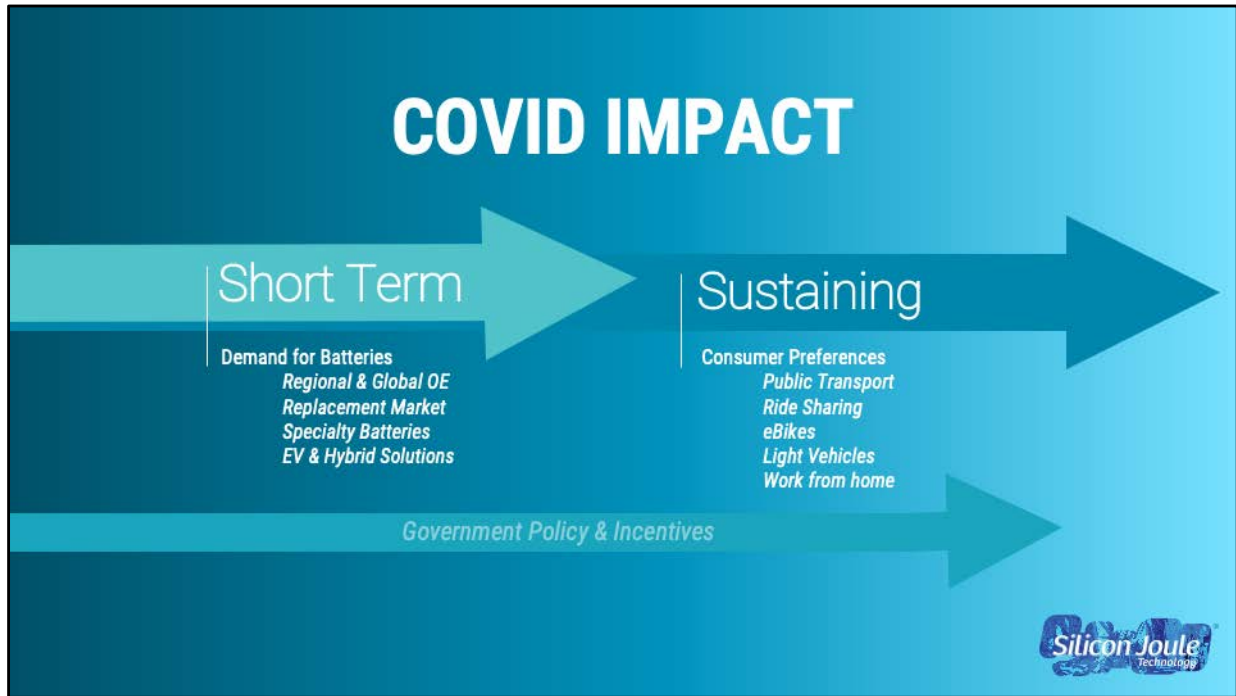




Thank you. We read daily about the tragic health and economic consequences of the virus in our communities and worldwide. With many now out of work, and so many others working from home, there has been a significant and disruptive impact on transportation of all types.

My objective is to explain the impact in key vehicle sectors and the forecast demand for batteries worldwide from this pandemic compared to the last forecast given in April.

And first, I thank the many organizations listed in the attachment to this presentation who have aided me with data and perspective.



The impact is easier to capture for new vehicle batteries in developed countries, yet we will give you also a quick look at the much larger replacement battery and specialty markets, along with the impact on the broad electrification trend in many sectors and regions.

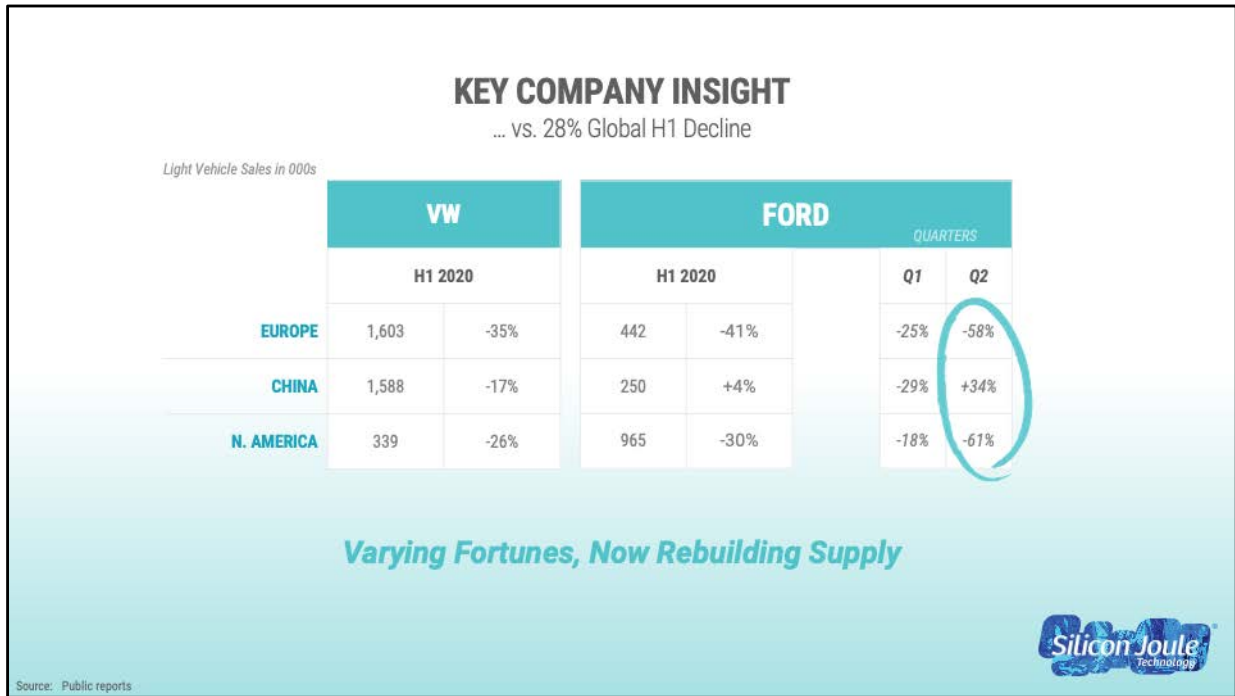
It is more difficult to forecast the longer term impact of changes in people’s travel behaviors from this virus experience in our daily lives for work, school and vacations.



The severe declines in new light vehicle sales followed the peak of the virus’s impact moving from the East in China where new light vehicle sales declined about 80% in February, reflecting the broad lockdown to contain the virus.

The virus impact of shutdowns and curtailments hit Europe hard just after China, with the dramatic vehicle sales reductions shown here for Germany and Italy, as plant shutdowns stopped supply, and stay at home orders meant few shoppers for the remaining inventory.

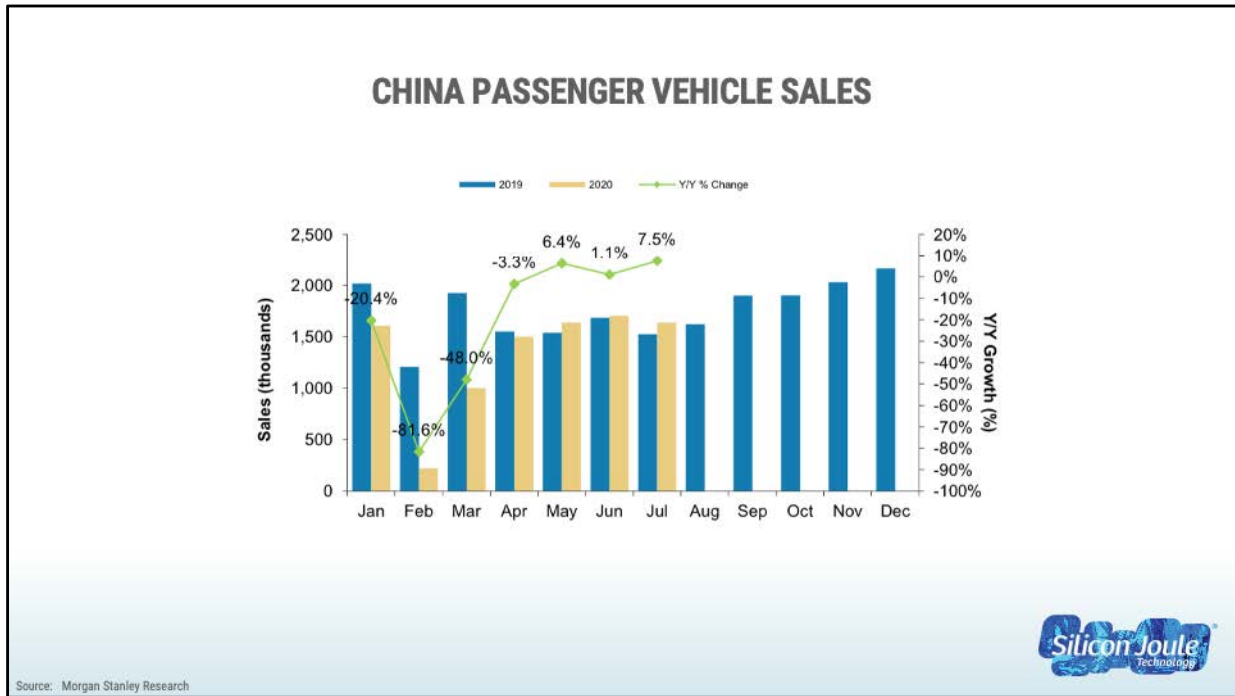
North American new vehicle sales were hit hard in April and May, before modest recoveries began in supply chains, vehicle factories and consumer demand.



