

The study concluded that across Britain, 32% of low voltage power feeder lines (neighborhood power systems) will require intervention when 40%-70% of customers have EVs

Another estimate of the impact of EVs on the UK electricity system came from a three-year research project. The project, called My Electric Avenue, was funded by the UK electricity industry regulator, and was designed to simulate heavy EV recharging demand. It found potential problems for the nation's power grid. Clusters of homes were provided Nissan LEAF electric cars for 18 months in an effort to mimic a future scenario where many people in an area choose to use EVs. The study concluded that across Britain, 32% of low voltage power feeder lines (neighborhood power systems) will require intervention when 40%-70% of customers have EVs, based on 3.5 kilowatts (kW) of charging power needed. These feeder lines are typically characterized by available capacity of less than 1.5 kW per customer.

Exhibit 15. Incremental U.S. Power Demand For EVs

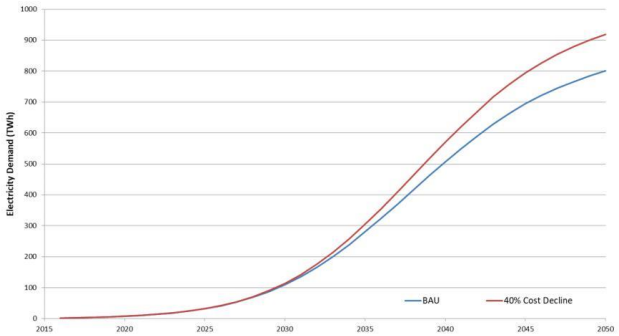


Figure 6. Annual electricity demand by electric LDVs in the U.S. in the BAU scenario and in a scenario with gradual cost declines reaching 40% of the BAU value in 2050.

Source: Energy Policy Solutions

Based on the higher penetration rate assumption, the Energy Policy Solutions model projects that by 2050, the U.S. will need an incremental 900 terawatts (TW) of electricity just to recharge the EVs in the fleet

In one EV study for the U.S. market, the forecasters assumed that EVs will account for at least 65% of sales in 2050, and given strong technology cost declines or high oil prices, could represent 70-75% of sales in that year. Based on the higher penetration rate assumption, the Energy Policy Solutions model projects that by 2050, the U.S. will need an incremental 900 terawatts (TW) of electricity just to recharge the EVs in the fleet. Without technology improvement or high oil prices, the nation will need at least another 800 TW of power. To put those estimates into perspective, the high estimate represents a 25% increase in the total amount of power used in the United States for all of 2016. The lower incremental EV power need would represent about a 20% increase in total power consumed, assuming that current demand remains flat with 2016.

Some mining experts say there will not be sufficient capacity available due to the lack of resources

While many EV forecasts are optimistic about the ability of the nation to shift to driving EVs rather than ICE cars, there are a number of logistical and infrastructure challenges that are often assumed away. Will there be enough rare earth minerals? Some mining experts say there will not be sufficient capacity available due to the lack of resources. If correct, then we can expect sharply higher prices for rare earth minerals that will impact EV costs. We still need to expand the recharging network, but there are serious questions about meeting future electricity needs for a high penetration rate for EVs in the nation's fleet. Having sufficient capacity to power the EVs still leaves open the question of what upgrading needs will be required by the power grid and local distribution systems. The multitude of issues involved in transitioning the nation's and world's vehicle fleets to electric power suggests taking every EV projection with a certain amount of salt.

Given our holiday schedule, the next issue of *Musings From the Oil Patch* will arrive in your inbox on January 9, 2018. Happy Holidays.

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