Thank you, and I am happy to be back with you at the Asian Battery Conference.

The review today is based on a model built for the transportation and industrial markets for five years to 2023, and split across the lead and lithium technologies by application.

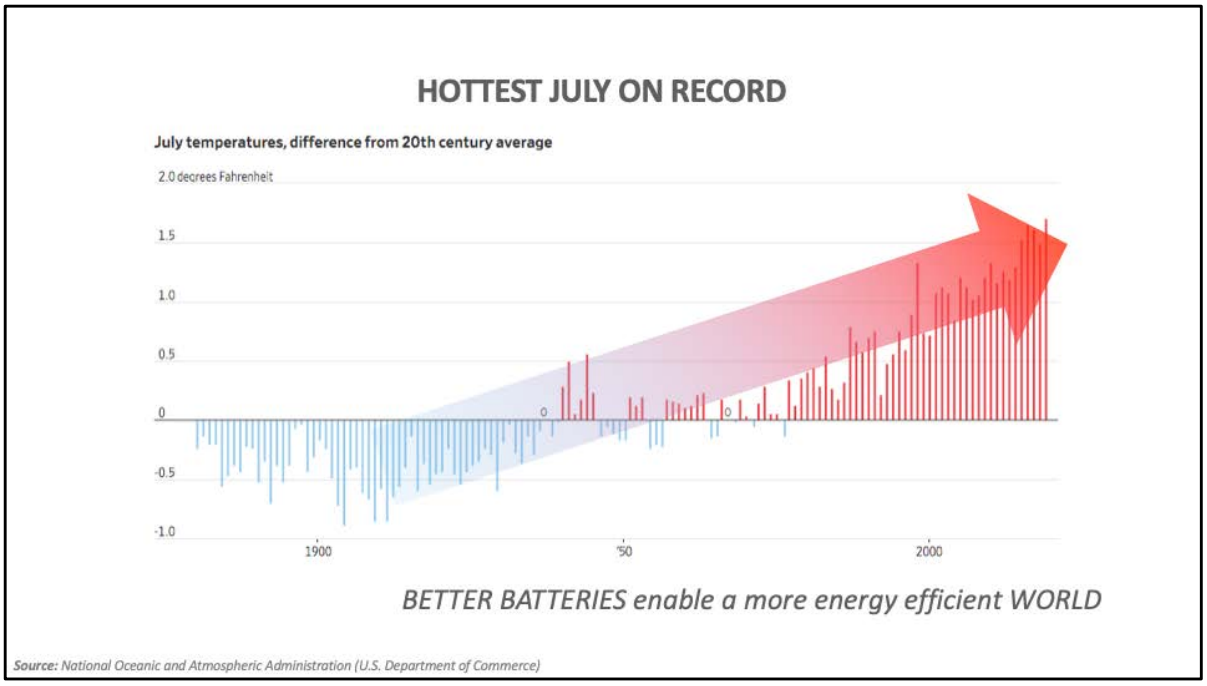
I will offer my key points upfront, then back it up with data and examples, and encourage you to take some aggressive action for the future of your companies.

(1) Our high industry growth, goes even higher,
(2) Lithium batteries will be over half of our industry by 2023,
(3) If we move together, advanced lead batteries can more than double, possibly triple their performance on key metrics driving great opportunities,
(4) Yet, unless we demonstrate real progress in the next two years, the shift to lithium could be much higher, hard to reverse, and painful for many of your companies.

This is why I believe the title “The RACE to SURVIVE and THRIVE” is appropriate today.
It is right that I have biases. My two biggest investments are in Lithium materials company, Albermarle, and Gridtential, the provider of Silicon Joule technology combining silicon wafers with lead active material in a bi-pole format. I expect both investments will do well in the best applications for growth in our industry, so I added to both investments last week.

The are many dynamic influences on the forecast. Economists are calibrating the impact of economic slowdowns in China and Europe along with trade conflicts. Politicians are changing regulations and incentives to address climate change, while still threatening bans for lead batteries, and challenging lithium solutions after some high profile fires at installations, and also landfills worldwide.