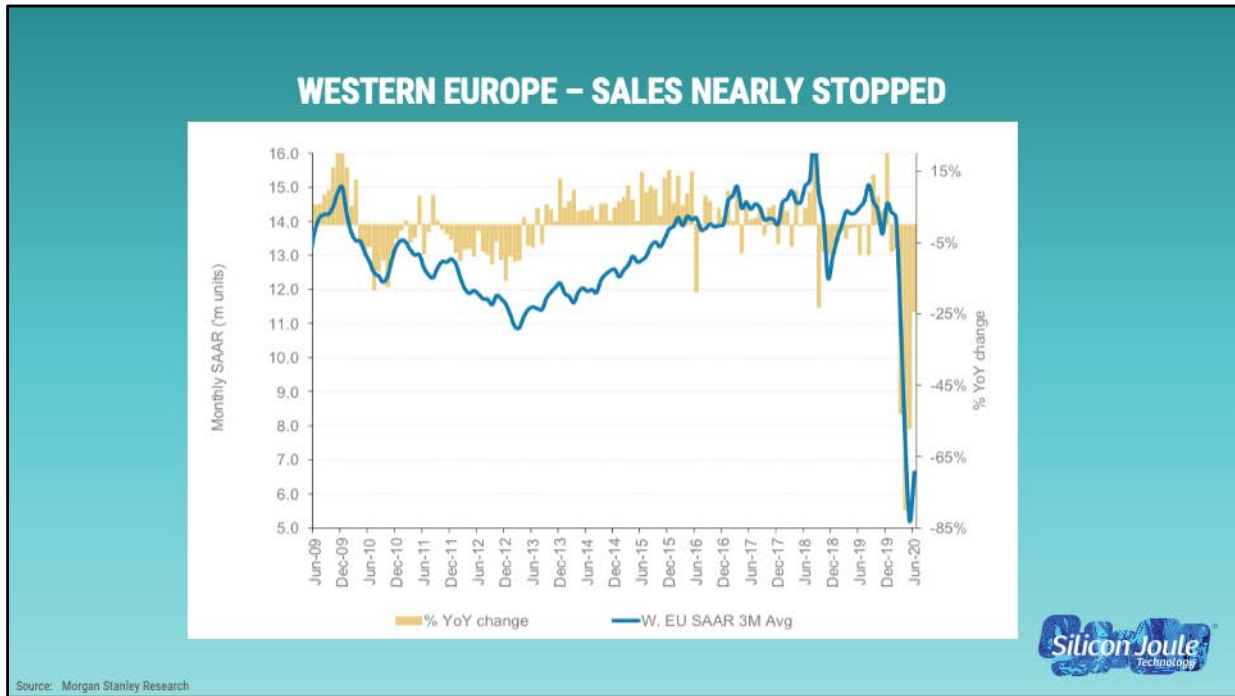
Total new light vehicle sales worldwide in the first half of 2020 declined 28% from 2019, and VW and Ford with their global footprint gives us another look at the impact for the three largest regions for car sales being China, Europe and North America.

Though there is variability by company, the huge changes by region give you a sense of the challenge faced by these companies, and of course their battery suppliers.

With quarterly data from Ford you can see the dramatic, roughly 60% declines for their sales in the second quarter in Europe and North America.

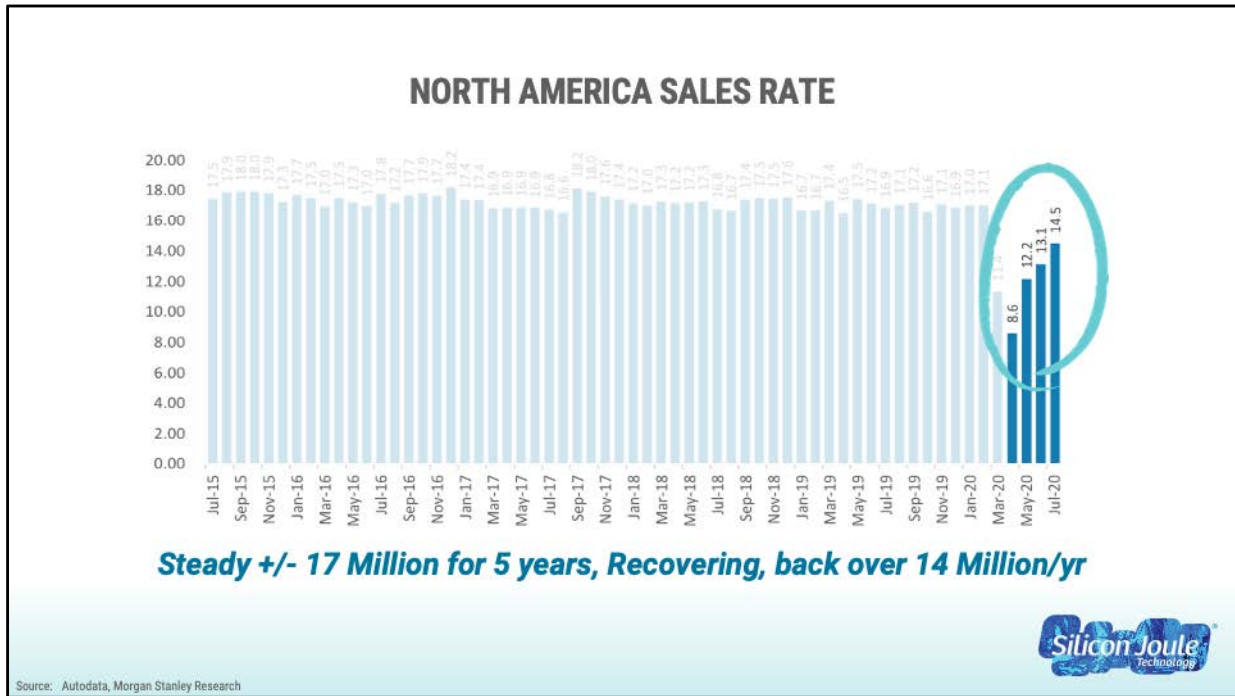


This monthly chart shows the rapid recovery of light vehicle sales in China following the near stop in February. The Chinese government at the national and local level offered incentives for both New Energy (EV & PHEV) and internal combustion engine vehicles which helped spur the recovery in demand. Also impressive is the implied quick recovery in the supply chains supporting vehicle production.



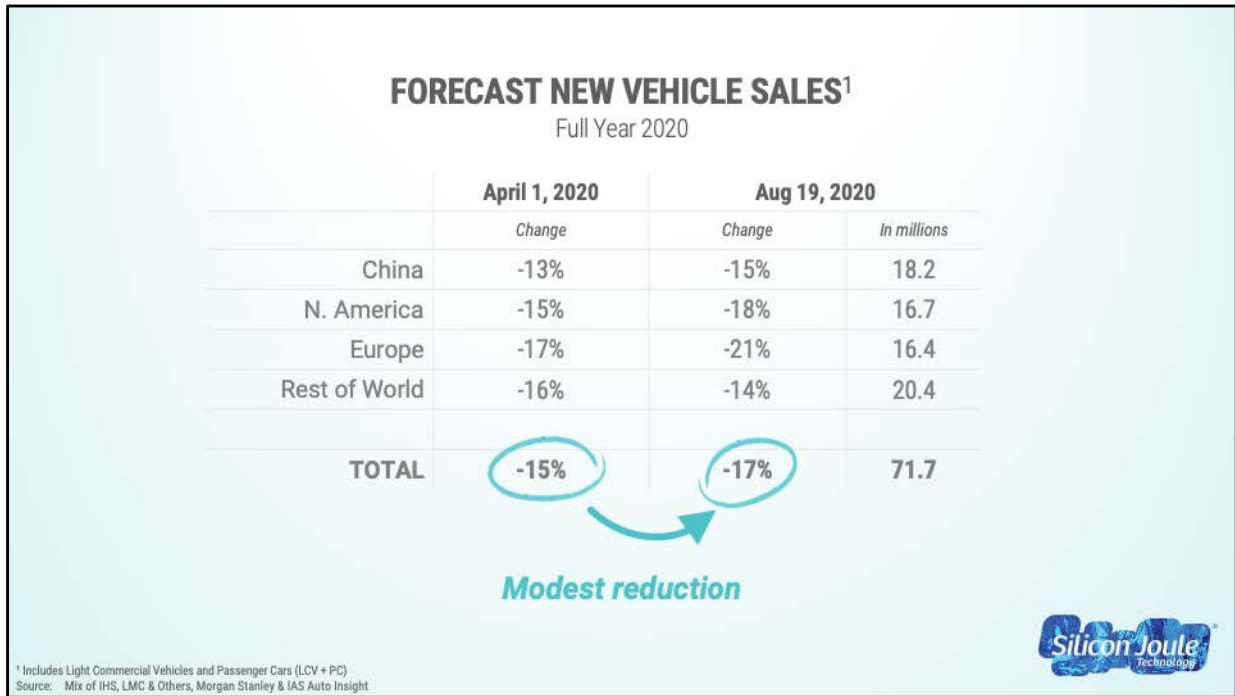
Across Europe the severity of the virus and breadth of shutdowns varied, yet as this chart of the annualized monthly sales level depicts, shipments nearly stopped completely in March, and recovered only slowly into the second quarter as countries varied in their opening, and as vehicle plants and suppliers were integrating new protocols for spacing of people and addressing other issues.

The large German and French markets did benefit from new vehicle sales incentives, and these were biased toward full electric and other efficient vehicles in line with national Co2 reduction objectives.

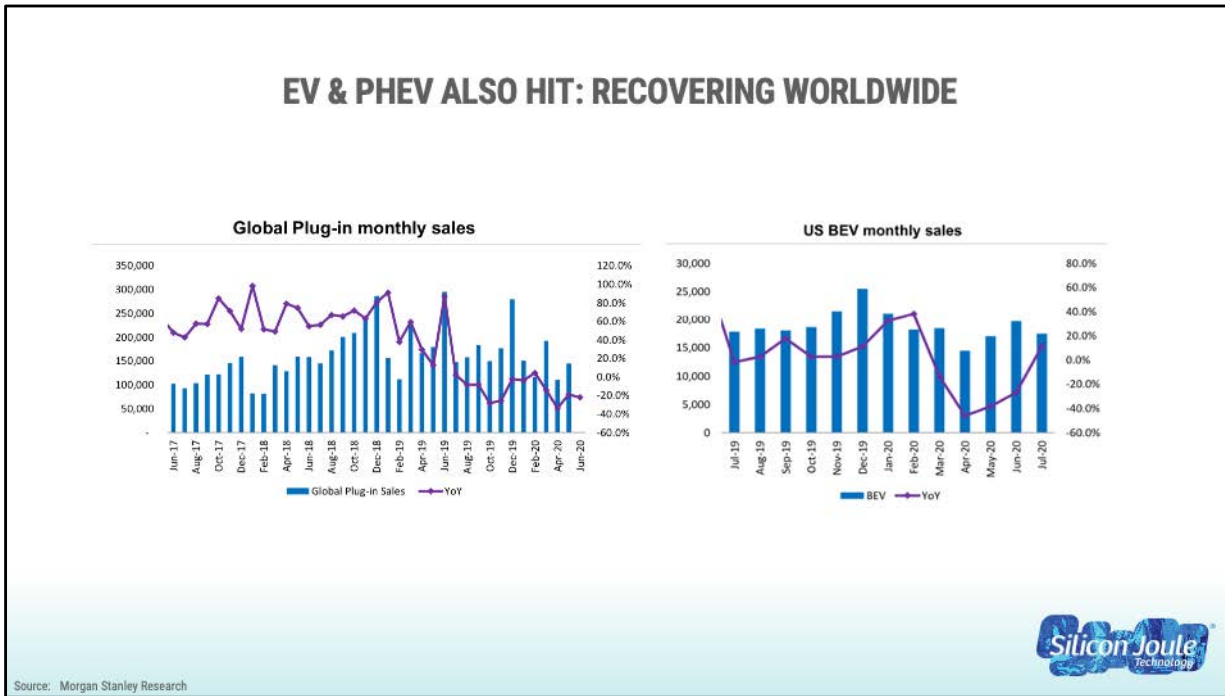


This chart depicts the North American monthly annualized sales rate back to 2015, which as the graph shows sales were steady at about 17 million light vehicles for six years running.

