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

Crude Oil Prices: Divining The Future; Is It Possible To Do?

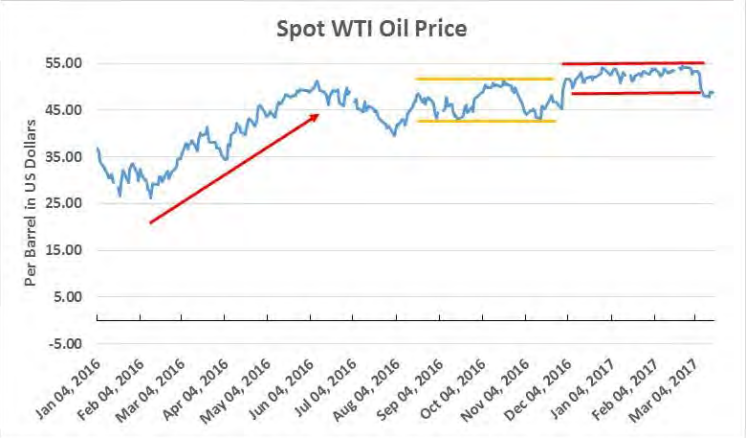
The reality is that crude oil prices have essentially been trading in a fairly narrow range - $50 to $54 a barrel since the surprise OPEC announcement last November

If you have been following the oil market in recent days, you might feel you need seasick medicine, but the reality is that crude oil prices have essentially been trading in a fairly narrow range - $50 to $54 per barrel since the surprise OPEC agreement last November. It has been in a slightly wider range for much longer. Exhibit 1 (next page) shows crude oil prices since January 2016. Following February's $26 a barrel low, oil prices rallied, climbing to $51.23 in four months. Not surprisingly, oil prices then retreated as oil traders and speculators, believed the climb had been too fast and gone too far and decided to take profits. Their que to sell act were signals that a market rebalance would take longer than thought.

If one widens the price channel of crude oil prices to $40 on the low side, then prices have been range-bound for over seven months!

From a technical trading perspective, from the low, oil prices rose by roughly $25 a barrel to the high, so the pullback of nearly $12 was about what would have been expected. From just under $40 a barrel, oil prices then retested the "old" high. That prior high was eclipsed in mid-October when spot oil prices reached $51.59, before falling back on news that an OPEC production cut agreement might not occur. The market was then surprised in November by the announcement of an OPEC production cut agreement and reports that key non-OPEC exporters, principally Russia, supported a coordinated production cut. That news spiked oil prices from $45 a barrel to $51.73 before they fell back and then re-tested the $52 threshold as the follow-up meetings between OPEC leaders and Russian oil officials confirmed Russia's commitment to the overall master plan for rebalancing global oil markets. Since then, spot oil prices have traded in that $50-$54 a barrel range until the crash of a week ago. The tight price range has existed now for over 90 days. If one widens the price channel of crude oil prices to $40 on the low side, then prices have been range-bound for over seven months!

Exhibit 1. Oil Prices Have Been Fairly Stable For Months



Source: EIA, PPHB

Attempting to divine the direction of oil prices is extremely difficult as there are so many factors influencing them – some positive with others negative

Attempting to divine the direction of oil prices is extremely difficult as there are so many factors influencing their direction – some positive with others negative. A brief (but certainly not all inclusive) list of factors impacting oil prices would include global economic growth, oil demand, OPEC and non-OPEC oil supply/exports, U.S. oil output, U.S. drilling activity, refinery maintenance schedules, geopolitical events, internal OPEC oil consumption, the value of the U.S. dollar, oil price volatility measures, global and U.S. oil and refined petroleum product inventories, and the investment positions of crude oil speculators. We don't plan on commenting on all these factors, but we will address a few.

The IMF indicated it was seeing an improvement in global economic growth, supporting its January forecast for 3.4% growth in 2017 and 3.6% growth in 2018, up from 3.1% in 2016

In advance of the G20 Finance Ministers meeting last weekend, the International Monetary Fund (IMF) indicated it was seeing an improvement in global economic growth, supporting its January forecast for 3.4% growth in 2017 and 3.6% growth in 2018, up from 3.1% in 2016. The IMF continues pointing out that developing economies are the primary driver of global growth, representing three-quarters of the global rate. A more positive economic growth outlook helps offset some of the negative sentiment from the reduced Chinese growth forecast for 2017 (6.5% down from last year's 6.7% growth) and a weakening of India's economic growth.

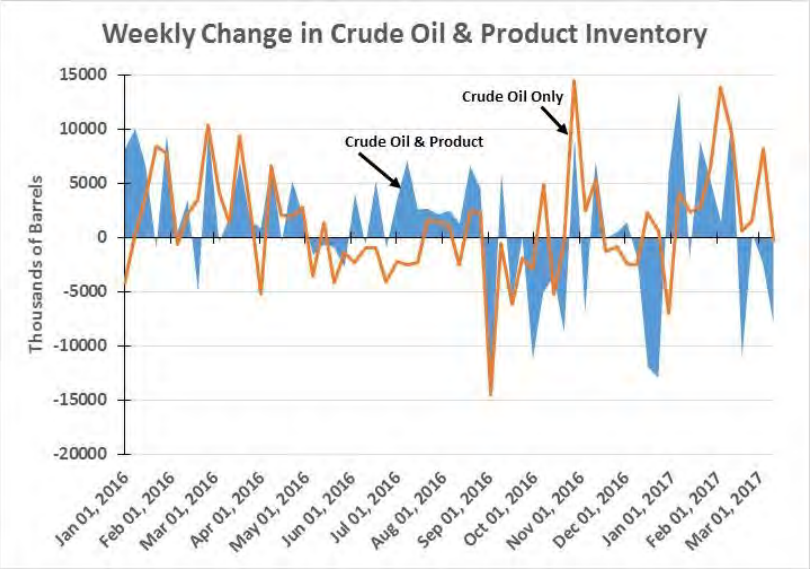
The nearly 10% decline in oil prices between the end of February and last Friday, was primarily attributed to a surprisingly large weekly oil inventory build reported the week before last

The nearly 10% decline in oil prices between the end of February and last Friday, was primarily attributed to a surprisingly large weekly oil inventory build reported the week before last. While the crude oil build of 8.2 million barrels was sharply higher than analysts had expected, it was more than offset by a drawdown of refined product inventory of 10.6 million barrels. That fact was mostly ignored by oil traders, analysts and the media. In our view, this surprise inventory build was not unusual given the pattern of weekly builds normally experienced whenever the oil industry moves into its shoulder months for demand when it shuts refineries for maintenance and reconfiguration for a new product output slate.

In the early months of the year, the industry routinely experiences large weekly oil and product inventory builds

Exhibit 2 shows the weekly change in crude oil and refined product inventories since January 2016 and just the change in crude oil inventories. The point of this chart is to note that in the early months of the year, the industry routinely experiences large weekly oil and product inventory builds. The recent week's surprise increase was followed the next week with a surprising decline in inventories. It is important to examine weekly builds and declines experienced in 2016's first quarter versus this year's experience. Combined, the industry has experienced more and larger inventory withdrawals. Does that reflect a sustained strengthening of demand and reduced supplies, or are these draws only one-off events? If the former, it would be a healthy sign for the market and future oil prices.