And leading engineers are striving to improve battery cost, performance, sustainability and safety. They are trying to meet the needs of the new generation of more electrified vehicles and also keep our power and communication networks operating reliably.



We know our planet is warming, as shown by the slope on this graph of average July temperatures over the last 120+ years. And if you question the data, just ask the people in Germany, California or the Amazon about the surge in fires in recent years.

People can debate causes, along with the best policies and actions, however, more and better batteries are making a significant contribution to the transition of our energy and transportation industries to reduce CO_2 emissions.

It is clear that EVs and Renewable generation are a big part of our future, yet I do not believe they are the panacea, at least across the next five to ten years. This is due to the nature of power networks across the world, and consumer acceptance due to many practical issues and costs.

I do believe there is huge potential quickly from greater efficiencies combining batteries with diverse renewable and other resources with better controls, new vehicles and diverse hybrid solutions across industries.

The forecast includes transportation batteries for EVs, Hybrids, eBuses, eBikes, and others, as I covered for the Battery Council Meeting earlier this year.

Before we discuss EVs, let me explain two recent examples of creative and efficient designs.

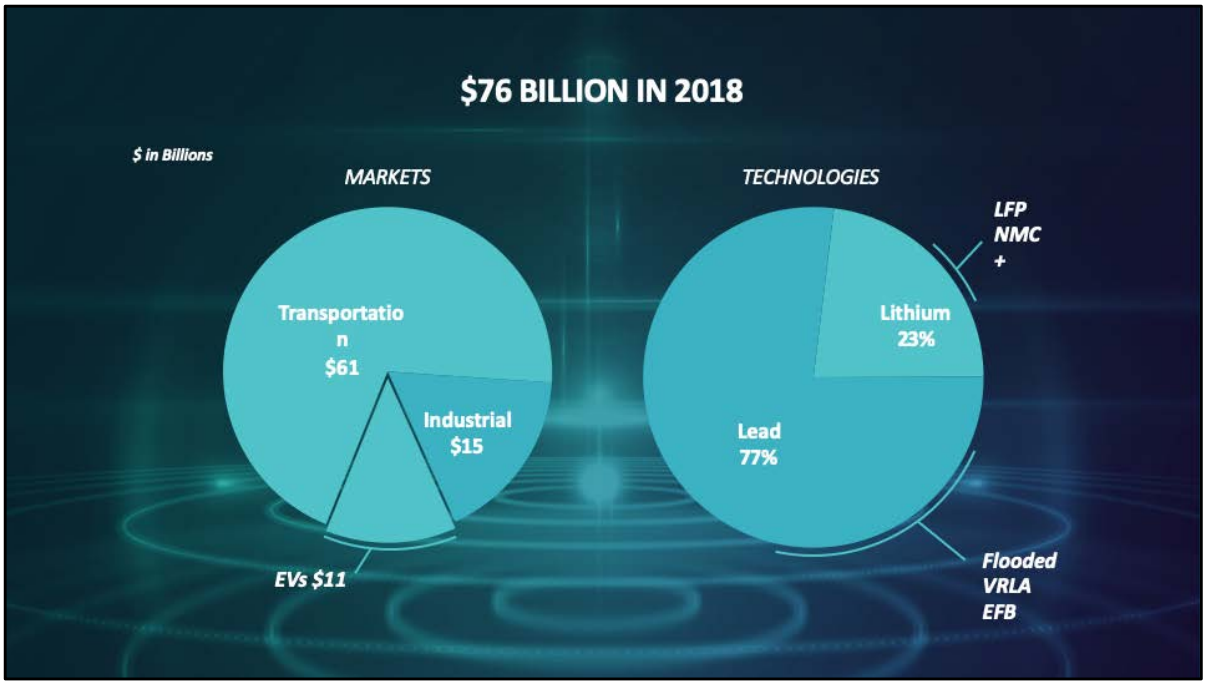
Think about the duty cycle of a typical ferry boat. It may have a short range of 30 kilometers traveling one hour, then unloads and loads for 30 minutes, and returning.