After the huge hit in April, the sales rate has been increasing, and in July exceeded 14 million, and in August exceeded 15 million. This rate has been constrained by supply chain issues, worker attendance and low inventory for the most popular SUVs and pickup trucks.



After the big drop in new vehicle sales in the first half, here is the forecast for the full year of light vehicle sales, compared also to the outlook shared in April. Best estimates now are for a full year decline of 17% to about 72 million new vehicles worldwide which is slightly larger than the 15% decline forecast in April. As noted the sales recovery has begun well in China, and there is a mixed, but improving picture in Europe and North America this Summer.




Electric and hybrid vehicles have also faced declines in the first half. As the global chart for EVs and PHEVs on the left shows, the rate of growth had already slowed in the second half of 2019, as China reduced New Energy vehicle incentives. The US EV sales shown on the right were reduced by curtailment of Tesla’s production across the 2nd quarter, and have now returned to growth this Summer.

And Tesla’s new China factory and other new EV and PHEV vehicle launches are now contributing to global EV sales growth again.

VOLUMES & VALUES

		Unit Sales Millions	H1 2020 Change	Market Cap 8/27 Billions
LARGEST	Toyota	4.02	-23%	\$217
	VW Group	3.89	-27%	\$87
OTHER	GM	2.77	-26%	\$42
	Ford	1.80	-29%	\$27
NEW	Tesla	.179	+13%	\$417
	Nikola	0	NA	\$14
	Nio	.014	+87%	\$23



Let's look at the interesting developments of some key vehicle companies, both the volume and their market values, which I will update based on the news of the last couple days.

The world's two largest vehicle companies Toyota and VW, each faced about 1 million or a one- quarter sales decline to about 4 million vehicles in the first half of 2020, and their valuations were roughly \$200 and \$100 Billion respectively at August 27th.

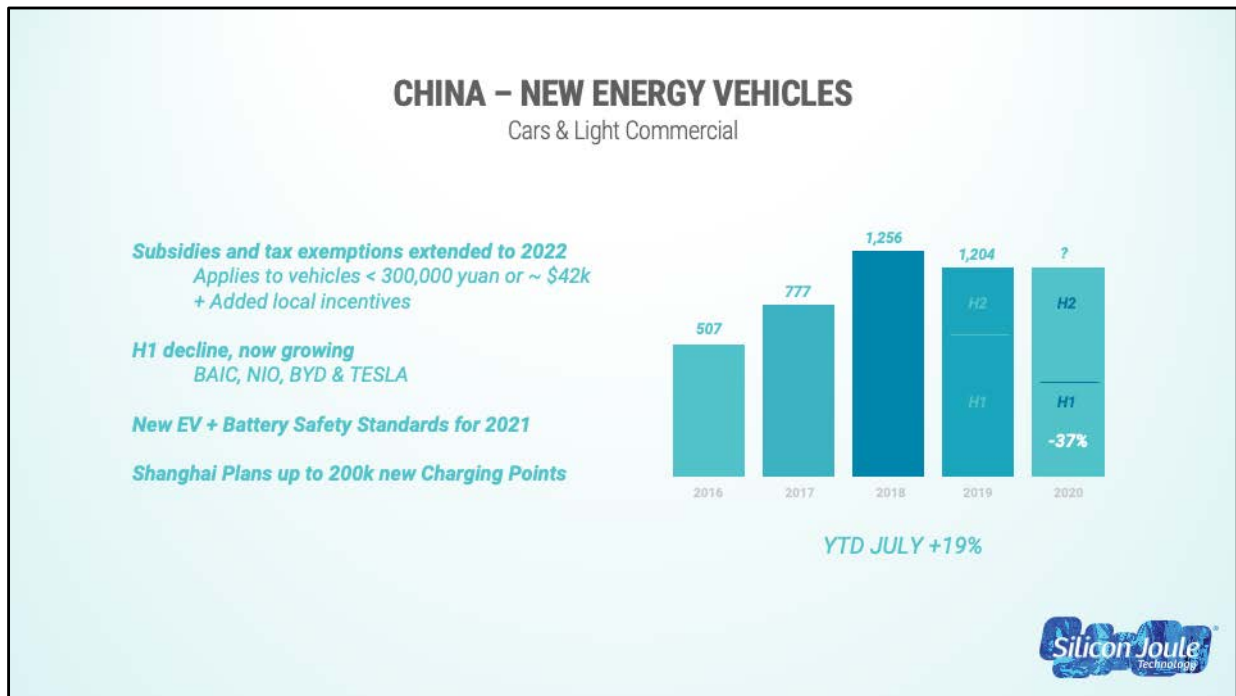
GM and Ford faced similar first half percentage sales declines, and valuations have struggled to recover to pre-Covid levels, given the sales and earnings shortfalls, and a halt to dividend payments. And combined the two companies have a market valuation of about \$75 Billion, no matter their profitable sales mix of pickup trucks and SUVs in North America.

However, Tesla, the newly public Nikola and Nio are a completely different story. Tesla's market valuation which was over \$400 Billion at August 27th exceeded the combined value of the four major car companies noted, and they shipped under 200,000 vehicles in the first half. The last couple days have seen the valuation slip back to still impressive \$300 Billion.

Nikola, with its heavy duty and pickup truck designs are scheduled to make their first shipments in the coming years, yet they already have a \$14 Billion market value at August 27th. With the news of their partnership with GM on September 8th, Nikola's market value has further increased to \$18 Billion.

Nio, the so-called Chinese Tesla, shipped 14,000 vehicles in the first half, and their valuation stood at \$23 Billion, nearly as much as Ford.

So, clearly investors are betting heavily on the transition to Electrified Vehicles.



Let’s now take a deeper look at some of the data on EVs by region, and for some insight into the New Energy Companies just discussed.

China remains the world’s largest market not only for total new vehicles, but also New Energy Vehicles, which in China includes EV and plug-in Hybrids.

In 2019 New Energy vehicle sales began with high growth, and then cooled off with the expiration of some incentives. Then COVID hit further blocking even more sales, so that New Energy vehicles in the first half of 2020 declined 37% compared to 2019.

However, the Chinese recently reinstated national incentives for two years for modest priced New Energy Vehicles, essentially vehicles \$42,000 or less, and sales are now increasing.

The government also initiated new tougher safety standards for EV buses and light vehicles to better manage the risks of lithium batteries. And most recently, Shanghai announced its plan to support electrification with 200,000 new charging points across its huge metropolis. The Chinese continue to support more EVs, and their electricity grid is starting a modest shift from coal to nuclear power, which offers the possibility to eventually help with CO2 emissions.

NIO'S APPROACH



- Up to 100 kWhs/370 miles
- ~ \$50,000 before subsidies
- Premium features & performance



- Swappable batteries
- Range of chargers
- Mobile charger



Let's take a closer look at Nio, one of the China's new champions for EVs.

They have a classy SUV, offering long range enabled by a battery pack up to 100 kWh, great acceleration, and also the premium 'connected' features you might expect from a up-market New Energy Vehicle, and it sells for about \$50,000 in China before incentives.

Interesting is their ALL-IN approach to provide, however-wherever you need battery power. They offer to swap the complete battery in 3 minutes at automated cabins, and a suite of chargers from overnight at home to on the road fast DC chargers, and even a mobile van charging unit to come to your rescue if needed. This concept sounds ambitious if you only operated on an island the size of Oahu, yet given the size of China, the vision can certainly be described as bold. And they claim they have already swapped batteries over 50,000 times.



From a low base, German EV sales have started to increase, reaching 44,000 vehicles in the first half, or nearly 4% of new vehicles sold, which was double the rate in 2019. However, with VW's ambitious product launches for the ID.3 and ID.4 coming, and the progressing Tesla factory near Berlin, along with increasing government incentives, Germany will likely be a major factor in global EV battery sales within a couple years.



And it is not all EVs in Germany, Porsche, true to its performance image is launching a Panamera Hybrid including a large 17.9 kWh battery aiding both acceleration and extended pure EV run time.

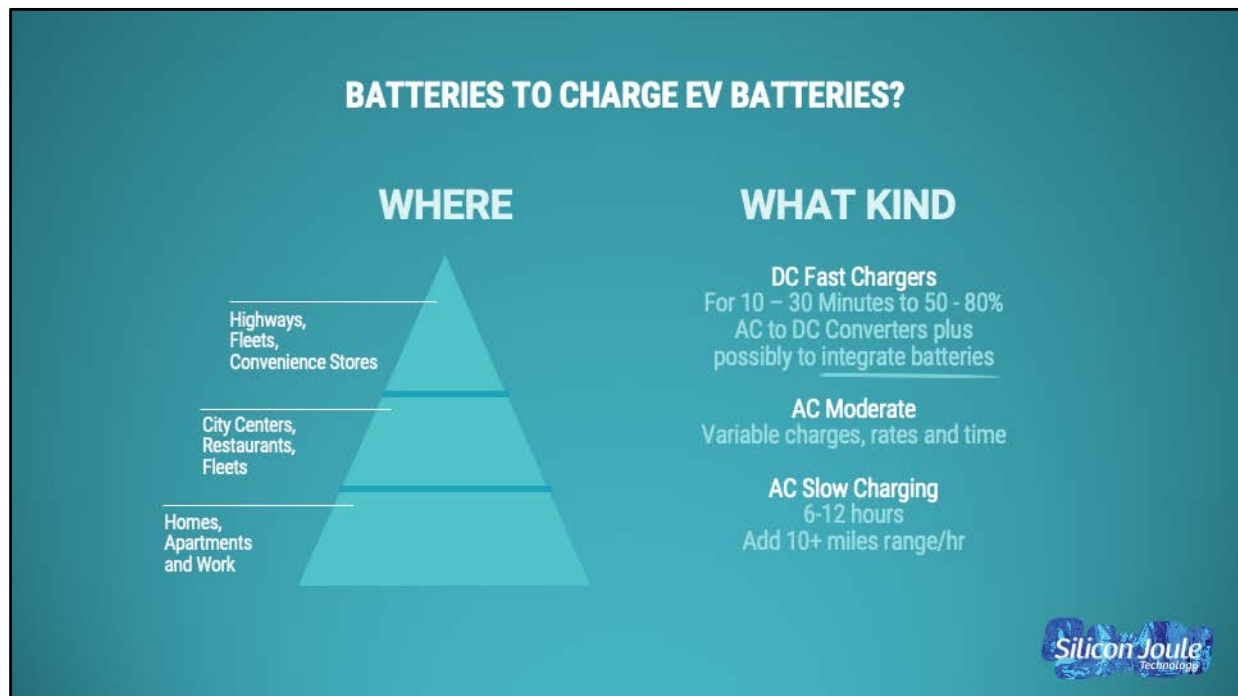


Shifting from high voltage to low voltage hybrids, here is a schematic of the mild hybrid being delivered in VW's most popular passenger car in Germany, the Golf, which aids the small, gas sipping, 1 and 1.5 liter engines in acceleration and overall efficiency.