Exhibit 2. Latest Inventory Draws May Signal Market Turning



Source: EIA, PPHB

Both Libya and Nigeria, OPEC members who were exempted from the production cutbacks, are both struggling to keep their production volumes flowing

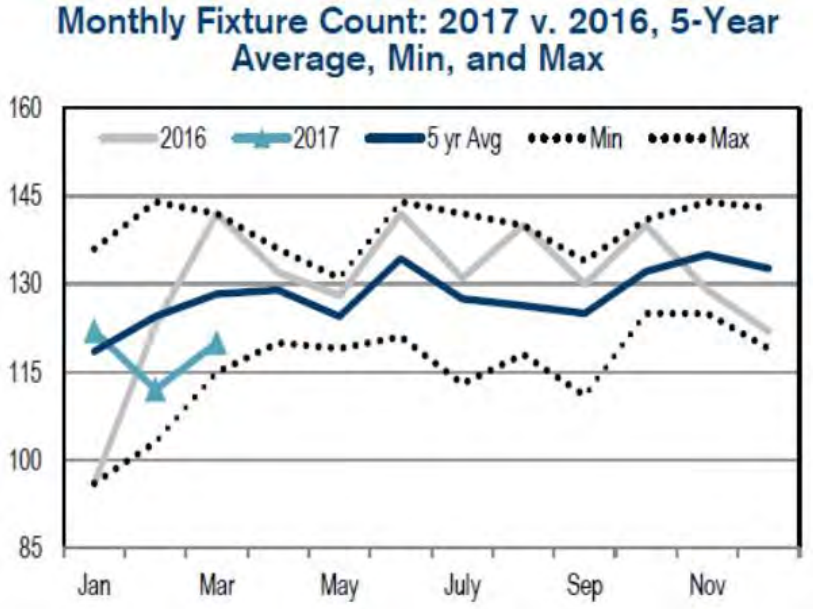
Some analysts are pointing to the crude oil inventory build as a sign that either global demand is weak or the OPEC production cut is not as successful as indicated by the surveys of OPEC member country compliance. At the same time, both Libya and Nigeria, OPEC members who were exempted from the production cutbacks, are both struggling to keep their production volumes flowing due to a civil war in the former country and social unrest in the latter. If their volumes cannot be sustained, it should help the market rebalance sooner, if all other trends hold.

The latest media and International Energy Agency surveys show that OPEC is meeting somewhere between 85% and 90% of its agreed production cuts. The problem OPEC has is Russia's slow response. Russian oil officials repeatedly state they are on schedule to meet their lower output target and remind us that they said it would take them until the middle of 2017 to reach the target. As a result, non-OPEC output is only 50% of its target reduction.

Industry data shows VLCC charter rates are sharply lower, further indicating reduced demand

Another judge of OPEC production volumes is oil tanker traffic, which shows a reduction in the number of very large crude carriers (VLCCs), carrying one million barrels of oil each, hauling oil from the Middle East. Industry data shows VLCC charter rates are sharply lower, further indicating reduced vessel demand. The number of ship charters is below the 5-year average and closer to the minimum number of ships used. This is further proof of reduced oil volumes moving out of the Middle East, supporting the conclusions of the oil production surveys.

Exhibit 3. Fewer VLCCs Are Hauling Oil From The Middle East



Source: Credit Suisse

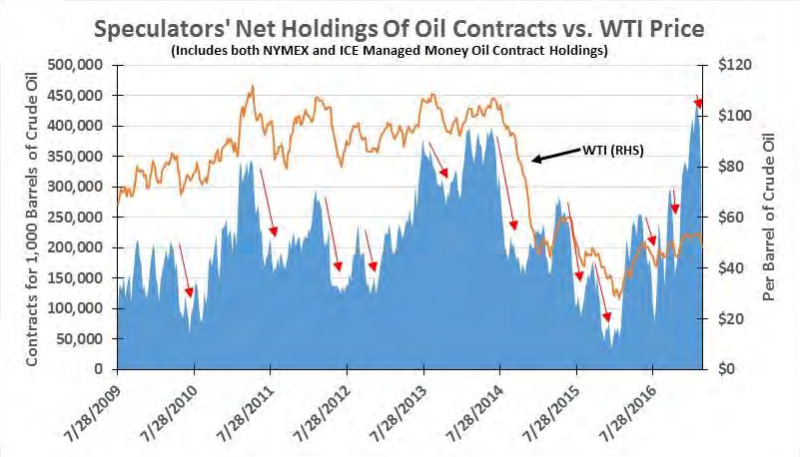
After building their bullish bets for higher oil prices, speculators are unwinding their positions in concert with the drop in oil prices

Another industry dynamic we would point to is sentiment for oil prices among the crude oil speculators that is lower than in prior weeks. After building bullish bets for higher oil prices, speculators are unwinding their positions in concert with the drop in oil prices. As Exhibit 4 (next page) confirms, this is not a surprising outcome given the long and frequent history (red arrows) of traders making bullish bets just as crude oil prices moved in the opposite direction.

The world's economies had to adjust to the reality that the age of super-low oil prices with abundant supplies was over

For those impatient with the pace of the oil market rebalancing (oil speculators), they will continue suffering angst. The damage done from years of super-high oil prices will not be repaired by a brief OPEC/NOPEC (non-OPEC) production cut. Go back and review the mid-1980s history. After what was a relatively brief period of super-high oil prices, the world's economies had to adjust to the reality that the age of super-low oil prices with abundant supplies was over. That adjustment required more than a decade to happen, and even then, the industry recovery was muted, partly because the natural

Exhibit 4. Oil Speculators Follow Pattern Of Calling Price Tops



Source: CFTC, EIA, PPHB

gas business fell into disarray necessitating a complete industry restructuring. In this cycle, we are confronting not only oil and gas trends, but also the new market dynamics of renewables coupled with the demise of nuclear power. The energy world of the 2020s will be different than it is now or in the recent past, just as the 1990s-2000s' energy world was different from that of the 1980s.

We look forward to watching, analyzing and commenting on the twists and turns of this journey

What we are re-learning is that energy market transitions take longer than expected and lead to different places than where everyone thinks they are headed. We are not wise enough to know where oil and gas prices are headed, but we are sure the journey will prove interesting, frustrating and stressful, but hopefully profitable by the time we arrive at our destination, wherever it is. We look forward to watching, analyzing and commenting on the twists and turns of this journey, while always trying to not lose sight of the bigger picture.

Challenges For EVs In Revolutionizing Transportation Sector

The outlook for EVs is improving due to gains in battery technology as well as mandates for reduced vehicle emissions

If you are an optimist, electric vehicles (EVs) are about to revolutionize the globe's transportation sector in response to environmental concerns. On the other hand, a pessimistic (realistic?) outlook suggests that the share of EVs in the world's vehicle fleet will increase, but not to such an extent as to prevent gasoline and diesel consumption to continue growing for several decades. In our estimation, the outlook for EVs is improving due to gains in battery technology as well as mandates for reduced vehicle emissions, but we seriously doubt that the most optimistic projections for EVs will prove accurate.

