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ELECTRIC VEHICLES: ARE THEY DISRUPTIVE?

"To see a world in a grain of sand
And a heaven in a wild flower
Hold infinity in the palm of your hand
And eternity in an hour"[1]

All of this could be possible in the not-too-distant future thanks to advances in nanotechnology, virtual and augmented reality, nuclear fusion and artificial intelligence, to name but a few. This is not quite what the good Mr. Blake had in mind, but they are just some of the technologies that are profoundly changing the world in which we live. Robotic exoskeletons are allowing individuals with complete paralysis to walk; CRISPR, a new 'cut-copy-paste' tool, allows scientists to edit genomes with unprecedented precision and flexibility, such that a cure for any genetic disease may be conceivable; while an artificial intelligence system called Deepmind is shaving tens of millions of dollars off Google's electricity bill.

But are these all examples of disruptive technologies at work? Any attempt to answer this question must begin with an understanding of what exactly disruptive technology is. The term 'disruptive technology' was coined by Professor Clayton M Christensen of the Harvard Business School in his book The Innovator's Dilemma. He observes that most new technologies improve performance and are characterised as sustaining technologies regardless of whether the changes they bring about are incremental or radical in nature. Disruptive technologies, on the other hand, are typically simpler, cheaper, more reliable and convenient than established technologies. In their early days, unlike sustaining technology, they lack refinement, often have performance problems, appeal to a limited audience and may not yet have a proven practical application.

That disruptive technologies are simpler and cheaper implies that early successes are likely to be in bite-sized markets catering to the least profitable segments that are often shunned or underserved by incumbents (and with good economic reason). Whether a certain technology is rapidly advancing or experiencing breakthroughs is another good indicator. Truly disruptive technologies transform the way we live and work, render obsolete familiar business models while enabling new ones, thereby upending the norm—they are thus broad-reaching in impact and affect sizeable profit pools.

As investors, we believe it is important to develop a framework so we can evaluate emerging technologies to protect and create value. While it is possible to apply this framework to the many innovative developments globally, the landscape is changing so rapidly that it is not feasible to ascertain exhaustively which emerging technologies are potentially disruptive.

So how do we analyse these types of technologies? In this article, we use the example of electric vehicles (EVs) to illustrate our approach towards analysing emerging opportunities and identifying the investment implications. We have focused on electric vehicles for a few reasons—there has been considerable debate as to whether EVs are, in fact, disruptive; Tesla and its founder Elon Musk have captured the popular imagination; and, a slew of auto-makers globally have announced bigger plans for EVs. In our view, EVs will have significant implications (both positive and negative) for many sectors, particularly automotive and oil, presenting investors with interesting opportunities, particularly in Asia.

Electric vehicles: back to the future?

An EV is a vehicle that is propelled by one or more electric motors, using stored electrical energy. A hybrid EV combines an internal combustion engine (ICE) with some form of electric propulsion; a plug-in hybrid EV is essentially a hybrid EV with rechargeable batteries; and a battery EV (BEV) does away with the ICE and relies entirely on an electric motor for propulsion, with a bank of rechargeable batteries providing the energy. Strictly speaking, EVs also refer to rail, air, sea and even space vehicles, but we restrict ourselves to automobiles in this article.

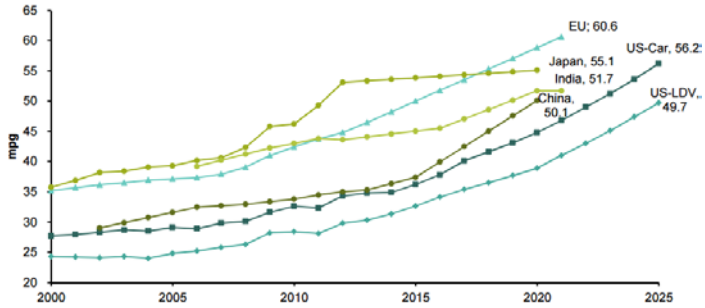
Although the concept of an electrically powered automobile may be a novel one for the current generation, the first electric car was built in 1837 and was powered by batteries. By the 1890s, there were actually 10 times as many electric cars sold as gasoline cars. Around 40% of all cars in the US were electric in the first decade of the 20th century, a good 100 years ago! However, mass production proved to be the downfall of EVs. In 1910, the earliest modern assembly lines were introduced and gasoline-powered cars were the first to be put on the lines. Consequently, these manufacturers enjoyed a significant cost advantage over electric car manufacturers. This also coincided with a number of oil discoveries and improvements in road infrastructure while limited charging infrastructure restricted the range of EVs. Thus, cheaper and more convenient gasoline-powered cars disrupted the electric car industry, until now.