Sure it needs a big battery pack for the heavy load, yet high voltage fast charging fills it back up. A fixed route, quiet cruising, and no emissions from the boat. Brilliant.

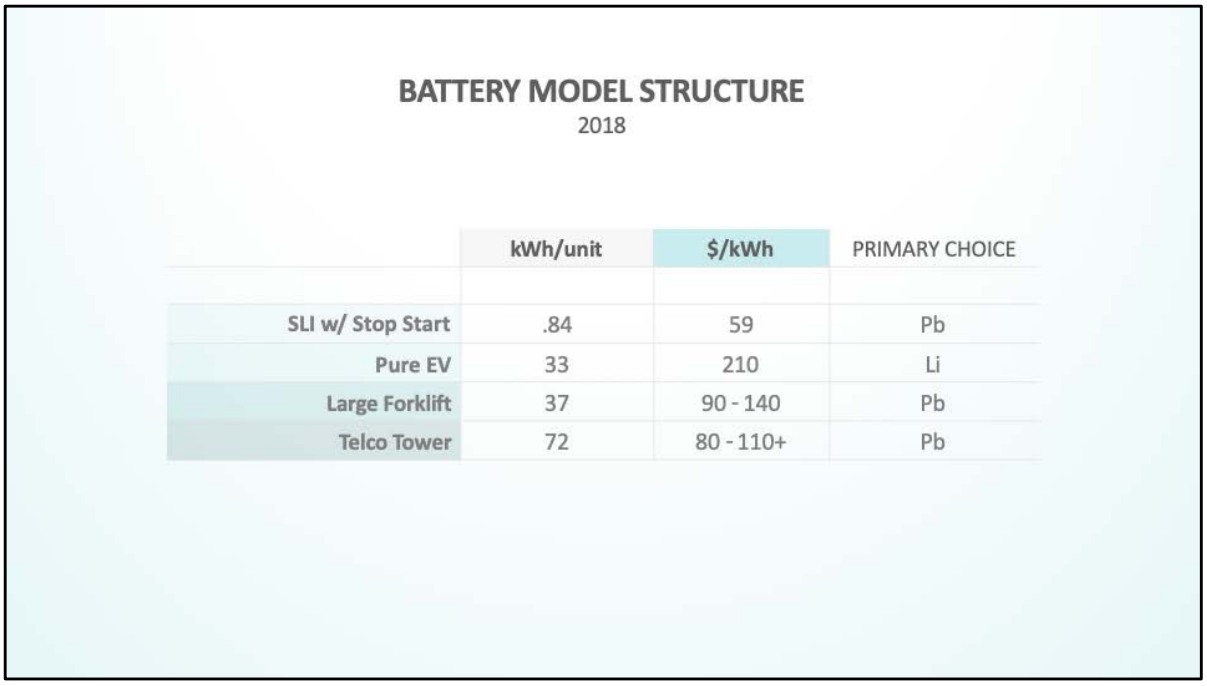
How about the largest known EV, the new mining truck shown from Switzerland. It claims NEVER needing plug-in recharging. It climbs to the mining area empty, loads, then comes down the hill very heavy, capturing the kinetic energy potential. Not a big market, but simple, and brilliant. Heavy equipment makers Caterpillar and Komatsu are not threatened by this solution, yet hopefully they are working on some hybrids, noting those huge diesel engines are idling a lot of the time on work sites.

Though diverse in applications and battery systems, I have also modeled the value and energy across the key Industrial battery markets, gauging the impact and prospects for especially lithium and lead battery technologies. We will cover Forklifts for Material Handling, Telecom and other Back-Up power batteries, and the advancing Renewables-linked Energy Storage markets.

The available industry data on these sectors is difficult to capture, yet thanks to the help of many contributors, we can give you a credible view to help your business plans.



Let me establish a baseline from 2018 for these markets. The estimate for the global sales value of batteries into the transportation and industrial battery markets for 2018 was $76 billion, with $61 billion in the transportation sector, as EV batteries surged to $11 billion covering 1.6 million pure EV vehicles. Though changing quickly, lead-based batteries still represented 77% of the dollar value of these markets.