Following the efficiency gains from the stop/start or idle off systems in the recent years, the 48Volt systems are now proving the next step in cost effective solutions improving fuel efficiency and costs for drivers and CO2 reduction for the environment. Part of the gains come from the smaller, lighter engines whose power is amplified by the smart 48V systems and batteries.



Here is a picture of the three smart components powering VW's mild hybrid solution; the 48v belt- integrated starter generator, the hard working .5 kWh 48v battery and the DC/DC converter. Though today's 48v batteries are lithium, soon advanced lead batteries with bi-pole architecture will also be designed in for some vehicles worldwide.



Let's talk battery chargers, both because of their role in building confidence in EV drivers, and also because applications are emerging which may include batteries to help with the fast DC charging stations evolving in many countries.

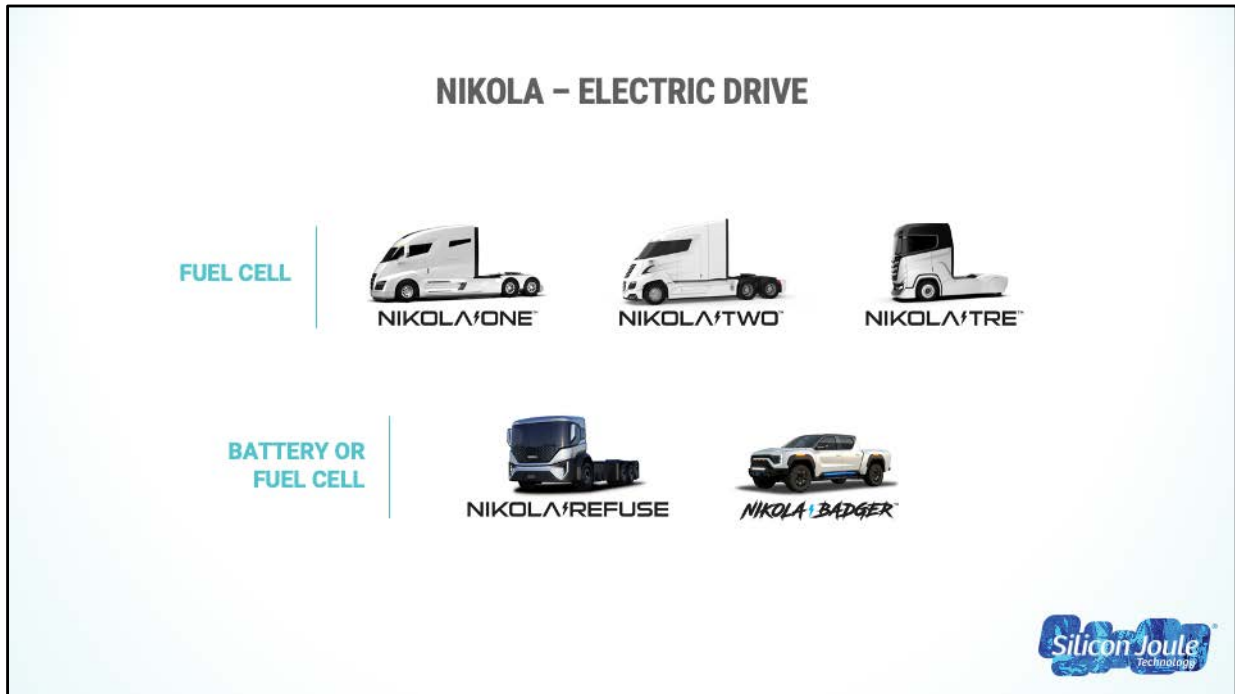
A recent US Dept of Energy study of EV charging showed that 80% of EV charging occurs at home, typically overnight, depicted here on this diagram as the base, where low cost (<\$1000) AC chargers can fill you up in 6-12 hours, and often be programmed to charge when electricity rates are optimal.

Next up the pyramid is a range of slow to moderate rate AC chargers at city centers, offices, restaurants, and fleets where you can conceive a 2 hour or so top up, while shopping or eating.

The fast or super-fast chargers are expensive DC chargers where you can fill-up in 30 minutes, and networks of these charger types have been rolled out by companies worldwide. Along highways, and for fleets, these chargers offer interesting business propositions for attracting

customers. For example you could stop and plug in at your nearby convenience store for a 20 minute charge, while you step inside for coffee, a breakfast roll and a few email responses.

Because of the huge power demands for fast charging, and the ability of batteries to help manage the peaks in local demand loading, some are envisioning very hard working batteries to improve the overall effectiveness of the fast charging solutions. These could include large batteries replacing one of the legacy fuel tanks underground, where the earth's steady/cool temperature helps the battery's efficiency and life.




Moving to larger commercial vehicles, Nikola’s platform of electric drive vehicles certainly has the attention of the investing public, and now GM, for large vehicles and a Badger pick-up truck, based on mix of battery and fuel cell platforms. I remain skeptical on the true economics and environmental benefit of fuel cells, whether using ‘blue’ hydrogen from natural gas, or ‘green’ hydrogen from renewable sources. However, there are a lot of smart people in Japan, Germany, California, and now Detroit, with the backing of governments, who believe in a role for hydrogen power in the future, at least for larger vehicles.

*Covid lifts eCommerce
... which accelerates EV fleets*

WHY ELECTRIC URBAN DELIVERY?

LIMITED RANGE	<i>< 100 miles</i>
FLEET SCALE	<i>50 to 50k common trucks (US)</i>
COMMON DEPOT	<i>Infrastructure & planning</i>
DUTY CYCLE	<i>Truck only moving 1/3rd of time</i>
MODEST WEIGHT	<i>Not 20+ ton trucks</i>
MGMT QUALITY	<i>UPS, AMAZON & FEDEX</i>

- > Start in modest climates, then move North*
- > Trucks last 10-20 years; 3 battery replacements?*
- > Leasing to address batteries, recycling & uncertainty?*



The acceleration of eCommerce due to the Covid virus has been significant, with trucks delivering goods all day long, and often across weekends in many countries.

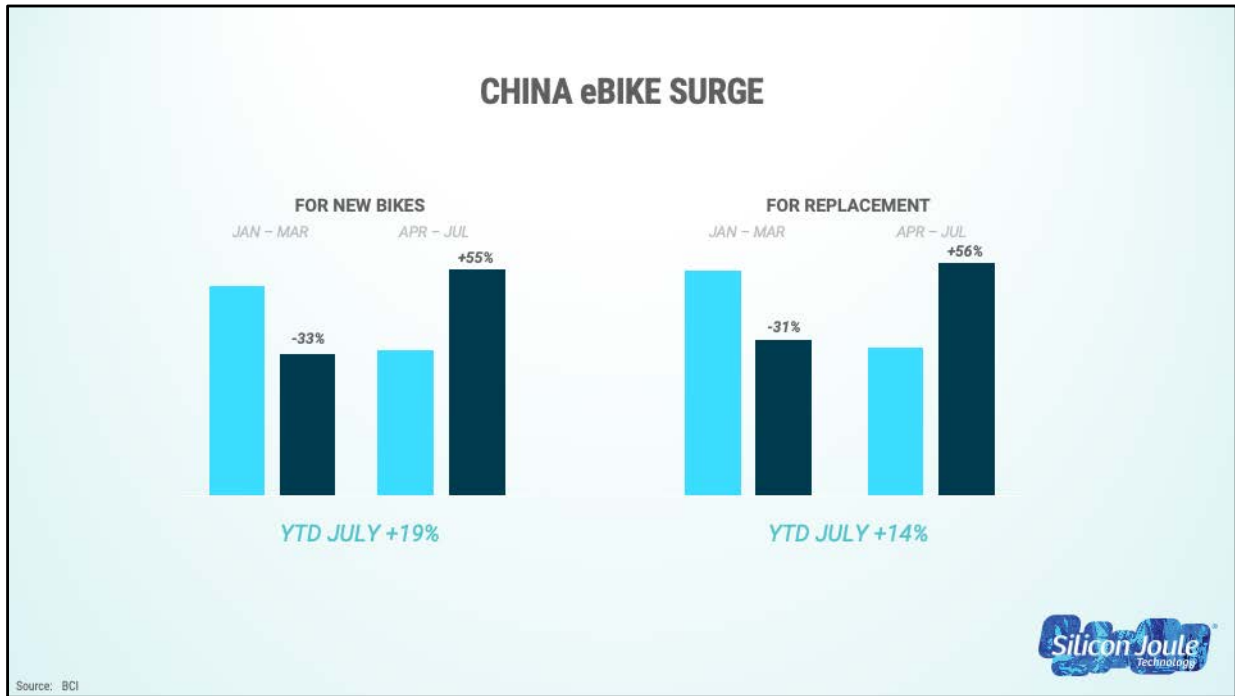
Does this trend of much higher eCommerce growth lead to faster adoption of Urban EV delivery trucks ?? Amazon’s purchase orders alone would suggest this is very possible.

The economics for eFleets with moderate ranges continues to improve, while policies for cities and companies are pushing for adoption. Smart fleet management through centralized hubs and dispersed smart charging networks may likely accelerate the adoption of eFleets, at least in areas with moderate climates to start.