We would consider the most optimistic forecast for EVs to be the one developed jointly by the Carbon Tracker Initiative and the Grantham Institute at Imperial College London. Their report, Expect the Unexpected: The Disruptive Power of Low-carbon Technology,

offers an engaging analysis of the impact rapidly improving trends in solar photovoltaics and electric vehicles may have on energy demand, and crude oil specifically, over the next 33 years.

The operating life of vehicles continues to grow in response to manufacturing and engine improvements

With respect to EVs, which includes both plug-in hybrid (PHEVs) and battery electric vehicles (BEVs), the report projects that "EVs occupy over half the road transport market in 2040 and ICEs (internal combustion engines) just a fifth. By 2050, BEVs have saturated the passenger vehicle fleet." Given that conclusion, the only market the world will have for gasoline and diesel fuels is to power the legacy ICE vehicles in the global fleet. Of course, that could be a significant number as the operating life of vehicles continues to grow in response to manufacturing and engine improvements.

BP sees the number of EVs rising from 1.2 million in 2015 to around 100 million in 2035, or to approximately 6% of the global vehicle fleet

In contrast, British Petroleum's (BP-NYSE) 2017 Energy Outlook projects a significantly different outlook for EVs. In its report, BP employs the following assumptions to forecast the impact of EVs in the transportation fleet in 2035 on gasoline demand. First, BP sees the global car fleet doubling from 0.9 billion cars in 2015 to 1.8 billion in 2035. Almost all that fleet growth occurs in developing markets as a result of rising incomes (more middle class people) and improved road infrastructure. BP sees the number of EVs rising from 1.2 million in 2015 to around 100 million in 2035, or to approximately 6% of the global vehicle fleet. The company also believes that 25% of EVs will be PHEVs with the balance BEVs. The BP estimate of EVs in 2035 contrasts with the Carbon Tracker/Grantham Institute projection for a 35% share.

"A key driver of the pace at which EVs penetrate the global car fleet is the extent to which fuel economy standards are tightened"

The most important point in BP's forecast is its assessment of how the pace of EVs penetrating the fleet may evolve. Quoting from the BP slide it used when presenting the 2017 Energy Outlook, the company stated: "A key driver of the pace at which EVs penetrate the global car fleet is the extent to which fuel economy standards are tightened. But EV penetration will also depend on a number of other factors including: (i) the pace at which battery costs continue to fall; (ii) the size and durability of subsidies and other government policies supporting EV ownership; (iii) the speed at which the efficiency of conventional vehicles improves; and crucially on (iv) consumer preferences toward EVs."

There won't be enough money to go around

The forces that BP identifies as influencing the pace of EV penetration are all important, but they are in a state of flux. For the United States, the primary contributor to the EV state of flux is the new Trump administration with radically different environmental beliefs than the prior administration. But potentially equally as unsettling is the growing recognition by state governments that the cost of providing subsidies for the purchase of EVs by their residents, along with the traditional methods for funding infrastructure investments, will need to be addressed. In other words, there won't be enough money to go around.

These issues were highlighted by a recent article in *The New York Times* titled: "The State-by-State Assault on Electric Cars." The key points from this "assault" were summarized in the following paragraph from that article.

"There is a move to repeal tax credits for battery-powered vehicles or to let them expire"

"Today, the economic incentives that have helped electric vehicles gain a toehold in America are under attack, state by state. In some states, there is a move to repeal tax credits for battery-powered vehicles or to let them expire. And in at least nine states, including liberal-leaning ones like Illinois and conservative-leaning ones like Indiana, lawmakers have introduced bills that would levy new fees on those who own electric cars."

The subsidy was pretty important in the car-purchasing decisions of Georgians

The article started by citing the Georgia situation where the legislature repealed the state's $5,000 tax credit for the purchase of an EV in July 2015, and subsequently imposed a $200 registration fee. Sales plummeted from nearly 1,300 cars in the month of June 2015, before the tax credit repeal and registration fee imposition, to only 97 cars in August. One would guess that the subsidy was pretty important in the car-purchasing decisions of Georgians.

Legislators, confronting a budget shortfall, were seeking revenues wherever they could be found

What was interesting was reading the author's narrative about the repeal of the Georgia incentive. Repeal efforts had begun in the late 1990s, but had gone nowhere. In 2015, the repeal measure was rolled into a larger transportation bill that targeted newly paved roads and repaired bridges. It passed with virtually no debate, as legislators, confronting a budget shortfall, were seeking revenues wherever they could be found. We suspect that is part of what is behind many of the state repeal efforts, such as in Illinois where the state is nearly bankrupt due to the cost of its constitutionally-protected state employee pension fund.

"By allowing these subsidies to continue, you are unfairly choosing to use our tax dollars to benefit a finite group of individuals and corporate interests"

In Colorado, the continuation of EV tax subsidies is being debated. The arguments against continuing these subsidies are shifting from purely revenue ones to issues of fairness. The bill being proposed would shift the money devoted to subsidizing EV sales to repairing Colorado's infrastructure. But Rudy Zitti, deputy state director at Americans for Prosperity, testified before legislators saying, "By allowing these subsidies to continue, you are unfairly choosing to use our tax dollars to benefit a finite group of individuals and corporate interests." This was an argument leveled against the Obama administration's clean energy investment focus that resulted in hundreds of millions of U.S. taxpayer dollars being committed to renewable companies such as Solyndra ($529 million), Abound Solar ($70 million) and Fisker Automotive ($139 million), all of which ended up broke.

Even China is backing away from EV subsidies and the government's mandate aimed at pushing auto manufacturers to build EVs. Sales of new-energy vehicles, the term China uses to refer to BEVs, PHEVs and fuel cell cars, fell 74% in January from a

year earlier to 5,682 units, according to data released by the China Association of Automobile Manufacturers.

An estimate of the average production of new-energy vehicles last year may have contributed only about 3%, or five percentage points below the target

China unveiled a draft rule promoting clean-energy vehicles last fall that set a new-energy vehicle credit score of 8% in 2018, derived from different weightings assigned to various types of zero- and low-emission vehicles. Manufacturers who fail to meet that target will either be fined or forced to purchase credits from companies exceeding the target. An estimate of the average production of new-energy vehicles last year may have contributed only about 3%, or five percentage points below the target. Chinese government officials have been advised by various economic ministers from Western countries that the target is unattainable. The policy is being reviewed with a goal of having it finalized by May 2017.

There are questions about the impact of a significant number of EVs charging on the stability of the nation's electricity grid

Much like other energy markets, low fossil fuel prices are undercutting the economics of both nuclear power in the electricity world as well as renewable power everywhere. In the transportation sector, low oil prices translate into low gasoline and diesel prices, which hurts the appeal of EVs as well as potential electric truck sales. But there are other issues besides fuel costs, such as range anxiety, how emissions gains may be offset by the fuel source to produce the electricity to charge car batteries, and the time-value for charging cars that are diminishing the current appeal of EVs. Furthermore, there are questions about the impact of a significant number of EVs charging on the stability of the nation's electricity grid. (Elsewhere, we have an article by a Philadelphia lawyer questioning the economics of a Tesla car.)