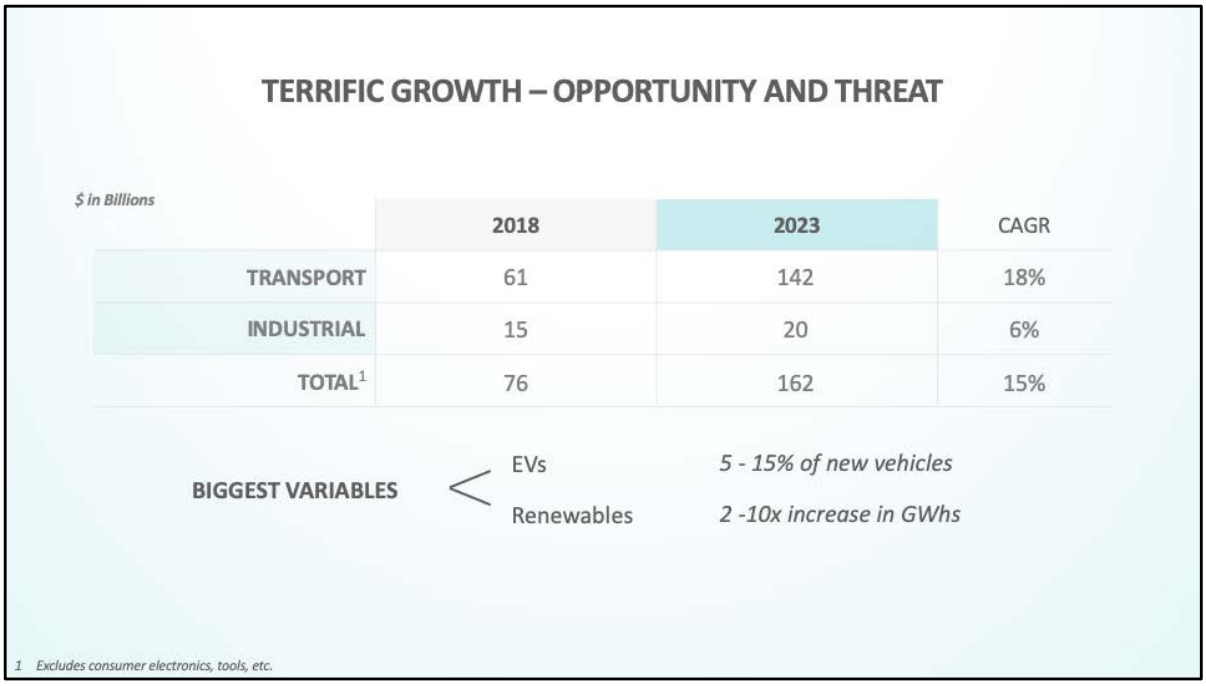


BATTERY MODEL STRUCTURE
2018

	kWh/unit	$/kWh	PRIMARY CHOICE
SLI w/ Stop Start	.84	59	Pb
Pure EV	33	210	Li
Large Forklift	37	90 - 140	Pb
Telco Tower	72	80 - 110+	Pb

Where do these numbers come from?

The model is built starting with the number of new and used vehicles or units of other applications using batteries, and we estimated the average size in kilowatt hours, and the global average manufacturer's selling price per kilowatt hour for the base year of 2018. We then use best judgment from myself and industry experts on changes in growth drivers, battery sizes, and cost trends to 2023.