Today, many people are not comfortable getting back in trains, buses or UBERS.

Ridership levels have dropped dramatically in many markets and systems, including New York’s metro and London’s Tube referenced here. Ridership may increase again with the confidence of new therapeutics and vaccines and some companies calling workers back to offices. And China’s efforts to deploy advanced technologies for screening and tracing has shown to improve ridership in their mega-cities. Putting 5 million more people in Shanghai in cars and eBikes would not likely have good result.



Yet a lot more eBikes are being bought this year, and many more replacement batteries are being shipped to power the 200 million+ eBike fleet across China.

Courtesy of the team at Leoch, recent data from China shows a strong lift in new eBike sales in the Spring, being 55% ahead of 2019, recovering strongly from the shutdown, showing a 19% lift year-to-date.

And on the replacement market eBike battery sales are up 14% through July, also with a big surge in demand from April through July.

Some of this, in the opinion Annie Zheng of the Leoch team, is the preference for private vs. public transport.

URBAN OR 2nd SUBURBAN CAR?

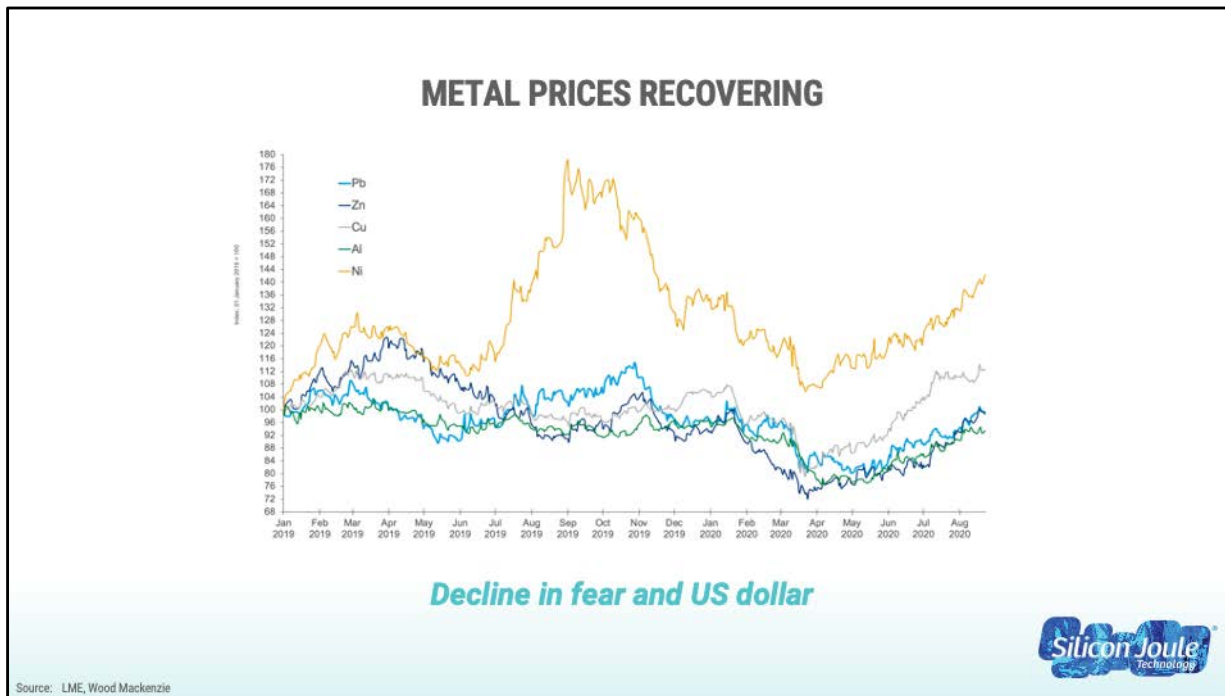


*Individual safety...w/o public transport,
between the eBike and Highway car*



Something else to watch I believe is the development of the small EVs, and not just in China and India, like this new one from Honda. Not everyone needs 400 miles range if your primary travel is urban, or for your second family car, where the typical range for schools, shopping and all other activities can be under 25 miles or 40 kilometers in a day. And with the smaller battery packs, it can be a 5 minute fast charge, not much more than a gas fill up. This Honda has over 130 mile range, or 220 kilometer range with a 36 kWh battery.

Small cars have not sold well this past decade in the US as they have in much of the world. With the need for more private transport, even with modest ranges, might the US market respond to a high quality small, affordable eCar or eSUV?



Let's shift gears for an update on commodity costs, which are especially important in batteries.

Shown here is a graph of the five key base metals with nickel in yellow, and lead in blue, which are critical cost elements in lithium and lead batteries. As often the case, they have trended together with copper, zinc and aluminum, except for the extra interim lift in nickel. From the lows in late March as the Covid crisis led large immediate demand declines, the slow, yet steady recovery in prices is evident. Farid Ahmed from Wood Mackenzie who provided this graph, explained the easing fear about demand, the recovery starting in China, and also the decline in the US dollar as key factors for the price recovery.

COMMODITY ASSUMPTIONS

In \$/ton	2019	ORIGINAL	UPDATED	CHANGE	2024
		APR 2020	AUG 2020		
Lead	2,007	1,750	1,813	➔	2,100
Lithium¹	11,200	8,124	8,350	➔	9,700
Oil²	64.20	42.00	43.70	➔	75.80
Cobalt³	37,038	35,274	33,510	➔	44,092
Nickel	13,936	14,250	12,751	➔	14,505

Not much annual change since April
... except US Dollar

¹ Lithium carbonate

² Brent Barrel

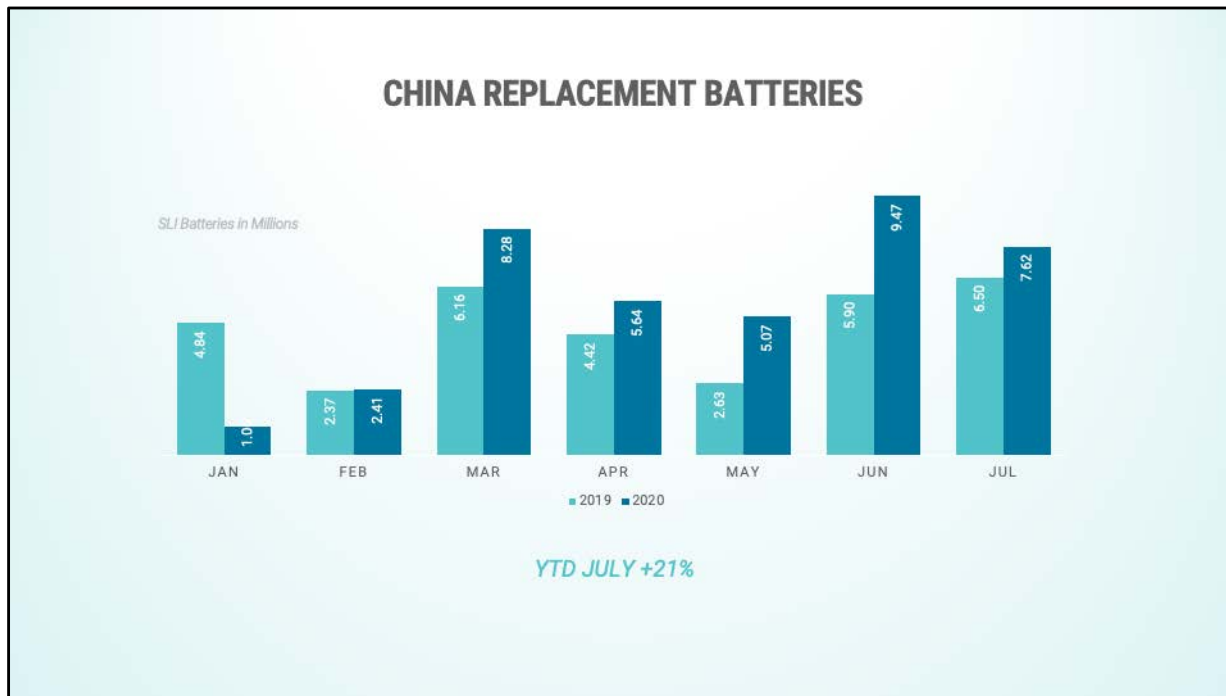
³ Cobalt is 98.8%

Source: CRU Commodities



Shown here from Neil Hawkes at CRU Commodities are the forecasts for the 2020 full year metal prices per ton and for oil as of April and as of today. I have to give CRU credit as regardless the volatility we have seen since March in oil and all these metals, their forecast remains pretty close to where it was. Again, part of their explanation for sustaining the forecast despite a few weeks of very cheap metals and oil after the virus hit was that demand was recovering and the notable decline in the US dollar.

For lithium battery metals, it is worth noting the continued efforts by many to reduce the content of expensive cobalt, and some shift to lithium iron phosphate designs in transport and industrial applications for cost reduction.

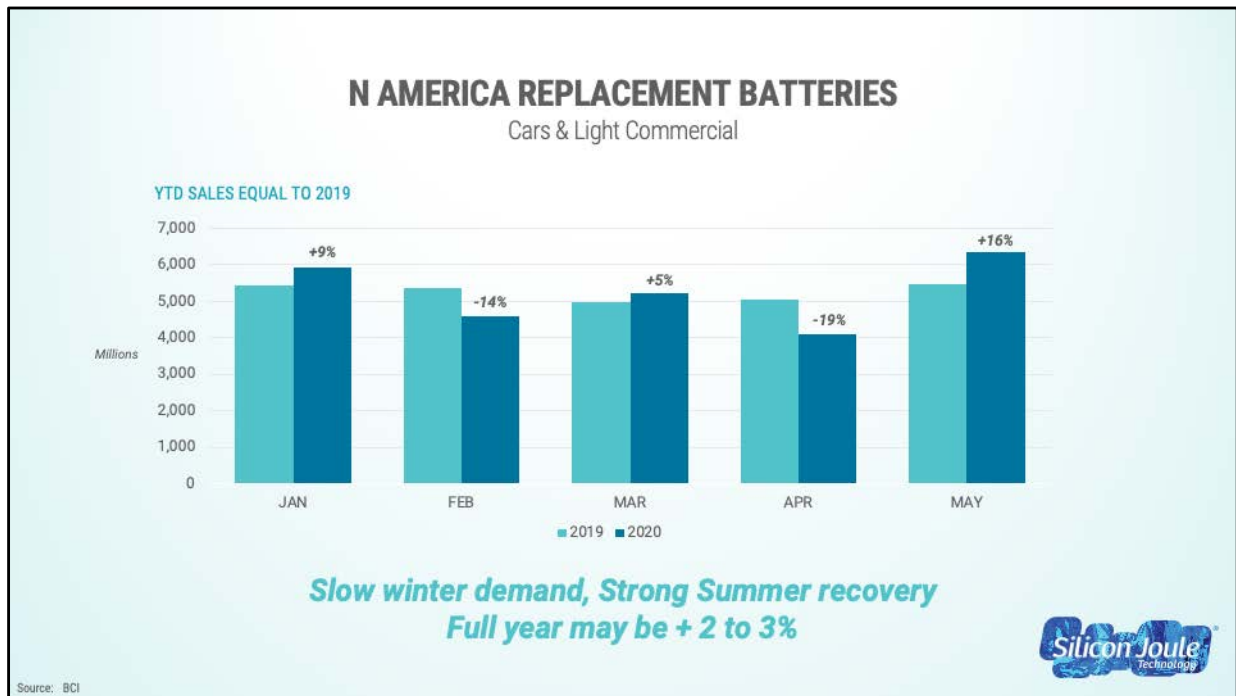


Let's shift to cover the large replacement battery markets.

