Research Note
The Implication of Electric Vehicles For Valuation of the Oil Industry
January 2023

Widespread adoption of electric road vehicles, namely cars and trucks, directly reduces demand for hydrocarbon fuels – specifically gasoline and diesel. Currently production of these fuels represent about 50% of end volume demand and about 70% of end product value for the oil industry. Other important products are jet fuel, natural gas and petrochemicals. Although these products are also effected by the ongoing green transition, they are not specifically effected by the transition to electric road vehicles. In this note we evaluate the impact of the vehicle transition on the oil industry as a whole. To understand the impact on any specific firm, it is necessary to further evaluate that firm's specific product mix.

At this point a number of countries have adopted phase-out plans for hydrocarbon fueled vehicles. The most common policy is to set a date after which sale of new hydrocarbon fueled vehicles will be prohibited. There is considerable variation in detail around this base policy. Some governments allow sale of hybrid vehicles to continue longer or exempt heavy duty vehicles from the policy. In general health concerns lead to faster bans or restrictions on diesel powered cars and light trucks. After the new vehicle sale cut-off date, most countries will allow continued use and resale of existing hydrocarbon fueled vehicles, but a few countries plan on mandated retirement of such vehicles. Table One summarizes policies in place for the top 20 vehicle markets, which collectively represent about 65% of the total vehicle market.

Table 1: Phase Out Policy For Hydrocarbon Vehicles

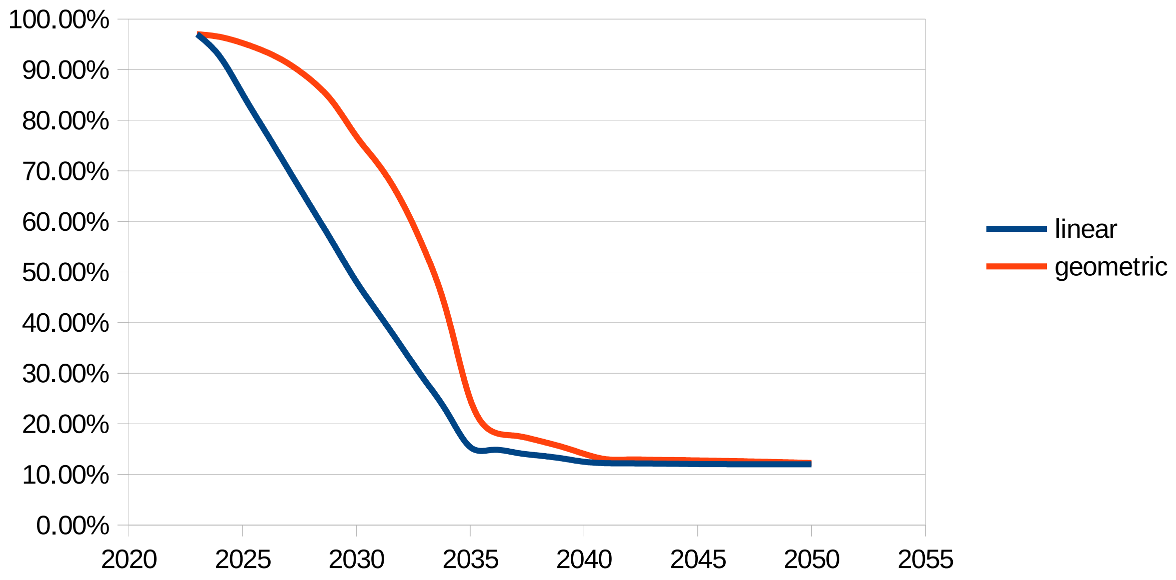
Phase Out Year	Number Countries	Market Size (units/year)	% Market	Cum % Market
2030	2	4,284,000	6.58%	6.58%
2035	7	46,421,000	71.31%	77.89%
2040	4	5,693,000	8.75%	86.63%
2050	1	887,000	1.36%	88.00%
no date set	6	7,814,000	12.00%	100.00%
Total	20	65,099,000		

As can be seen, at least half of the global market for new hydrocarbon fueled vehicles will have been eliminated by 2035. If the phase out in markets outside the top 20 proceeds in a similar fashion to the top 20, then nearly 80% of the market for new hydrocarbon fueled vehicles will be gone within twelve years.

Currently an ongoing switch from hydrocarbon fueled to electrical vehicles is taking place. There are many paths by which such a transition could occur. We consider two paths which we term the linear and geometric paths. Under the linear path a constant fraction of consumers switch each year until everyone is fully switched by the phase out date. This path is approximately what would apply if at each vehicle replacement point consumers opted for the electric vehicle. Under the geometric path the market share of electric vehicles increases at a steady rate until it reaches 100% in the phase out year. To start the geometric path we arbitrarily select a 3% market share for electric vehicles in 2023. These calculations are performed for each of the 20 markets and then summed to get the result shown in Figure 1 (next page.) Note that it is possible the share of new vehicle sales won by hydrocarbon fueled vehicles could drop even faster than shown in figure one if consumer tastes drive the transition rather than government mandates and incentives.