When used as the woman normally does – 100 mile a day roundtrips – the Bolt is perfectly fine, especially since she can charge it overnight at her home

The most interesting recent blog about EVs that we have read involved a woman in Southern California taking her daughter on a tour of colleges. She wrote a detailed blog about her experience with her new Chevy Bolt, a 238-mile per charge EV, which included lessons learned about driving the car, the charging infrastructure in California, the challenges of charging the Bolt, and the planning necessary for making an 800-mile roundtrip. The blog was posted on the web site *Green Car Reports* and had over 1,000 comments, as of last week, including a number of interesting points from long-time EV, especially Tesla (TSLA-Nasdaq), owners. One of the pointed conclusions was that the Chevy Bolt is not designed for long-distance travel. When used as the woman normally does – 100 mile a day roundtrips – the Bolt is perfectly fine, especially since she can charge it overnight at her home.

The key conclusion this woman took away from her trip was that the journey home - 380+ miles - took 11.5 hours

The key conclusion this woman took away from her trip was that the journey home - 380+ miles - took 11.5 hours versus hypothetically only five hours in a gasoline-powered vehicle due to the additional time for charging stops. She also needed to travel off the Interstate highway in order to access charging stations, which are not as conveniently located as the Tesla charging station network in California. This route added roughly 40 miles to the direct route,

with additional time required. She reported that the cost to charge her car came to $88, compared to her estimate of $84 for a gasoline-powered vehicle getting 25 miles per gallon, at $3-per-gallon, driving the same distance. For her, she questioned whether the time trade-off was worth it for being environmentally sensitive.

"With my little lead foot taking us down the freeway at an average of 80 mph, we got nowhere near the 238-mile rated range"

Other issues she encountered with her Bolt included the loss of charge (range) due to high speed driving and the inability to charge it at the vehicle's advertised rate. According to comments posted, the charging speed is inflated by General Motors (GM-NYSE) to help overcome owners' range anxiety. Her first shock was finding out that her normal driving style wasn't good. As she wrote, "With my little lead foot taking us down the freeway at an average of 80 mph, we got nowhere near the 238-mile rated range. After 103 miles, we showed only 70 miles of remaining range." Commentators suggested that she needed to drive closer to the highway speed limit to boost her vehicle's range.

Using the heater and other accessories also consumed some of the charge, further reducing the vehicle's range

She also found that using the heater and other accessories also consumed some of the charge, further reducing the vehicle's range. What she didn't confront was the problem of high ambient temperatures, which reduce the capacity of the battery. This is especially true when the temperatures climb above 85° F, meaning people living in the southern portion of the United States will face an issue during summer times.

There were a number of issues with the charging infrastructure available for the Bolt, as GM has no plans to develop a nationwide charging system as envisioned by Tesla. Since the location of the charging stations, the rate of their charge, and their condition create issues for EV owners, long-distance travel will require more pre-planning than when using a gasoline-powered car.

With three hours needed to cover 125 miles and to be ready for the next leg, it equates to an average speed of 40 mph!

One of the commentators who argued that the Bolt is not capable of making long-distance trips, pointed out that the true range was more like 75-125 miles between charges, depending on whether one wanted to devote 30 minutes or 60 minutes to recharging. What that means is that the car will be driven for 1-2 hours with an additional 30-60 minutes for re-charging, or a time ratio of 2:1. With three hours needed to cover 125 miles and to be ready for the next leg, it equates to an average speed of 40 mph!

Not everyone has the leisure for planning and executing a long-distance trip with a Bolt, suggesting it will remain a niche vehicle until there is a ubiquitous charging network

As the experience from this woman's trip highlighted, many of the charging spots she was directed to were owned by companies and located either on their property or in office building parking garages with expensive parking, making them unavailable for the typical EV traveler. Not everyone has the leisure for planning and executing a long-distance trip with a Bolt, suggesting it will remain a niche vehicle until there is a ubiquitous charging network. The time required to build out the nation's charging network will partially dictate the pace at which EVs penetrate the American vehicle fleet.

So, will people opt for one EV and one gasoline-powered car in the future? We think this may be a popular solution for some period of time, further slowing the penetration rate of EVs in our vehicle fleet.

Germany Acts To Ban ICE Vehicles; Risks Higher Emissions

Germany's Bundesrat called for the government to phase out gasoline-powered vehicles by 2030

Last October, Germany's Bundesrat, the country's upper legislative chamber, called for the government to phase out gasoline-powered vehicles by 2030. While this is not official policy, the talk of such a ban, as well as the proposed ban of diesel-powered cars due to the Volkswagen greenhouse gas emissions scandal, is sending strong signals to Germany's huge, and economically important, automobile industry.

An analysis of the situation was reported in *Nature* and showed that if Germany were to get to a 100% electric vehicle fleet by 2030, depending on how that power was generated, the country could easily have more carbon emissions, and not less.

Exhibit 5. How Green Electric Vehicles Are Often Powered

Source: ***Investors' Daily***

Angela Merkel, had announced plans to slow the country's expansion of new wind farms

The potential ban on internal combustion engines (ICE) was announced after Germany's chancellor, Angela Merkel, had announced plans to slow the country's expansion of new wind farms since too much intermittent renewable electricity was making the power grid unstable. The renewables slowdown was also prompted by the need to modify the incentive aspects of the country's *Energiewende* plan to create a carbon-free economy. This suggests that the gasoline ban was conceived without much forethought or analysis.

Germany paid people to use electricity

On May 8, 2016, for a few hours around lunchtime on a bright and windy day, Germany paid people to use electricity. The country's investment in renewable power generation capacity paid off when almost enough power to meet national demand came from green energy sources, while at the same time electricity from fossil fuel sources were running. The result was that spot power prices went negative, something that Texas has experienced occasionally during night times, meaning that the more power commercial customers used, the more money they made.

Germany ranks third in the world in terms of renewable-power generation capacity behind China and the United States

Electricity produced from renewable sources in Germany has tripled over the past decade. On most days, the renewable power supplies almost one-third of domestic electricity needs. Germany ranks third in the world in terms of renewable-power generation capacity behind China and the United States. At 1.1 kilowatts per capita of renewable power, the 92 gigawatts that the nation produced in 2015 represents more than twice the renewable power per capita of any other large economy.

German' households, as a result, pay the highest cost of electricity in Europe

Despite all the progress Germany has made in growing its renewable power capacity, it has come at a significant cost. German households pay more than €20 billion (US$23 billion) in annual surcharges for the fixed feed-in tariffs that go to individual producers. German' households, as a result, pay the highest cost of electricity in Europe, in order to keep power costs down for the country's manufacturing sector, which is so important to the health of its economy.

The planned slowdown in the expansion of renewable power will set a 45% cap on the amount of renewable electricity generation in Germany by 2025

The planned slowdown in the expansion of renewable power will set a 45% cap on the amount of renewable electricity generation in Germany by 2025. The plan will also embrace the European Union's demand that future wind and solar energy promotions be linked to tenders that favor producers who generate electricity at the lowest price. These adjustments have upset virtually all sectors of the power market – small producers and homeowners who have invested in rooftop systems to offset their power costs and as a revenue source, as well as green lobbyists who believe the reforms favor the fossil fuel industry and may signal that Germany is no longer the role model for renewable energy investment.

