WELLINGTON MANAGEMENT®

November 2017

Brian Barbetta
Global Industry Analyst — Technology

Alan Hsu
Portfolio Manager and Global Industry Analyst — Energy, Renewables, and Utilities

Eugene Khmelnik
Global Industry Analyst — Oil Extraction and Production

Saul Rubin
Global Industry Analyst — Automotive

Power on: Five insights on electric and autonomous vehicles

AS THE SHIFT TOWARD ELECTRIC VEHICLES (EVS) AND AUTONOMOUS VEHICLES (AVS) PROGRESSES, the potential impact on a variety of industries, and on the oil market, should come into sharper focus. Recently, several of Wellington's global industry analysts debated and discussed these trends, and some of the issues they believe are underappreciated by many investors and economists.

KEYPOINTS

- The shift to EVs will be a revolution; the shift to AVs will be an evolution.
- EVs may eventually impact the oil market, but not before 2025.
- Battery cost and technology, including large-scale storage, are keys to mass EV adoption.
- EVs will compete with traditional vehicles on cost and performance.
- Winners and losers are likely to emerge.

The shift to EVs will be a revolution; the shift to AVs will be an evolution.

SAUL: A period of extraordinary change is coming. EV adoption will likely increase gradually through the end of the decade and then accelerate sharply. The move to AVs is a separate trend and should occur more gradually. However, when the age of AVs does arrive, this fleet will almost certainly be electric, given the fuel-economy benefits that EVs provide.

I believe that EVs will first take off in the premium-auto segment and then move into the mass market. There is also likely to be a move to EVs within commercial vehicles — for short-haul in the medium term, and long-haul over the longer term. Eventually, the growing prevalence of EVs will likely affect oil demand, but the timing of that is difficult to predict. My projection is that EV sales could be 20% of worldwide passenger car sales by 2025; and 20% of the global automobile fleet could be electric by 2030. And once we hit 20% of sales, the move from 20% to 80% could happen very quickly.[1]

[1]Actual results may vary, perhaps significantly, from projections.

> Expanding autonomous capabilities can happen sooner, and they may not facilitate the adoption of electric vehicles. It's a question of hardware versus software.
>
> — Alan Hsu

ALAN: I also have a bullish view on EVs, but the effect of AVs complicates that trend. Expanding autonomous capabilities can happen sooner, and they may not facilitate the adoption of electric vehicles. It's a question of hardware versus software. EVs represent a major change to the auto fleet's hardware composition. This shift is highly capital-intensive and dependent on the build-out of charging infrastructure. Autonomous driving requires changes in a vehicle's software composition that alter how the vehicle processes information and behaves — changes that tend to advance faster than hardware and are less capital-intensive. Anyone can download a ride-sharing app without having to buy an electric vehicle, for example. Tech-enabled learning also levers up the rate at which software improves. And unlike EVs, there is no network of powerful incumbents opposed to autonomous driving. An autonomous fleet could temporarily support the status quo for traditional automobiles and infrastructure, especially if EV cost reductions do not materialize as rapidly as expected.

BRIAN: The only realistic way, from my perspective, to solve autonomous driving without rebuilding the global transportation infrastructure is to have a machine-learning-based system that makes decisions similar to humans behind the wheel. Self-driving cars need the right sensors, cameras, and image-recognition software to navigate existing infrastructure. They have to be able to distinguish objects on the road — a rock from a paper bag, for example. I think the only way to do that is through advances in algorithmic systems and machine learning.

A few of the biggest names in technology are already working toward this goal. Computer scientists and engineers at one leading company have driven over three million miles in an autonomous car, but they have simulated many billions more. By running algorithms through their simulated world, they can learn more from machine-learning-enabled simulation than they can from just real-life driving. The timing of mass availability of autonomous is difficult to forecast, but it's clear that developing groundbreaking technology for mass consumption will take some time. There are many hurdles to overcome.

EVs may eventually impact the oil market, but not before 2025.

EUGENE: I believe that EVs should eventually become the dominant form of road transportation once the trend converges with autonomous, but I think meaningfully a negative impact on the oil market won't occur for the next five years, and probably longer. There are one billion cars on the road today, and that number is expected to rise to 1.7 billion by 2040.[2] Gasoline demand is currently about 25% of total oil demand. If sales of EVs go from, say, 1% to 15% by 2025 — slightly lower than Saul's expectations but higher than many industry forecasts — EVs would make up about 4% of the total automobile fleet. That would translate to a cumulative decline in oil demand of 1.5% over the next eight years. For context, we estimate that a 5% change in OPEC production could have about the same effect over the same period; a 50-basis-point change in GDP growth could have twice the impact; and a 10% per annum productivity change in the Permian Basin could triple the impact.