Though OE battery shipments are important, the replacement markets reflect the continuing lengthening of the average age of the roughly 1.2 billion passenger car and light commercial vehicles on the road worldwide, which need new batteries periodically.

Starting in China, after very low shipments in January and February due to the Covid lockdown and the Chinese New Year, shipments have rapidly recovered through July with a cumulative growth in shipments of 21% compared to 2019. Leoch's Dong Li, explained the challenges of getting operations back to normal levels, including getting people back to the plants after Chinese New Year vacations, with travel bans, and then the gradual lifting of restrictions on movement of people.

The overall replacement market growth in China clearly reflects the high new vehicle growth over the last ten years.



North American replacement shipment data from the BCI through May reflects a mix of factors from the near shutdown of intercity travel in many regions, temporary government-imposed plant and customer shutdowns, reduction in driving, and also the comparable challenge of getting people back to work to produce batteries.

Though manufacturer shipments in N. America have caught up to the prior year by May, it has been one of the most challenging years for production planning execs. We started out with a very mild Winter, and resulting excess inventories, then the shutdown orders closing car factories, and orders to stay at home. Managers were striving to keep plants going for essential products with social distancing. This means assembly lines, locker rooms and lunchrooms set up for three shifts with loads of workers crossing was no longer tenable. Creative solutions were found, which included effectively 50+ shift starts in a day by one example at Crown Battery to achieve social distancing.

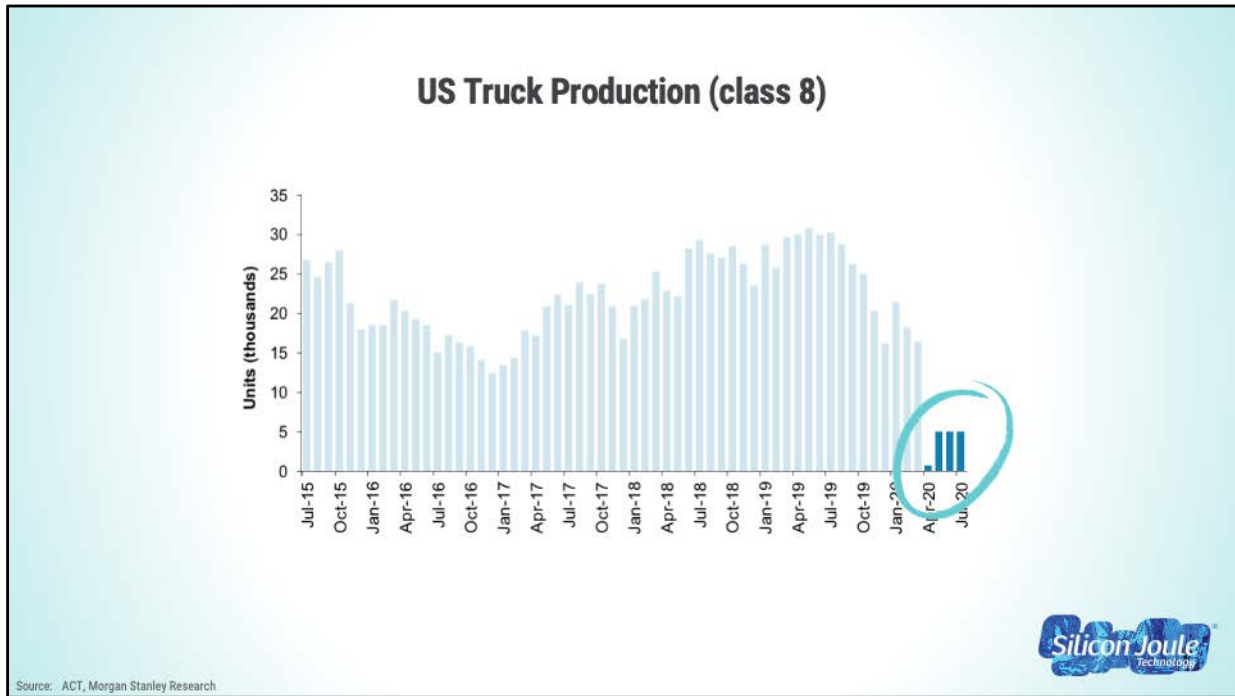
By May excess inventories were gone, and starting in June orders grew quickly and manufacturers across the North America have been striving to catch up with orders ever since. It is unclear if current excess demand is caused by the catching up from slow Winter demand, high Summer heat, or even shortened battery lives from sulfation from so many cars idled or driven very lightly across the shutdown and work at home months.



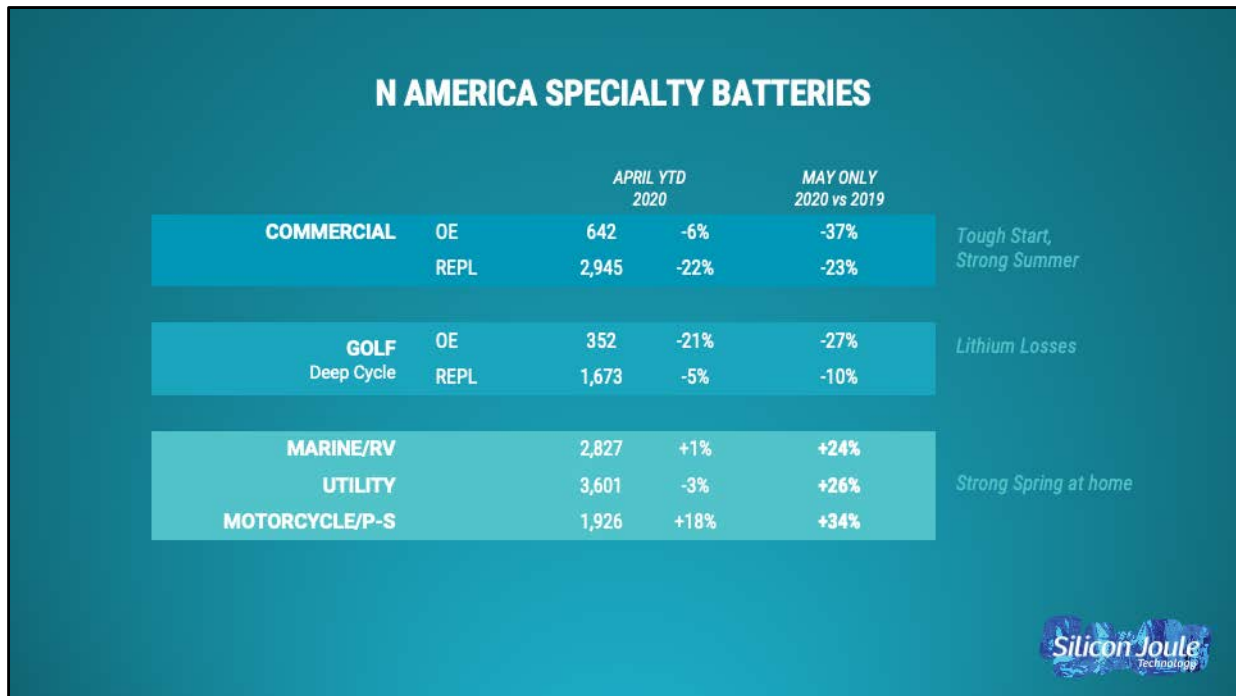
One interesting development this Summer has been the far more intense retail battle for automotive replacement battery sales in North America.

The catalyst has been the purchase by Advance Auto, one of the three large US auto chains of the the legacy Diehard battery brand from the remnants of Sears, and a concurrent broad promotion to attract customers to their stores.

This big investment, reportedly \$200 million, reflects the confidence to take high profit margin market share from other retailers with strong private label brands, notably the Duralast from AutoZone, plus also from O'Reilly's, Walmart and NAPA stores. Building customer awareness and confidence through strong marketing and expanded services has been a real success story for the three major auto chains. As with its thousands of other items, Walmart's approach to battery sales continues with its everyday lower price approach with EverStart batteries.



Staying in North America, here is a look at the large (class 8) truck production, which came to a complete stop in April, then modestly re-started beginning in May. Large truck production was already expected to decline back to normal levels in 2020 after two strong years aided by new emission standards and the high economic growth. Truck production has been gradually expanding with the progress across the integrated supply chain between the US, Mexico and Canada.



Here is a look at sales data from BCI of non-automotive batteries in North America through May.