The ICE has never been more reliable or offered such high performance at such affordable prices. So what is driving the resurgence in electric vehicles? In short, the desire for 'sustainability' is the principal catalyst. In the US, regulations will compel automakers to improve mileage from 30 miles per gallon (mpg) to 38 mpg by 2020 and 54.5 mpg by 2025.

[1] William Blake, Auguries of Innocence

Europe will require that they improve mileage from 42 mpg to 58 mpg by 2020. Although the 2025 targets for Europe may change, the currently contemplated target is 71-81mpg. It is therefore inevitable that the marginal cost of conventional internal combustion technology will increase significantly.

Chart 1: Headline corporate average fuel economy (CAFE) standards by country



Source: GFEI, Sanford Bernstein

Unlike EV sales in the US and Europe, which are driven by regulatory changes (the 'stick'), we believe China EV sales are, and will continue to be, driven by government subsidies (the 'carrot') and purchasing quotas on traditional vehicles in Tier I cities. Subsidies for commercial and passenger EVs can be as high as 60% of the selling price of a commercial vehicle, or nearly 40% in the case of passenger vehicles. In 2015, China became the largest EV market in the world; some 330,000[2] units were sold, a staggering 343% increase over the previous year.

But are electric vehicles truly disruptive?

To answer this question, let's revisit our definition of disruptive technology— technology that is simpler, cheaper, starts small, advances rapidly and is broad-reaching in impact.

An EV is certainly simpler; it has one moving part (the motor), whereas an ICE-powered vehicle has a multitude of moving parts. It follows that the EV requires less maintenance and is more reliable. In addition, an electric motor is inherently more energy efficient than an ICE, which translates directly to lower operation and maintenance costs. It therefore comes as no surprise that an EV is cheaper than an ICE vehicle of comparable specifications (power, acceleration, torque). The recently unveiled Tesla Model 3 (estimated production by mid-2017) comes with a price tag of USD 35,000, placing it in the same category as the BMW 3-series, Mercedes C-class, the Honda Accord and the Toyota Camry.

Chart 2: Vehicle pricing and key specifications

	Tesla Model 3	BMW 320ix	Mercedes C300	Honda Accord LX	Toyota Camry SE
Starting price	$35,000	$35,150	$38,950	$22,205	$24,675
Price after subsidies (USA)	$28,000	$35,150	$38,950	$22,205	$24,675
0-60mph (seconds)	4.4	7.1	6.2	7.5	8.0
Horsepower (HP)	300-350	180	241	185	178
Max torque (lb-ft)	300	200	273	181	170
Range (miles)	225	450	500	396	425

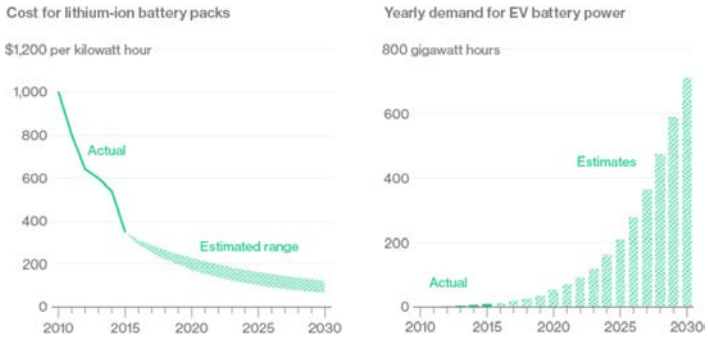
Source: Nikko Asset Management

[2] http://www.hybridcars.com/top-six-plug-in-vehicle-adopting-countries-2015/

EVs on the market today target the USD 25,000-or-higher price segment, which accounts for only a third of the total global car market. To be disruptive, EVs will need to be able to address the remaining two-thirds of the market and this appears likely in the next five to six years. Admittedly, prices for a particular car can vary significantly across countries, but most of the world's largest vehicle markets have broadly similar pricing.