Here's an example of how tricky the potential effect on oil is to forecast. Autonomous-driving technology already exists for traditional long-haul trucks. It is reasonably sound and improving, so I think by 2025, one driver may be able to control a fleet of five to eight long-haul trucks. This shift would have several consequences. It would reduce a driver's cost-per-ton mile by about 30%. It would make trucking competitive with rail over short

[2]Wood Mackenzie

Given the potential increase in miles driven by traditional long-haul trucks, oil demand could actually go up for a few years, until electric for long-haul trucking catches up.

— Eugene Khmelnik

distances and increase the breakeven point for trucks versus rail. And it would dramatically increase miles driven per truck, as human-operator fatigue becomes a nonissue.

At the same time, EV technology for long-haul trucks will still likely have very low penetration in 2025, mainly because battery size and cost are larger for trucks and infrastructure is still nascent. Given the potential increase in miles driven by traditional long-haul trucks, oil demand could actually go up for a few years, until electric for long-haul trucking catches up.

Another consideration is from the oil supply side. Oil fields have natural decline rates. When zero capital is put to use, the supply of oil declines annually by about 3% to 4% globally and by 30% in the US. With approximately US$400 billion spent in 2016, supply stayed flat.[3] In 2017, amid even more capex, growth finally ticked up, mostly in shale. It takes a lot of capital to move that needle. Additionally, while upstream capex has increased tenfold over the last 25 years, a large portion of that has been funded recently with debt and private-equity capital. Nearly half the growth in shale has been driven by capital outside of operating cash flows.

So, the more that businesses — and energy investors — fear the EV-demand story, the less capital energy companies will receive, and the less likely it is that they will focus on drilling for growth. Oil companies tend to demonstrate a herd mentality, shifting en masse to focus on either growth or returns. Over the last decade, the focus has been on growth, but historically, stocks of integrated oil companies have performed better when management focuses on returns.

All told, demand for oil may certainly take a hit from EV penetration over the long term, but in the near to medium term, oil demand may go up in some pockets of the market, while supply could shrink dramatically if capital continues to retrench from the industry.

Battery cost and technology, including large-scale storage, are keys to mass EV adoption.

SAUL: Given current momentum, I think it's only a matter of time before the industry has the right-sized battery for the right cost to catalyze mass EV use. Before Tesla, the industry was focused on developing small, intracity EVs to meet regulatory standards and tick a marketing box. These vehicles were not designed to be commercial; they were smaller, had limited range, and were still far too expensive to build. Tesla showed the world that a long-range EV could be commercially viable by going after the top end of the market, where consumers would pay a premium for a great design and performance. Investment capital followed, and now the industry is scrambling to improve batteries. As a result, battery costs are falling quickly, bringing the tipping point to EV adoption forward.

ALAN: In addition to lower battery costs, a mass transition to EVs depends, in my opinion, on improvements in battery density. This will allow energy dispatched from a utility to be stored effectively and economically. Utility-scale, dispatched-energy storage has always been the Holy Grail for clean tech and renewables. If utilities can build wind or solar farms far from population centers, charge batteries, and then transport and dispatch power to load centers (densely populated areas), demand for EVs could grow very quickly, assuming the requisite charging infrastructure is developed.

[3]Wood Mackenzie

> EVs are not just better for the environment; in my view, they are inherently superior vehicles in terms of ownership cost and overall performance.
>
> — Saul Rubin

[4]This is provided for illustrative purposes only and is not intended to constitute investment advice or a recommendation to buy or sell any security. The specific security was selected to illustrate key trends and major shifts in the automotive and related industries, and was not selected for performance-based reasons. The security identified is not intended to reflect the holdings of any Wellington Management portfolio and is not representative of all of the securities purchased, sold, or recommended for clients. Actual holdings will vary for each client and there is no guarantee that a particular client's account will hold the security listed. It should not be assumed that an investment in the security identified has been or will be profitable.

EVs will compete with traditional vehicles on cost and performance.

SAUL: EVs are not just better for the environment; in my view, they are inherently superior vehicles in terms of ownership cost and overall performance. Initial sticker price is still higher, but considering the savings on fuel and service, along with better residual values, the total cost of ownership is smaller and falling. As for performance, we met recently with a Chinese company that has developed a high-performance EV with the help of British and German engineers. At Germany's legendary Nürburgring track earlier this year, that vehicle notched the fastest lap on record, for any vehicle. (The record was broken again two weeks later by a specially modified high-performance British sports car.)

In an EV, energy loss is greatly reduced relative to an internal-combustion-engine vehicle; energy is dispatched to the wheels immediately, enabling quick acceleration. Because the battery pack can be mounted on the bottom of the car, EVs have near-perfect weight distribution — so they handle better as well. By the beginning of the next decade, EVs may compete head-to-head on total ownership cost with premium vehicles; a few years after that, they will likely compete fully with the mass market, without the need for subsidies.

Winners and losers are likely to emerge.