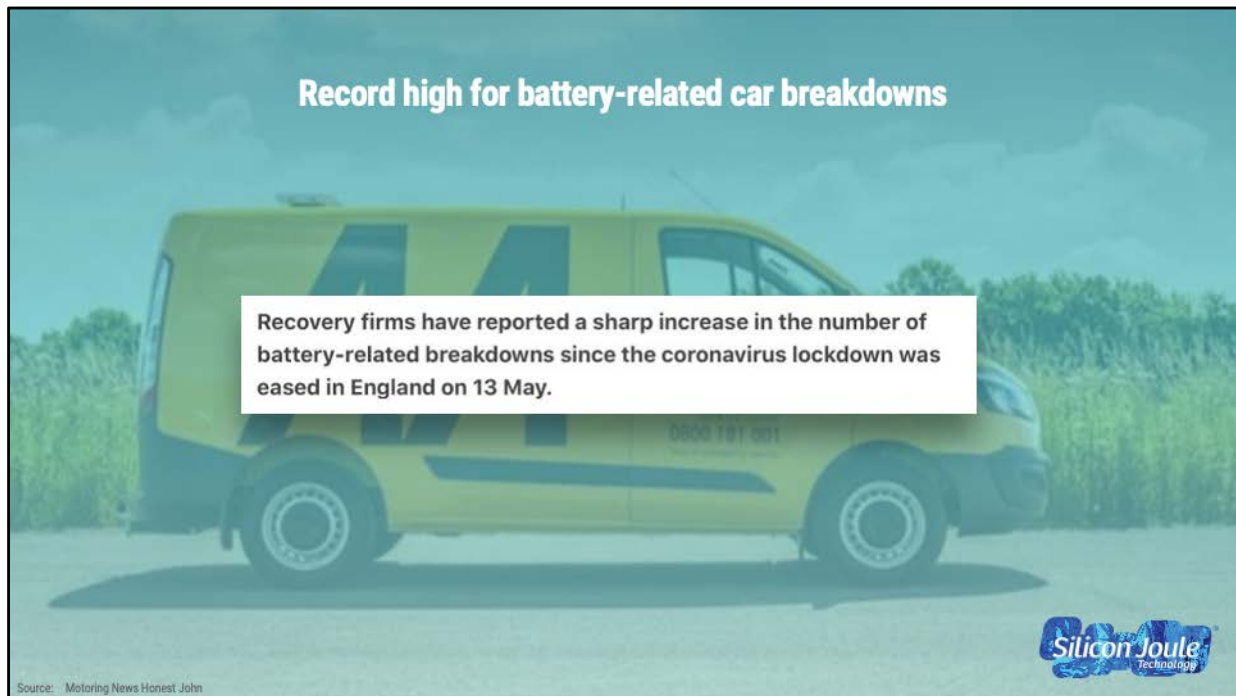
First are the OE and Replacement commercial vehicle batteries which declined 37% and 23% respectively through May. However, based on feedback East Penn’s transportation business leader, Pete Stanislawczyk, and other reports from US distributors, commercial battery sales have been very strong across the

Summer, and whether this is just a catch up of deferred sales is unclear.

Sales of deep cycle, golf cart sized batteries at the OE level are down 27% which reflects a mix of curtailed activity early Spring and continued lithium market share gains in new carts.

The last group of battery sales shown on this slide of marine/RV, utility (mostly lawn and garden) and motorcycle/power sport batteries offers some unique insight to what many Americans have been doing during this COVID period. These maybe reflect vacation changes, more free time, and also the huge US stimulus payments to consumers, while at the same time many are not heading into offices, stores and factories for work or to restaurants for the evening.

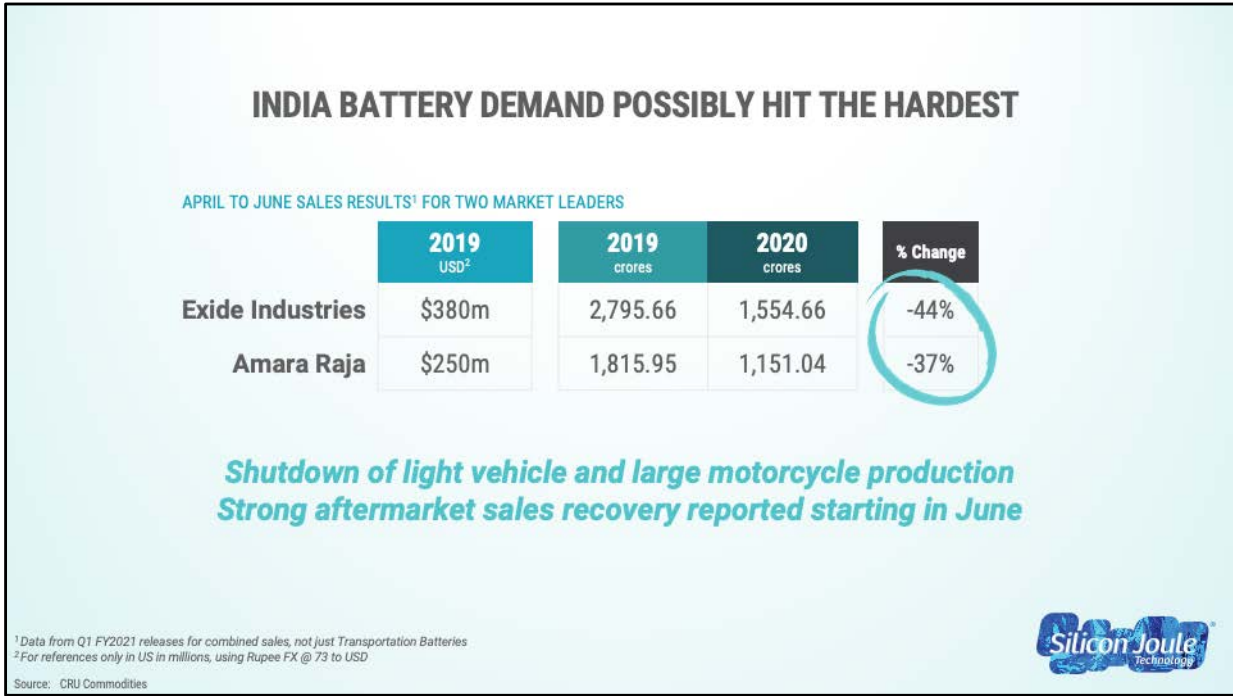
Across the US there has been significant increases in the purchase and use of recreational vehicles (or private rolling hotels), and boats, and backlogs persist into September at these producers. And a lift in work in the yards and gardens are also evident with a surge in small tractor batteries. And also batteries for power-sport vehicles and motorcycles were up one-third in May and over 20% YTD. And good growth in these categories has continued through the Summer.



We do not have interim European data for replacement battery sales, yet anecdotal reports from European Battery distributors, such as EcoBat Technologies, reported a similar pattern of Post Covid recoveries for replacement automotive batteries.

One insight for the replacement of failed batteries post lockdown comes from Farid Ahmed of Wood Mackenzie who sent along this report of record call outs for emergency battery replacement by AA - the roadside assistance service, as people and vehicles started getting back on the road after the UK lockdown.

When asked about specialty, RV and marine batteries in Europe this Spring, the market trend was quite different than North America. The usual flow from Germany, Holland and UK to Southern Europe with so many campers did not happen this year, with most staying home in their own country, so the sales of specialty batteries actually declined.



Let's now focus on the large battery market in India. It may have been the hardest hit from the Covid virus shutdowns, at least as we can see through the results of the two market leaders in India, Amara Raja and Exide Industries.

Concurrent with the government imposed restrictions, total sales of the two battery companies declined about 40% for the April to June quarter. Beyond starter batteries for cars and trucks, two of the larger battery categories in India are for inverter batteries for the home and motorcycle batteries which are included in these declining sales totals.

And predictably the growing market for eRickshaws or eTukTuks also slowed temporarily with people traveling less.

FORECAST & CHANGES

<i>Total</i>	2020	2024
April	\$90 +19%	\$178
Sept	\$80 +7%	<i>TBD</i>

<i>Batteries for</i>	<i>Actual Change in 2020</i>
New Vehicle Sales	-17% or 15M
Replacement Light Vehicle	+14% or 17M
Commercial Vehicles	<i>Level by year end</i>
BEV	+3%
Hybrids HV + 48V	+5%
eBikes	+10%, not 6%
Specialty vehicles/apps	>10% + US <i>Mixed elsewhere</i>



To pull together the global summary of battery demand, both in value and energy I will update the full model for the BCI event scheduled next Spring in Naples, Florida. However, here I offer a quick summary of my estimate of the numbers.

This past April the estimate was for the market to increase by an average 19% to \$80 billion in 2020 and to \$178 Billion by 2024. This was being driven the broad electrification trends from EVs, high voltage and 48v hybrids, global growth, and also the continued evolution to more expensive, harder working batteries in many other applications both by lithium and advanced lead batteries.

My estimate is the global market in 2020 for transportation batteries will be closer to \$70 Billion, reflecting about 7% growth, instead of the earlier 19% forecast.

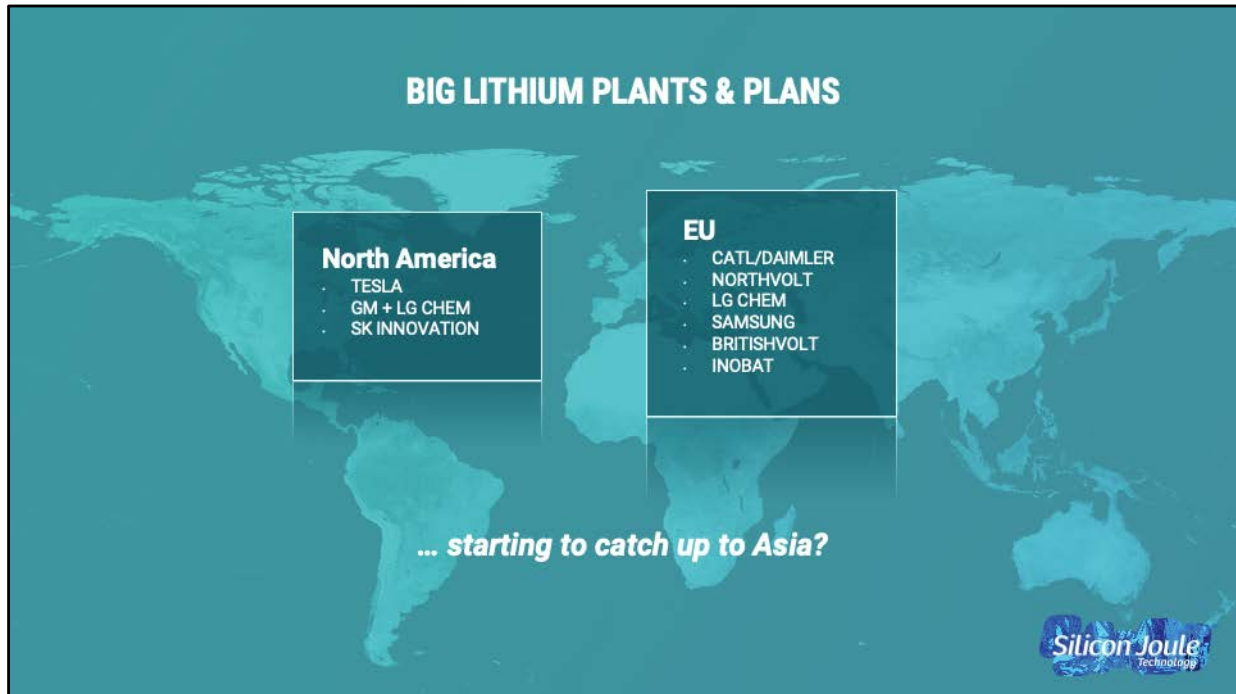
The large OE new vehicle declines from the first half will likely be offset by somewhat higher growth in the larger replacement market for light vehicle batteries.