Germany cannot erase fossil fuels and nuclear power from its energy and transportation sectors at once without creating other problems

The reality is, however, as the conclusion of the study in *Nature* reports: Germany cannot erase fossil fuels and nuclear power from its energy and transportation sectors at once without creating other problems. As the authors wrote: "What Germany's case does illustrate is that this transition must be backed by comprehensive energy plans. To incorporate fast-growing, decentralized power generation into electricity grids requires improved networks, reliable tools to predict supply and demand, efficient storage and more-flexible conventional plants."

Electric cars are more efficient that gasoline-powered ones in transforming power into energy – 30% for gasoline versus 75% for electricity

As the study reported, electric cars are more efficient than gasoline-powered ones in transforming power into energy – 30% for gasoline versus 75% for electricity. Each year, German vehicles burn around 572 terawatt-hours' (TWh) worth of liquid fuels. Using the above efficiency measures, a fully-electrified road transportation sector would use around 229 TWh. As a result, Germany would use considerably less power with the switch, but the issue is how to generate that power. Since the country is also committed to phasing out its nuclear power plants by 2022, or 2030 at the latest, Germany will need to create 321 TWh of new generation by 2030, which includes the 92 TWh needed to replace the lost nuclear power.

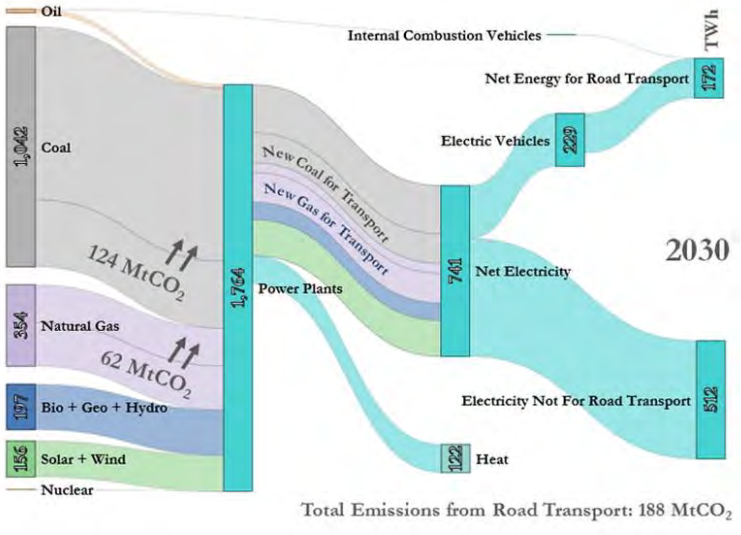
It must close the 258 TWh gap with power from coal or natural gas plants

If renewable energy expands at the maximum rate allowed by the newly proposed German plan, it will only produce around 63 TWh of new capacity. While hydropower, geothermal and biomass don't suffer from the same intermittency problems as wind and solar, Germany is about maxed out on these resources. Therefore, it must close the 258 TWh gap with power from coal or natural gas plants. That is the equivalent of the total electricity consumption of Spain, or of 10 Irelands.

Unless the entire power shortfall is made up from natural gas, Germany would have a net increase in emissions

With respect to emissions, the German road sector currently emits around 156 million tons of carbon dioxide (CO_2). Closing the power gap by generated electricity from coal would create an additional 260 million tons of CO_2, annually. Using natural gas, the incremental CO_2 emissions would only increase by 131 million tons. Unless the entire power shortfall is made up from natural gas, Germany would have a net increase in emissions.

Exhibit6X. How Germany's Emissions Might Increase With EVs



Source: ***Nature***

In Exhibit 6, the study's authors have assumed that half the necessary electricity for electric cars would come from new gas

Emissions from the road transportation sector actually increase by 20%, or 32 million tons of CO2

plants and half from new coal plants. They have also assumed that both coal and natural gas become 25% more efficient in creating power. The result is that emissions from the road transportation sector actually increase by 20%, or 32 million tons of CO_2, or comparable to the annual emissions of Uruguay or Montana.

The light at the end of this tunnel may actually be a wall

Maybe Chancellor Merkel should push the pause button on the nuclear power plant phase-out, and acknowledge that the decision was made hastily, and emotionally, in response to the Fukushima nuclear power plant accident, rather than as the result of a thoughtful analysis of how to successfully transition Germany to a low-carbon economy over time. We doubt this will happen. Rather, we would suggest that the light at the end of this tunnel may actually be a wall that will create significant dislocations for the German economy.

Climate On Center Stage; How Well Are Renewables Doing?

Cries from environmentalists about placing a fox inside the hen house failed to derail the nomination

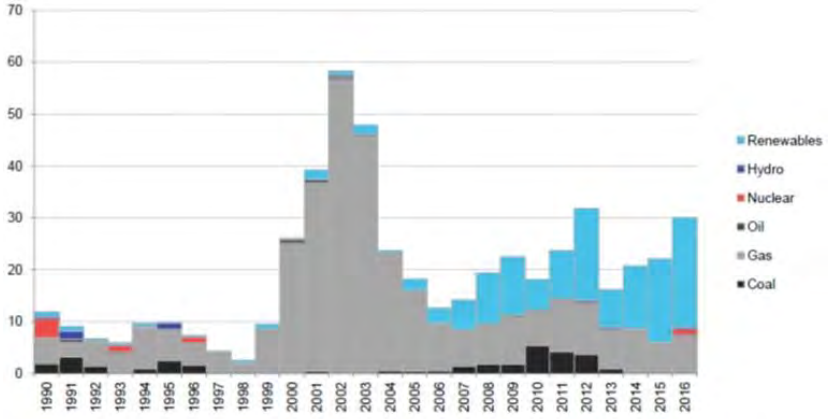
Maybe you are Rip Van Winkle reincarnated, or maybe you've decided to ignore the news for sanity's sake, but climate change is now front and center in the Washingtonian political world. The drama started with the appointment of former Oklahoma Attorney General Scott Pruitt (R), a long-time critic and adversary of the Environmental Protection Agency (EPA), to head that organization. Cries from environmentalists about placing a fox inside the hen house failed to derail the nomination as Republican politicians, who campaigned on a platform of enacting laws to boost economic growth, pointed to environmental regulations as a major impediment to that goal.

As we are still early in the year, we continue seeing annual compilations of 2016 industry statistics. In one case, an article titled "2016: Another Monumental Year for Clean Energy" crossed our desk. Clearly, the heightened focus on climate change that precipitated the U.S. supporting the Paris climate accord last fall, is dominating the national debate about our energy mix. We were not surprised to see the article's title, but it led us to review some of its points in the report it was based upon, which was the Sustainable Energy in America Report from Bloomberg New Energy Finance.