SAUL: With original equipment manufacturers (OEMs) and traditional car companies, winners and losers may depend on how they decide to respond to the threat from Tesla,[4] and how they regard the intellectual capital of Silicon Valley. The strategic directions they take today will determine their viability tomorrow. Additionally, the auto industry is saturated and needs to consolidate to generate long-term value. A handful of OEMs may navigate the coming years successfully. But I think investors will be able to short companies that are expensive because of flawed strategies and sheer hubris.

I'll share a couple of examples. Five or six years ago, a leading German automaker was dismissive of Tesla. But in 2015, the company announced its plans to compete in up-market EVs. It was a shocking about-face for a staid OEM, but they clearly saw Tesla's advances as an opportunity to compete and gain share in a growing market. On the autonomous side, certain auto-company CEOs recognize that they can't develop the necessary algorithmic technology in-house. They are eager to partner with Silicon Valley to incorporate the best available technology. At the other end of the spectrum are CEOs who think they can do it all, including developing their own mobility technology and services, which is not their specialty. In my mind, that kind of hubris can lead to ruin.

ALAN: We have a mantra on our team: "The world is moving from molecules to electrons." Molecules from hydrocarbon-based fossil fuels are being replaced by electrons that come right off the grid. We believe as this shift progresses, power grid owners and electric utilities should be clear long-term winners.

> When I apply my technology lens, I think about how to invest in the enabling technology, whether that's the best batteries, the most advanced sensors, or other systems.
>
> — Brian Barbetta

SAUL: On the supplier side, companies linked into the power train — transmission, engine, etc. — are probably going to struggle. On the other hand, those making seating systems and other interior parts should be fine. As miles driven go up and costs come down, the tire industry should do very well. And of course, companies that produce batteries or power-electronic componentry, or that focus on battery recycling should also be long-term winners, as will manufacturers of autonomous technology and sensors.

In the near term, investment decisions are rather nuanced. I met recently with a Japanese company that makes clutches for manual and automatic transmissions. They acknowledged that their business will eventually disappear, but over the next few years, they can barely keep up with demand. There is still a huge appetite for sophisticated automatic transmissions, especially in China. That market is unlikely to dwindle anytime soon. But when it's gone, the value of the company will be determined by how management chooses to allocate capital in the intervening period.

BRIAN: When I apply my technology lens, I think about how to invest in the enabling technology, whether that's the best batteries, the most advanced sensors, or other systems. I also consider the interplay of technology and commodities. Is lithium the way to go, or will another material be the future of batteries?

We have found many innovative technology companies that are well positioned to potentially benefit from these changes. I prefer some of the sleepier names in the tech supply chain, those that supply components for smartphones and PCs and that now have products for use in autonomous vehicles. I also like companies that are benefiting from the shift to EVs. I don't have to worry about the level of penetration in 2025 or 2028 or 2032. I believe it's going to be a nice tailwind for decades to come. Finally, data centers, semiconductors, and storage look to be winners as well. Massive amounts of compute power and data will be necessary to train these models, further contributing to the already-strong demand for data centers.

ABOUT THE AUTHORS

Brian Barbetta
Global Industry Analyst
Technology

Brian's coverage includes the Internet and video game software companies across all market caps. He contributes to portfolio manager ideas and research. Brian works in our Boston office.

Eugene Khmelnik
Global Industry Analyst
Oil Extraction and Production

Eugene conducts fundamental research on the global energy sector and helps manage several energy portfolios. He is responsible for following oil and natural gas exploration and production companies, midstream companies, and various energy-related commodities. His research supports the investment decision making for a range of portfolios managed for clients of the firm. Eugene works in our London office.

Alan Hsu
Portfolio Manager and Global Industry Analyst
Energy, Renewables, and Utilities

Alan conducts fundamental analysis and research on the utilities, energy midstream, and renewable energy/clean technology sectors, and is a member of the Utilities/Energy team. He is also a portfolio manager of our Global Environmental Opportunities approach. Alan works in our Boston office.

Saul Rubin
Global Industry Analyst
Automotive

Saul is responsible for analyzing investments within the automotive industry, focusing on manufacturers and suppliers across the world. He has more than 20 years' experience following the automotive industry. Saul works in our London office.

WELLINGTON MANAGEMENT COMPANY LLP Boston | Chicago | Radnor, PA | San Francisco
WELLINGTON MANAGEMENT AUSTRALIA PTY LTD Sydney
WELLINGTON MANAGEMENT CANADA LLC Serviced from Boston and Chicago
WELLINGTON MANAGEMENT HONG KONG LTD Hong Kong | Beijing Representative Office
WELLINGTON MANAGEMENT INTERNATIONAL LTD London | Frankfurt
WELLINGTON MANAGEMENT JAPAN PTE LTD Tokyo
WELLINGTON MANAGEMENT SINGAPORE PTE LTD Singapore
WELLINGTON MANAGEMENT SWITZERLAND GmbH Zurich
WELLINGTON LUXEMBOURG S.à r.l. Luxembourg

www.wellington.com