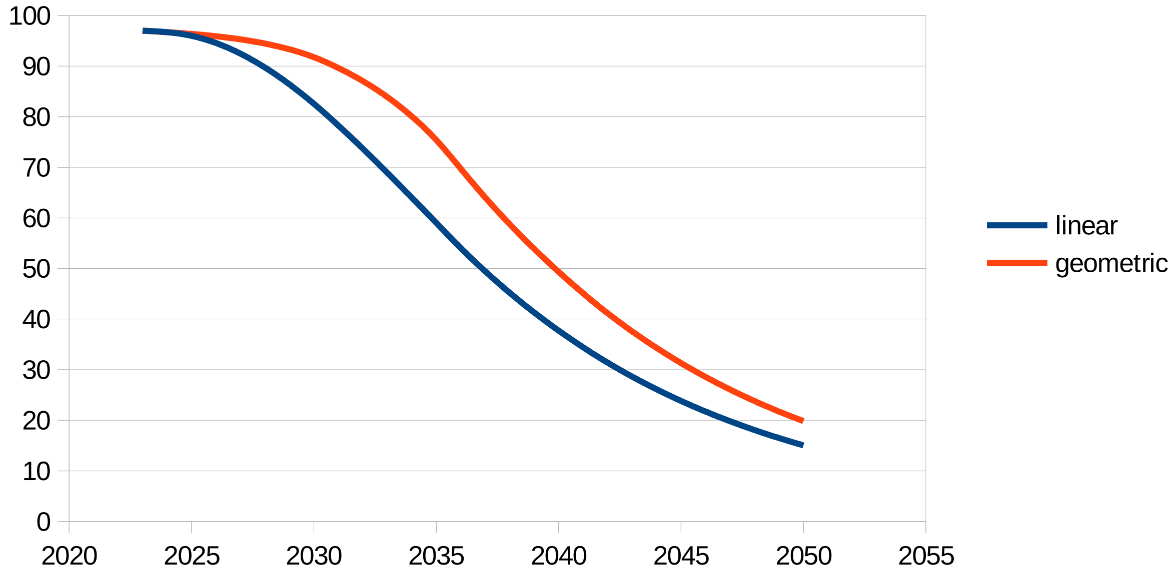
To understand the impact of this transition on demand for hydrocarbon fuel we must consider the shrinkage of the fleet of hydrocarbon cars. To estimate this we assume a ten year life for vehicles and a uniform fleet turnover of 10% per year. Figure 2 shows the percent of the fleet which remains hydrocarbon fueled under the two path scenarios. We call attention to the fact that the fleet share

Figure 1: Market Share Hydrocarbon Vehicles



of hydrocarbon vehicles drops to 70% of current value by 2033 for the linear path and by 2036 for the geometric path. In this figure we are assuming that there is no expansion in absolute fleet size, or equivalently that all absolute expansion occurs through the addition of electric vehicles. Expansion is fairly slow moving (3%-4% per annum) and highly cyclical so this is likely a reasonable assumption. Clearly the volume demand for hydrocarbon fuel must be decreasing at nearly the same rate as fleet contraction.

Figure 2: Percent of Fleet Hydrocarbon Fueled



It is also evident that a dramatic drop in demand for hydrocarbon fuel must impact the oil market at some point. For fifty years the market for internationally traded oil has been controlled by a seller's cartel (OPEC.) It is difficult to see how this market structure can persist in the face of plummeting demand. For producers such a market presents the choice of pump it now or lose it. Instead of the cartel being able to allocate market shares to its members, it is likely that a free for all competition will break out causing the price of oil to plummet. Compounding problems, there are a number of non-cartel producers such as the US. Currently these countries seek to maintain long term energy independence from OPEC and so they are neutral on the question of local production versus imports. But in a pump it or lose it environment they might well adopt policies reserving domestic demand for domestic producers. Additionally some countries, such as Mexico, may protect nationalized producers because of their importance to the local political economy independent of economic rationality.

In short, we believe the current market structure will break down and after a period of chaotic transition we will have a market structure in which the lowest cost producers have a monopoly on the supply of internationally traded oil, there are collection of local protected markets and oil prices are close to production cost. Note that we do not think these developments in the oil market will accrue to vehicle owners. Governments do not want the transition to electric vehicles to be stretched out by low fuel prices and they will likely raise excise taxes to maintain a stable retail fuel price even as feedstock prices drop.