In 2016, renewables-powered capacity added was nearly twice the amount fueled by natural gas – 76 gigawatts (GW) versus 39 GW

A conclusion from the report was that the "rapid pace of renewable energy deployment accelerated…and the economy grew more energy efficient than ever." That point sent us to examine a couple of charts from the report. First, we looked at new electric generating capacity added each year from 1990 by fuel type. It shows rapid growth in renewable fuel powered generating capacity in recent years. In 2016, renewables-powered capacity added was nearly twice the amount fueled by natural gas – 76 gigawatts (GW) versus 39 GW.

Exhibit 7 Electric Generating Capacity By Fuel Type (GW)

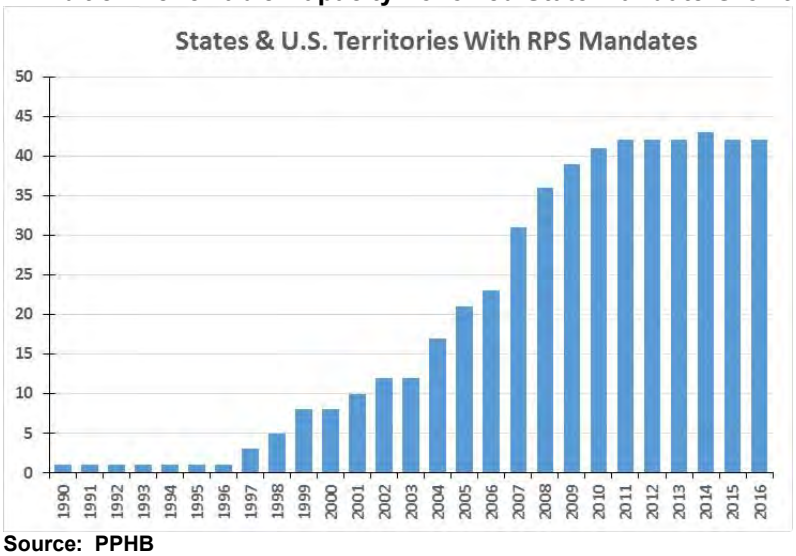


Source: Bloomberg New Energy Finance

California, surprisingly didn't enact such legislation until 2002

When one examines the history of new electricity generating capacity added, it is clear that starting in 2005 renewables took off. What is interesting is to compare the growth in renewables electric generating capacity added with the increase in the number of U.S. states and territories enacting Renewable Portfolio Standards (RPS) mandating utilities generate more power from renewables. The pattern we found initially surprised us as the first state to enact a RPS was Iowa in 1983. Many of the Northeast states joined the movement in the late 1990s, when environmentalism became a higher profile issue. California, surprisingly didn't enact such legislation until 2002. But the real push for RPS mandates began in 2004 when five states voted them in, followed in subsequent years by multiple states and territories. West Virginia, which enacted RPS legislation in 2009, rescinded it effective in 2015.

Exhibit 8. Renewable Capacity Followed State Mandate Growth

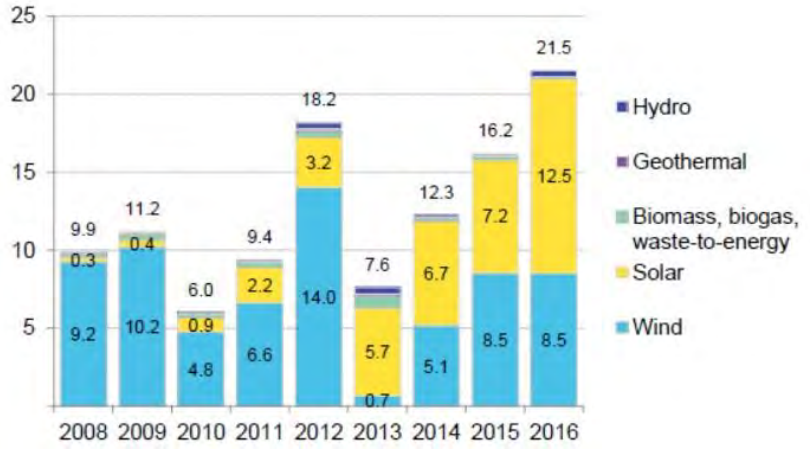


Source: PPHB

It has only been since 2013 that solar has become a significant portion of new renewable capacity

When we looked at the Bloomberg report's chart on the composition of the new renewable generating capacity for 2008-2016, it has only been since 2013 that solar has become a significant portion of new renewable capacity. We suspect that is tied to the sharp decline in the cost of solar panels due to China entering the market and beginning to dump its surplus output into the U.S. market. That, coupled with net metering (residents selling surplus solar power to their utility company at retail power prices), has enabled solar power to become more popular.

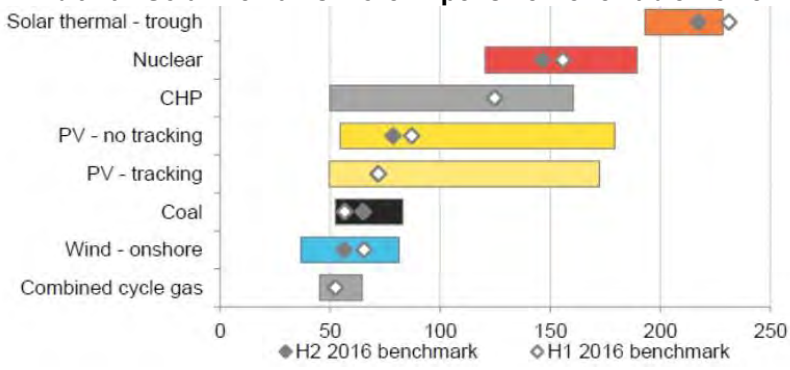
Exhibit 9. Renewable Power By Fuel Type



Source: Bloomberg New Energy Finance

Notice that we didn't say that solar power was cheaper, because Exhibit 10 shows Bloomberg's estimate for power costs by fuel in the U.S. It shows PV (photovoltaic) power substantially higher in cost than for coal, wind or natural gas.

Exhibit 10. Solar Remains More Expensive Renewable Power

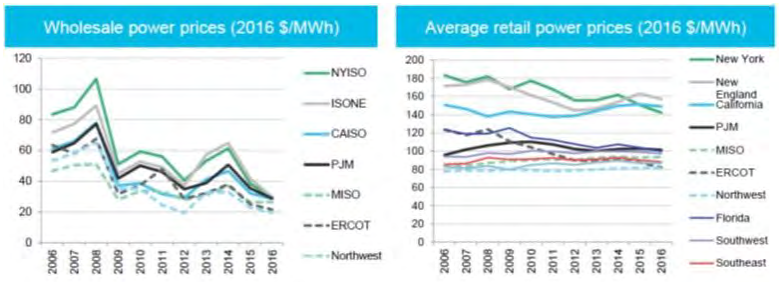


Source: Bloomberg New Energy Finance

What is interesting, as well as distressing, is the two charts from the report showing trends in wholesale power prices over the past decade compared to average retail power prices. Consumers have yet to truly benefit from the significant fall in wholesale power costs

due to cheaper fuels. We are, however, assured that renewable power costs have played an important role in their growth, especially in 2016.