Lower prices for EVs are a direct function of battery costs since batteries account for 35% of the cost of an electric vehicle. Battery costs (lithium-ion batteries, to be precise) are, in turn, a function of chemistry, design and scale of manufacturing as these three factors determine the battery's energy density, power density and life. On all these counts, significant progress is being made.

Chart 3: Costs for lithium-ion batteries vs. annual demand for EV batteries



Source: Bloomberg New Energy Finance

The first lithium ion cells produced by Sony Corporation in the 1990s had energy density levels of roughly 90Wh/kg and cost USD 2,000/kWh. Today's Panasonic batteries used in Tesla's Model 3 are estimated to have an energy density of 300Wh/kg and cost less than USD 200/kWh. That the total cost of the Model 3's battery pack is already two years ahead of industry forecasts made only a month before the Model 3's unveiling illustrate the rapid advances in battery technology.

One issue with EVs that has taken up significant newsprint is 'range anxiety' (i.e. how far an EV can travel before the batteries need to be recharged). Most EV offerings in the market (with the exception of Tesla) have a range of 120-200kms (75-125 miles) and this can be a problem outside an urban setting. However, with improvement in battery technology as well as in the charging infrastructure, range anxiety is likely to ease over the next five years.
We have established that EVs are certainly simpler than ICE-powered vehicles; they are cheaper but not cheap outright, but the latter is a distinct possibility in the next few years; they cater to a small sliver of the market today but could address a much larger chunk in the future; technology advancement is continuing at breakneck speed. Which brings us to the last criterion—are EVs truly transformative?

In 2014, Professor Christensen was asked a similar question: Is Tesla disruptive? His team concluded that Tesla was not a disruptor but a 'sustaining innovation'—a product that, according to his own definition, offers incrementally better performance at a higher price. While Tesla is not synonymous

with EVs, it is still the furthest along in terms of innovation, product development and cost competitiveness.

Christensen does not discuss the funding element of disruptive technologies—i.e. how much money needs to be invested over what period of time to ensure that an emerging technology becomes a disruptor. However, he does note that "in the end it is really customers and investors who dictate how money will be spent because companies with investment patterns that don't satisfy their customers and investors don't survive". In our view, because Musk is an investor and a potential disruptor rolled into one, he has taken a path that is economically viable in order to have a shot at disruption. As he has admitted, his master plan "wasn't all that complicated and basically consisted of: create a low volume car, which would necessarily be expensive; use that money to develop a medium volume car at a lower price, use that money to create an affordable, high volume car". While the jury is still out on the last step in the master plan, it is worth pointing out that the Tesla Model 3 has racked up pre-orders to the tune of 373,000[3] units, which is well over three times what the company has sold in its entire history.

As they gain market share, EVs are likely to threaten a variety of industries

Global automakers account for over USD1 trillion in market capitalisation and this reflects an earnings stream that is virtually entirely dependent on the sale of ICE vehicles, making them vulnerable to the rise of EVs. If we assume that Tesla successfully extends its current c. 2% market share[4] in the 30% of the global auto market in which it currently participates (cars costing over USD 25,000) to the mass-market segment over the next five to seven years, it would be equivalent to roughly USD 200 billion in market capitalisation, assuming the market is willing to apply current earnings multiples. If one were to add that to Tesla's current market capitalisation, the result would be roughly equivalent to the entire capitalisation of Japan's automakers.

Another way that EVs could disrupt the auto industry is via the dealer networks. While Tesla has fewer than 100 showrooms in the US and Canada, Ford and Chevrolet together have 3,000 dealers in the US alone. If Tesla is successful, be it as a brand or a car-maker or a category leader, the distribution network of incumbent automakers will need a major overhaul if they are to compete effectively. The dealer networks that have proved a competitive edge for incumbents for decades also effectively prevent them from selling directly to the consumer. Any meaningful change in this operating model could significantly impact the sale of ICE vehicles.