The key question then becomes what level of stress can OPEC bear before the cartel breaks up. Some information can be gleaned from the Covid experience. Covid resulted in a drop in global demand which was broadly seen to be temporary. Specifically the 2020 demand was 7.64% below the peak demand seen in 2018. This comparatively modest decline resulted in a 50% price drop (peak to trough) and considerable stress within the cartel. This observation suggests that OPEC's break point might be around a permanent 10% drop in volume demand.

If this drop in demand were to be driven entirely by a the transition to road vehicles then we would need to see about a 20% fleet conversion. If the demand drop were driven entirely by the decrease in the top twenty markets then we would need to see a 30% conversion across the top twenty. As we noted earlier, that point is reached in the 2033-2036 time frame. If demand in the rest of world parallels demand in the top 20 markets, then the break happens sooner, namely once hydrocarbon fleet share drops to 80% in the top 20 markets. The time frame for that event is 2030-2034. We conclude that the break down point is likely to be reached in the first half of the 2030s. As noted, it could happen sooner if the vehicle transition is driven by consumer tastes rather than government policy.

Without the support of a producer cartel, the price of internationally traded oil should drop to the marginal production price. We are somewhat uncertain as to where that point lies, but somewhere between \$20/barrel and \$25/barrel seems plausible to us. The picture is a grim one for oil industry revenues as the combination of falling volumes and falling prices drive steep declines in revenue. The most efficient firms might maintain profit margins, with the result that profits decline in step with revenues. Less efficient firms will see profits disappear or fall steeply into the red. That is, after all, the process by which the high cost producers are removed from a shrinking market.

We summarize this analysis in terms of a discount factor F which we calculate as

$$F = \frac{\text{present value of scenario profits}}{\text{present value of steady perpetual profits}}$$

For this analysis we use the long term AAA dollar bond rate, which currently is 4.6% to calculate present values. Several different F may be calculated, depending on the scenario. In all scenarios we assume product volumes decline in step with fleet shrinkage. In the first set of scenarios we assume prices and profit margins hold at their current value up to the break point, but profits drop to zero thereafter. Here we get F=0.33 if the break point is in 2030 and F=0.46 if the break point is in 2035. For the second set of scenarios we consider that prices at the break point fall to 30% of their current levels and remain steady thereafter. We assume profit margins are steady throughout. In this case we get F=0.41 for a break in 2030 and F=0.50 for a break in 2035. In all scenarios we assume unit volume shrinks in step with fleet shrinkage. The set of scenarios correspond to a high cost producer whose profits end at the break point and the second set a low cost producer who enjoys some residual profits after the break point. We define a value ratio

$$V(X) = \frac{F(\text{high cost producer, break in X})}{F(\text{low cost producer, break in X})}$$

We get V(2030)=0.80 and V(2035)=0.92. This ratio gives a sense of the relative value of high cost versus low cost reserves. The striking thing about these numbers is that they are close to one. Under the particular scenario we have articulated the value of high cost reserves is only incrementally less than the value of low cost reserves.

Let us see how our numbers compare with current market valuations. We take the current PE ratio as the value measure. We can calculate F by comparison with the PE ratio on the S&P500 which is currently 20. Table 2 gives the results for some major oil companies.

Table 2: Valuations of Representative Oil Companies

Firm	PE	F	V
Shell	4.95	0.25	0.29
TotalEnergies	7.10	0.36	0.41
Exxon Mobil	8.88	0.44	0.51
Saudi Arabian	17.30	0.87	

Here we use Saudi Arabian as the benchmark low cost producer for the calculation of V. We see that the F values for Shell, TotalEnergies and Exxon Mobil are approximately in line with our analysis, but the market values Saudi Arabian more highly than we would. As a result the V values for Shell, TotalEnergies and Exxon Mobil are depressed relative to our analysis. Perhaps the market thinks domestic protection will not significantly shrink the market for internationally traded oil and Saudi Arabian will pick up enough market share to cushion any price declines. Or perhaps the market is not factoring in as steep a decline in crude oil prices as we expect.

To summarize our discussion
1) The transition from hydrocarbon fueled to electric vehicles will have major impact on the oil industry.
2) That impact could be felt as soon as 2030 and probably no later than 2035.
3) The most significant potential development is the breakdown of the OPEC cartel and movement to a new market structure at a substantially lower crude oil price.
4) In that scenario ownership of low cost reserves is better than ownership of high cost reserves, but possibly only incrementally more valuable.
5) Valuation of low cost reserves is rather sensitive to ones assumption about evolving market structure, while high cost reserves probably do not have a long enough economic life for such details to matter much.

Certainly valuation of oil firms is a challenging and interesting problem.