Exhibit 11. Wholesale Power Costs Fall More Than Retail Costs



Source: Bloomberg New Energy Finance

We are not going to debate the power cost issue, because it is a secondary consideration to the climate change argument, but when residents pay 3-4 times the cost of power generated by natural gas for offshore wind or solar power, due to government mandates, they begin to feel that they are the suckers in this debate.

It involves asking automakers for the cost and feasibility of providing 114,000 electric vehicles, the equivalent of 72% of total U.S. plug-in vehicle sales last year

We were equally curious after reading a headline stating that "Cities Shop for $10 Billion of Electric Cars to Defy Trump." The first sentence of the article was: "Dozens of U.S. cities are willing to buy $10 billion of electric cars and trucks to show skeptical automakers there's demand for low-emission vehicles…" The cities' effort is being spearheaded by Los Angeles Mayor Eric Garcetti, and involves asking automakers for the cost and feasibility of providing 114,000 electric vehicles, the equivalent of 72% of total U.S. plug-in vehicle sales last year. Interestingly, the request includes police cruisers, street sweepers, trash haulers, fire engines and heavy-duty trucks, some of which do not even exist. Based on the number of vehicles and the dollar amount quoted, we are talking about an average cost per vehicle of $88,000.

Nearly 40 automakers, truck makers, bus makers and others have responded so far

According to the article, Los Angeles started the effort for a joint electric-vehicle order during the period immediately prior to the Paris climate conference in late 2015. The request for a bid proposal went out to automakers earlier this year, with a planned initial order for 24,000 vehicles from Los Angeles, San Francisco, Portland and Seattle. Since then, 26 other cities have joined, including Boston, Denver, Kansas City and Houston. According to Matt Petersen, Los Angeles chief sustainability officer, nearly 40 automakers, truck makers, bus makers and others have responded to the proposal so far.

The problem with this article, and the effort of the mayors, is that municipality purchasing of vehicles are usually one-time events, although they are often repeated frequently, so they aren't a true reflection of consumer demand. Imagining that this order will

If the public was rushing to purchase electric vehicles, we doubt General Motors would be expecting to lose $9,000 per car for every Chevy Bolt it sells

convince automakers that there is a swelling movement in favor of electric vehicles over gasoline-powered ones is difficult to conceive. If the public was rushing to purchase electric vehicles, we doubt General Motors (GM-NYSE) would be expecting to lose $9,000 per car for every Chevy Bolt it sells. This suggests the car's cost is still way too high for the market, and probably largely due to battery economics. GM has to be worrying about what happens when it exhausts its allotment of federal tax credits, adding $7,500 to the final purchase price of a Bolt?

Houston's fleet showed it having 27 electric cars out of a total fleet of 7,500, but 801 hybrid vehicles

The City of Houston has had hybrid vehicles in its fleet since 2002, making it what appears to be one of the earliest cities to experiment with unconventional vehicles. That year, Houston put into service two Toyota (TM-NYSE) Prius hybrids. Today, the city is reported to have the third largest hybrid vehicle fleet among cities in the U.S. (Not surprisingly, deciphering the claims about how many clean energy vehicles a city has and where that puts it in a ranking of cities is impossible.) A 2017 listing (Exhibit 12) of the composition of Houston's fleet showed it having 27 electric cars out of a total fleet of 7,500, but 801 hybrid vehicles. It has no electric or hybrid medium duty vehicles, and only 25 hybrid heavy duty trucks out of a fleet of 1,500 vehicles. The city also has nine propane-powered cars and one CNG-powered heavy duty truck. This list refutes a 2013 claim by one local newspaper reporter that half the City of Houston feet was hybrid.

Exhibit 12. 2017 City of Houston Vehicle Fleet Composition

Vehicle Class	Fuel Type	No. in Fleet
Light Duty, Classes 1 and 2 GVW up to 10,000 lbs.	Propane	9
	Electric	27
	Hybrid	801
	Unleaded	6,663
	Total	7,500
Medium Duty, Classes 3-5 GVW> 10,000 to 19,500 lbs.	Unleaded	276
	Diesel	624
	Total	1,000
Heavy Duty, Classes 6-8 GVW> 19,500 lbs.	CNG	1
	Hybrid	25
	Diesel	1,474
	Total	1,500

Source: City of Houston

The city's sustainability goal is to have electric vehicles represent 50% of its annual vehicle purchases by 2017

The efforts by cities to embrace electric and hybrid vehicle technology has accelerated in recent years. In September 2015, Los Angeles leased a Tesla (TSLA-Nasdaq) and a BMW i3 that were converted to police cars. This was part of an initiative to make Los Angeles "the most sustainable city in America," according to Mayor Garcetti. The city's plan was to lease 160 electric vehicles and 128 plug-in hybrids. The city's sustainability goal is to have electric vehicles represent 50% of its annual vehicle purchases by 2017.

These two cities are using a company that purchases the vehicles and monetizes the $7,500 federal tax credit and then leases the vehicles to the municipalities

Other cities such as Atlanta and Indianapolis leased their first electric vehicles in 2015. These two cities are using a company that purchases the vehicles and monetizes the $7,500 federal tax credit and then leases the vehicles to the municipalities. This reduces a city's outlays as the lease payments are much lower than the capital cost to purchase a vehicle, plus the city doesn't have to deal with the federal tax credit, which is of no value to a municipality.

To handle its vehicle charging needs, Houston's transportation department has installed 98 electric charging stations in its garage

To further its environmental agenda, in 2012, the City of Houston began a partnership with Zipcar, Inc. to utilize its technology in 50 city-owned electric and hybrid cars, enabling city employees across all departments to schedule the use of these vehicles whenever they need to use a vehicle on city business that requires less than 70 miles of total driving. To handle its vehicle charging needs, Houston's transportation department has installed 98 electric charging stations in its garage.

Some of these decisions are driven by mandates and socially-responsible initiatives

There are many sound reasons why utilities and municipalities opt for new electric generating capacity and vehicles powered by renewables. On the other hand, it is important to keep in perspective that some of these decisions are driven by mandates and socially-responsible initiatives, rather than real economic measures. Confusing the two issues can lead to dangerous conclusions and unexpected outcomes.

One Man's Answer To: How Green Was My Tesla?

A newsletter (*Power Line*) we subscribe to posted an article from reader, Martin Karo, a Philadelphia attorney, about electric vehicles (EVs). In his article, he looked at the environmental thesis underlying Tesla's (TSLA-Nasdaq) success. We have opted to post an unedited version of his report, but be warned, there is math involved in the article. We are also not endorsing Mr. Karo's social commentary.

"Teslas grind my gears"

"Teslas grind my gears. Well, at least their owners do. Every time, it's a variation on an old "fighter pilot" joke: How can you tell when a Tesla owner is in the room? Answer: He tells you. Like the fighter pilot, he (seemingly always a he; must be the tech thing) is on a mission: to make sure you know he owns one, and you don't. And he's a better man than you, because he's saving the planet, and

you're not. A Tesla has the dual advantages, for the condescending set, of being both terribly expensive and highly efficient.