EVs should also be viewed in the wider context of industry efforts to improve fuel efficiency, with the CAFE standards being one example. The potential medium-term impact of EVs on the incremental demand for oil is non-trivial. The global oil & gas industry is capitalised at about USD 3.2 trillion and ICE-powered passenger vehicles account for 25% of global oil demand. It is plausible that EVs could account for 15-20%[5] of the passenger vehicle market by 2030 (compared with 3% currently), eroding some 3.8-5.0% of global oil demand, or the equivalent of USD120-160 billion in capitalisation.

Rise of EVs also presents a variety of investment opportunities

Whether or not EVs are truly disruptive, the more pertinent question for investors is: if we assume EVs will be disruptive, how can we participate?

The obvious starting point is the automakers. Besides Tesla, which has captured the popular imagination and is a pure EV maker, all of the major automakers have dipped their toes into the EV market by introducing at least one model. Volkswagen most recently upped the ante by pledging to launch 30 pure EVs by 2025 and target 2-3 million in annual sales by then, amounting to 25% of estimated total sales. However, it is the Chinese automakers, who are gearing up to meet the government's target of 5 million EVs on the road by 2020, that will easily surpass their global peers in terms of units sold. On the flip side, incumbent automakers are likely to lose market share little by little at the beginning, potentially followed by precipitous declines later. That Asian companies account for nearly 60% of the market capitalisation of automakers globally, followed by Europe and the US, should not be lost on investors; this is where fortunes can be made or lost.

Battery manufacturers are the logical next stop since batteries account for a third of the cost of an EV. Because EV battery specifications are not (yet) standardised, there are over 80 different lithium-ion battery configurations in production currently with differing performance metrics (energy density, power density, battery life) and costs. All the major EV battery manufacturers are Asian companies, with Japanese businesses such as Panasonic leading the way in terms of technology and Korean (Samsung SDI, LG Chemicals) and Chinese companies making up the remainder. Chinese companies will also account for the bulk of new capacity, with only Tesla's Gigafactory a notable exception. Lithium is a key ingredient of the EV battery because it is the lightest known metal, the least dense solid element with the greatest electrochemical potential which leads to excellent energy-to-weight performance, and also has a very low melting point, which enables it to be used in metallurgical applications. Last year, around 45% of global lithium supply was produced in China. The lithium supply market is fairly concentrated; two of the top five producers are Chinese companies[6] and account for just under 25% of the global market. Graphite suppliers and

[3] http://www.bloomberg.com/news/articles/2016-05-18/tesla-says-12-200-model-3-orders-were-cancelled
[4] Tesla Model S has a 1.8% market share in the USD 83-200k segment; pre-bookings for Model 3 imply a 1.4% market share in the USD 28-50k segment in its first year of production (2017)

[5] Assuming strict compliance with CAFE standards, BEV penetration is forecast to exceed 20% by 2025 as per industry consultants (Navigant); we interpolate a declining rate of growth in penetration and further assume a 20% slippage
[6] Sichuan Tanqi (#2), Ganfeng (#3) which has 100% attributable production from the Mt. Marion project; Albermarle, SQM & Orocobre are #1, #2 & #5 respectively

manufacturers are another possibility but this is hardly fertile ground for investors currently.

EVs require an electric motor and battery management systems, as well as charging equipment and infrastructure. A plethora of companies—some privately owned, others publicly listed— manufacture these different components. Here again, Asian companies dominate and the head-start they have should prove beneficial as the market heats up. Another, less available, opportunity is investing in the investors. However, given that these initiatives are still nascent, and any contribution isn't likely to be material in the next two to three years, patience is a prerequisite.

Only time will tell if EVs are indeed disruptive, not just to the auto industry but to the oil industry as well. However, in our view, they will dramatically alter the landscape in the years to come. The majority of the current investment opportunities are in Asia and straddle the supply chain; these are firmly on our radar.

Important Information