The slowdown in EV and hybrid sales in the first half is likely to be temporary, as stimulus, new models and capacity should support higher growth after the interruptions earlier this year for the balance of 2020 and into 2021.

Guessing beyond these months ahead for the impact from the virus on transportation batteries requires a lot of guesses about working at home, re-acceptance of public transport and UBER, and the pace of economic recoveries.

Yet I think it is safe to guess there will be a increase in the trends for private transport worldwide. That could be in eBikes in some countries, and more light vehicles, albeit more affordable ones with broad appeal, both EV and efficient 48v hybrids for Urban and 2nd family cars. And also in some countries like the US, Canada and Australia there could be increased demand for larger vehicles for mid-range trips rather than airplane travel.

As to the split for growth between lithium and lead batteries in 2020, I believe lithium batteries still achieved double digit sales growth with lead based transportation batteries likely showing overall 2% (+/-) per cent growth due to replacement light vehicle and eBike batteries.



Staying with Lithium batteries, here are the numerous capacity developments in Europe and the US, generally partnered with Asian manufacturers which continue with ambitious plans, especially by Northvolt in Europe, and now GM with LG Chem in Ohio. And this week you may have seen that SAFT with its parent company, Total, is partnering with PSA to build two added lithium cell plants in Europe. You can find forecasts for lithium battery shortages or excess capacity from all these investments, yet it is clear billions are being invested now for the very high growth in demand expected.

BETTER PACKAGES



The image displays three battery packages side-by-side. On the left is the BYD Blade, a flat, rectangular pack. In the center is the GM Ultium, shown as a battery pack mounted on a vehicle chassis. On the right is the Silicon Joule, a blue, rectangular pack with a textured surface.

BYD Blade®
Li - LFP

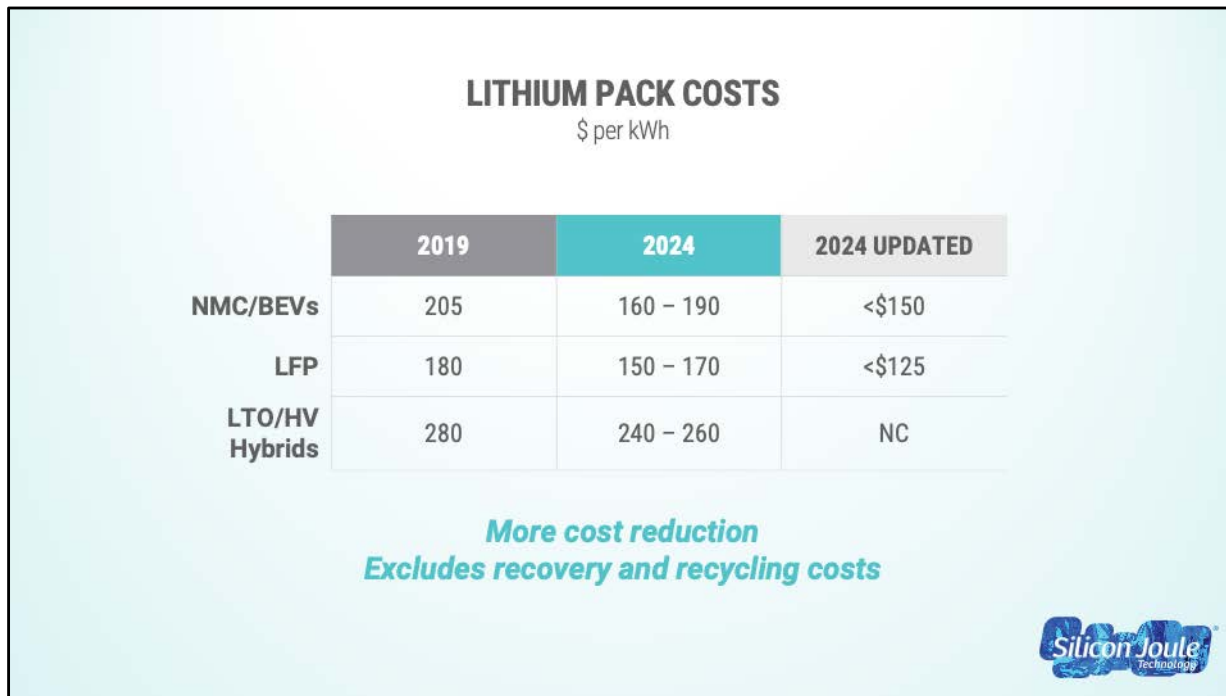
GM Ultium®
Li - NMC

Silicon Joule®
48V Si bi-pole



This is a picture of progressing battery packs, the Blade LFP pack from BYD in China, and the new Ultium pack from GM, which will be sourced in the future from the new Ohio plant making NMC cells, and the advanced lead solution featuring treated silicon wafers as a bi-pole for multiple applications including 48v mild hybrids.

These Silicon Joule technology batteries are also moving into co-production with a development partner of Gridtential starting later this year, and ramping up in 2021.



Here is a chart of the forecasted costs for select lithium types, which I have reduced about 15% in my forecast assumptions for 2024 based on the progress made in achieving both cell and battery pack improvements, along with the sustained low material costs covered earlier.

There are huge technology investments continuing in lithium for solid-state electrolyte for safety and claimed energy density gains. This includes QuantumScape, who is claiming safer, higher energy density lithium metal anodes with a ceramic electrolyte. And before any meaningful sales, their public value was \$3.5 Billion last week. Others are developing and promising higher performing solutions with silicon-based anodes or multiple other recipes. The application growth from transportation along with consumer electronics, industrial and grid-linked use just keeps attracting more development.

And many others are striving to develop a credible, scalable, value-generating recycling process for lithium batteries, which today still does not exist. This remains a safety and environmental risk until better controls and recovery of used lithium batteries are achieved for applications ranging from cell phones to vehicles.

KEY TAKEAWAYS

- Vehicle & battery companies were really disrupted, yet the recoveries are strong
- Global replacement battery growth offsets the new vehicle sales decline in 2020
- Working from home and aversion to public transport may increase vehicle sales
- EV sales were hit, yet recovering with better vehicles, capacity, incentives and charging
- eCommerce may boost urban delivery EV fleets
- Hybrid sales, especially efficient 48V platforms, continue to progress
- Lithium cost improvements and capacity additions continue with higher risks to lead-based batteries. Progress on recycling and safety needed.
- Advanced lead batteries are improving cycle life, DCA and architecture to higher voltages
- Transportation battery sales may increase only 7% in 2020 due to the temporary hit to high EV growth



Though our customers and our industry were really disrupted this year, overall our industry is recovering well, with most producers likely to match or exceed prior year sales in 2020 in the transportation sectors. I think you would agree our industry has been more fortunate than most.

There are many questions on the sustained impact on consumer behaviors from COVID, yet I believe private transport needs will increase, the electrification trends for light vehicles and urban delivery vehicles will continue strong, and lithium product development and capacity investments are even accelerating because of the acknowledged opportunities and the commitments of aggressive producers and investors.

Thanks to collaborative progress at Argonne National Labs in the US, plus the worldwide CBI group, and also many innovators, including those with bi-pole technology, I believe there remain terrific opportunities for those companies fully engaging and committing to the future for very high performance advanced lead batteries, which sustain their unique cost and sustainability track record.

I believe the market growth and development investments by so many appear a clear and present opportunity or danger to many competing companies in the industry today. Though you can't invest in all technologies, I highly encourage you to aggressively invest now in the advanced technologies the best fit the target markets for your company.



Again I want to thank these many companies and organizations who took the time to provide both data and anecdotal insight on our changing markets through these challenging times.

Thank you, and I look forward to seeing many of you in Naples next Spring.

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DEFINITIONS

ICE	Internal combustion engine (gasoline or diesel)	CAGR	Compound annual growth rate
BEV	Battery Electric Vehicle (all electric motors/no ICE)	IEA	International Energy Commission
HV Hybrid	High Voltage >60 volts to several hundred volts, can be plug in or not	Class 6-8 trucks	North American reference for the heaviest classes by weight for highway and off-highway equipment
48 Volt Mild Hybrid	Generally dual voltage system aiding regenerative braking, propulsion, etc. in conjunction with ICE engines	DCA	Dynamic Charge Acceptance is a measure of rate of charge acceptance, important in hybrid vehicle and other applications, especially at higher states of charge
AGM	absorbed glass mat separator, general reference for semi-sealed, reduced electrolyte, valve-regulated lead-based batteries.	MPG	Miles driven per gallon of fuel consumed.
EFB	Enhanced Flooded Batteries often used as a lower cost substitute for AGM batteries in stop/start applications.	P0, P1 & P2	Progressive measures of electrification and power assist in so-called mild hybrids, typically in 48 Volt system platforms.
SLI	Generic starting, lighting and ignition battery for light and commercial vehicles.	CTP	Cell to Pack, typically used to describe technology deployed to optimize beyond the cell chemistry in lithium batteries
LSEV	Low Speed Electric Vehicles - a range of eBikes to golf carts to eRickshaws, generally 36 and 48v systems with modest speed and range.	NMC811	Improved Nickel Manganese Cobalt design with smaller fractions of Manganese and expensive Cobalt.
eBuses	All electric propulsion buses	kWh	kilowatt hours measure of energy
NMC	Nickel Manganese Cobalt lithium batteries, often includes the sister NCA (Nickel Cobalt Aluminum) designs	GWh	Gigawatt hours measure of energy
LFP	Lithium Iron Phosphate lithium batteries	18650 & 21700	Alternate cylindrical lithium small cells, often packed into larger modules (or bricks) than managed battery packs.
LTO	Lithium Titanate Oxide batteries	Pouch cells	An alternative to cylindrical lithium cells
Bi-polar	Alternative battery architecture, whereby classic grids and connecting straps (in lead batteries) are replaced with a bi-plate offering alternate current flows and voltage blocks.		



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