"It takes the same amount of energy to move 4500 pounds, whether you do so by electric motor or gasoline; the only difference is efficiency loss"

"While one can't argue the expense, or the cachet – *de gustibus non est disputandum* — is the Tesla really efficient? Electricity has to be generated somehow, and in the US, the vast majority of that generation is via hydrocarbon fuels - coal or natural gas. And most of what isn't hydrocarbon is nuclear. And basic physics dictate it takes energy to convert energy from one form to another, and it takes energy to move energy, and frictional or resistive losses occur all along the way, and all other things being equal, it takes the same amount of energy to move 4500 pounds, whether you do so by electric motor or gasoline; the only difference is efficiency loss.

"Given all that, I've long been suspicious of the notion that Teslas, or any electric cars, are more efficient than their gasoline counterparts. Gasoline is converted to movement only once, at the site of usage; electricity at least twice, and it has to be moved a long way to get from source to speed. Ever felt a long-distance power line? They get very hot. Resistance at work – and not the social justice kind.

"So how much energy does it take to move a Tesla, say, 1000 miles, as opposed to a similarly-sized luxury car? Calculating the latter is fairly easy: using a roughly equivalent car (in size and status) as a baseline, a BMW 740i/Li, it gets (according to the DOE) 24 mpg combined, or 21/29 city/highway. 1000 miles /24MPG = 41.7 gallons.

"Now for the Tesla. A Tesla Model S uses about 38 KwH of power to go 100 miles, so to go 1000 miles, easy math, the car needs 380 KwH of electricity. The figures vary very little between city, highway and combined, because electric motors use no power when idling and are more linear in application. The main difference is air drag at speed.

"So the Tesla uses 380 + 24 + 120 = 524 KwH over that time and distance"

"Well, it's not exactly "no power when idle." There's a parasitic power loss. A Tesla uses power just sitting there, running its internal computers and whatnot. Teslas used to consume 4.5 KwH per day standing still, but Tesla claims to have improved that to 1 KwH per day. There's also the need to heat the battery, and heat the cabin; a gasoline motor uses waste heat for the latter and nothing for the former. Given that the average car is driven 15,000 miles per year, it would take 24 days to drive that far, so add another 24 KwH to the Tesla's consumption for parasitic loss, and add another 5 KwH per day for battery heating and climate control over that period. (The EPA tests are measured with the car at operating temperature and the climate controls off.) So the Tesla uses 380 + 24 + 120 = 524 KwH over that time and distance.

"That figure is not bad at electric power rates, but the issue is planetary efficiency – how green is it? How much fuel does a

powerplant use to create that much electricity? The petroleum equivalent of that at the powerplant is 13.76 KwH per gallon of petroleum equivalent (figures from the EIA), so generating the power to move the Tesla that far takes 524/13.76 = 38.08 gallons.

"Transmission power loss consumes between 8% and 15% of the power just moving it from point of generation to point of use"

"But there's many a slip 'twixt the cup and the lip, and with electric cars there are several. First, transmission power loss consumes between 8% and 15% of the power just moving it from point of generation to point of use.

"In California, the average figure is 9%. Add another 1% for the resistive power loss from where the power enters the home to when it gets to the Tesla's charger. Let's total it at 10%. So it takes 38.08 x 1.1 = 41.9 gallons to generate the amount of power the Tesla will use and then get it to the Tesla. But it takes even more than that, because the charging process itself is only about 85% efficient. (Tesla claims 91% efficiency, but real world experience seems to be more like 70-80%.) So 41.9 /0.85 = 49.28 gallons (678 KwH, if you were still counting those).

"The reason the Tesla is less efficient, but still cheaper to run, is that the power company pays a lot less for fuel than the automobile driver does"

"Liberals frequently care more about feelings than facts, and your smug Tesla-owning frenemy will never admit it, but in day to day usage, the big BMW is actually 18% more efficient, and 18% kinder to the planet. (Don't get too cocky, Mr. 7 Series: at a US average 12 cents per KwH, the electricity cost to the Tesla owner for 1000 miles works out in total to about $81, as opposed to $98 for the gasoline. The reason the Tesla is less efficient, but still cheaper to run, is that the power company pays a lot less for fuel than the automobile driver does. But when the issue is green impact, not greenbacks, the BMW wins handily.)

"Ah, but your frenemy retorts after mulling it over, 'MY Tesla can run on solar power! And I can put solar panels on my roof! It's free, I tell you! My S runs FREE!'

"Dividing that by 24, you need 26,200 watt-hours per day"

"Not really. The average solar panel produces about 10 watts per square foot. So some quick and dirty math: taking out of the equation the long-distance power transmission losses, and spreading out the power generation evenly over the time period, how much square footage would our Green Californian need to power his Tesla? 524 KwH for 24 days, as established above, plus 2% for transmission power loss at the solar panel and house level, and accounting for the 85% charger efficiency, you need 628,800 watt-hours. Dividing that by 24, you need 26,200 watt-hours per day.

"You get about five hours of useful sun power production per day, so you need to get 5,240 watts per hour. You lose about 20% of your electricity in large systems; and accounting for the fact that the sun also doesn't shine every day, add another 15% for reserve capacity, so you need 7,532.5 watts per hour capacity to account for efficiency losses and those rainy days. At top efficiency, that means you need

"At an installation price of $7-$9 per watt (average of $8), the Green Man needs to spend over $60k for that much power"

753 square feet of solar panels. At an installation price of $7-$9 per watt (average of $8), the Green Man needs to spend over $60k for that much power. If he's off the grid (i.e., stores the power instead of using net metering via his local utility), the storage system cost is on top of that. 753 square feet is a lot of ugly acreage, but it's doable.

"The Big BMW could travel, on that much fuel, 24,000 x 24 MPG = 615,384 miles"

"Of course, no self-respecting Green Weenie would settle for powering his car by the sun, but his house by Con Edison. And with the average efficient house using 1 KwH per hour, i.e., 24 KwH per day, the house needs 4.8 KwH capacity, and considering efficiency losses and reserve requirements, that means 6.9 KwH for the house. So to power both the Tesla and the house, Green Man needs at least 1,443 square feet of power production, at a cost of $115,000. But even using a Tesla-only setup, $60k would buy 25,641 gallons of gasoline (at the current US average price of $2.34 per gallon). The Big BMW could travel, on that much fuel, 24,000 x 24 MPG = 615,384 miles. Game, set and match – Munich and Detroit. Sad!"

"Tesla owners will not be swayed by Mr. Karo's analysis"

While we didn't do the analysis, all of Mr. Karo's numbers were sourced, which was not a surprise, given that he is a Philadelphia lawyer, and the math works. Although Mr. Karo expresses disdain for braggadocios Tesla owners, presumably because of his experiences with some owners he has encountered, the economics in this analysis suggest that gasoline-powered vehicles will have a longer future than EV-proponents suggest, or would like to see happen. Tesla owners will not be swayed by Mr. Karo's analysis. Instead, they will declare that with falling battery and solar panel costs coupled with their improving efficiencies, the cost advantage will soon swing in favor of EVs. However, the inability of EVs to be swapped for gasoline-powered vehicles in a one-to-one exchange for all applications means there is an extensive convincing period ahead before the public fully embraces them. Just how long that convincing period will be is anyone's guess.

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