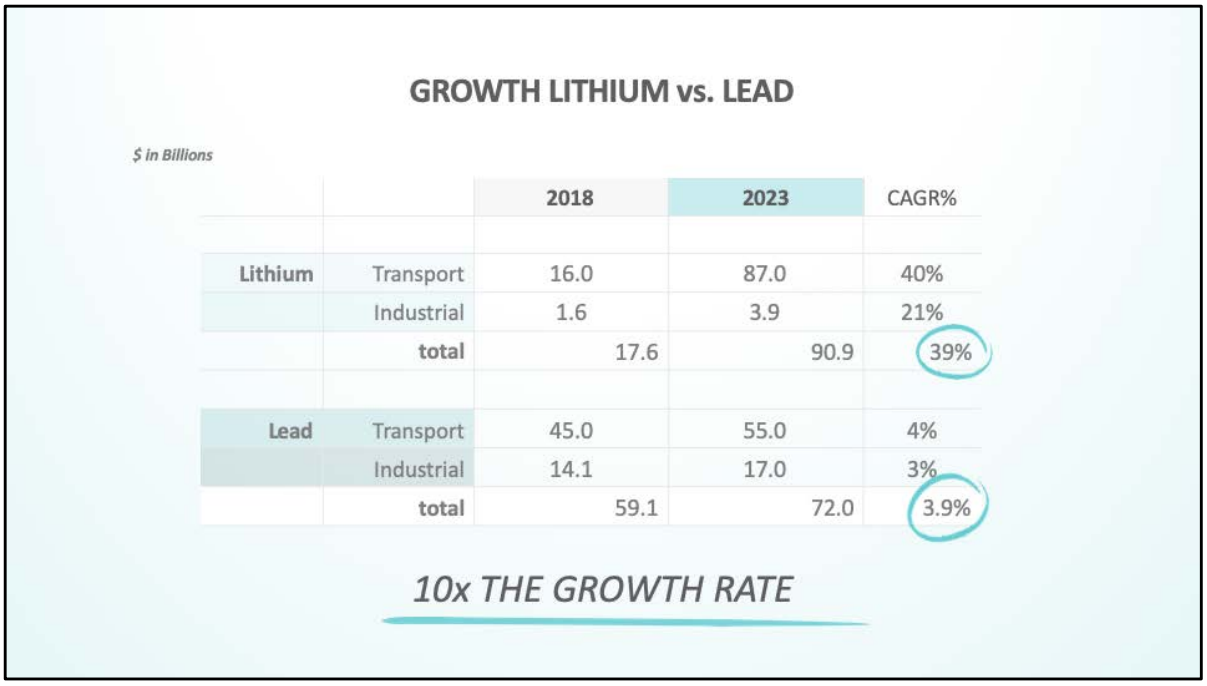
Before we get into the details and examples, let me summarize the results of the analysis.

The combined sectors grow at a 15% rate/yr to $162 Billion by 2023, with transportation growth at 18%/yr, and the Industrial sector growing at a still impressive 6% per year. Though almost all areas are growing, the most variability in sector forecasts are for pure EVs and the emerging Energy Storage applications across our electricity grids.

My forecast includes assumptions at the low end of the ranges for growth shown for EVs and Renewable-linked energy storage solutions, which I will cover later.

Yet I would also note this high growth rate could be easily scaled up to 20% per year if I took the more ambitious input of many on the growth for EVs, Renewable linked energy storage, and/or the higher penetration of lithium batteries many are forecasting.

By the way, I am not anti-EV. In fact I have a small EV boat with a fine German motor and an advanced lead battery pack from Crown Battery, and also a robotic electric lawn mower from the Swedish company Husqvarna, so in these suitable applications for me with the right batteries, we have moved to electric, and are reducing small engine emissions.



GROWTH LITHIUM vs. LEAD

$ in Billions

		2018	2023	CAGR%
Lithium	Transport	16.0	87.0	40%
	Industrial	1.6	3.9	21%
	total	17.6	90.9	39%
Lead	Transport	45.0	55.0	4%
	Industrial	14.1	17.0	3%
	total	59.1	72.0	3.9%

10x THE GROWTH RATE

Here is the model forecast split by sector and technology.

For transportation, Lithium battery growth is 40% per year to $87 Billion.

The market share of lithium batteries in Industrial markets was 10% in value in 2018, led by the Renewables-linked energy storage and Defense sectors, however the share is estimated to roughly double to 20% by 2023.

Overall, lead based batteries are forecast to grow at almost 4% per year, yet note the lithium battery growth is 10X the growth rate for lead batteries. This has many implications for R&D scale and capacity excess or shortages, which could change the lead battery forecasts

Going behind the forecasts, we can start with the Premium segment EVs. The new Porsche Taycan officially launches today worldwide with great performance, and a price average estimated at over $150k.

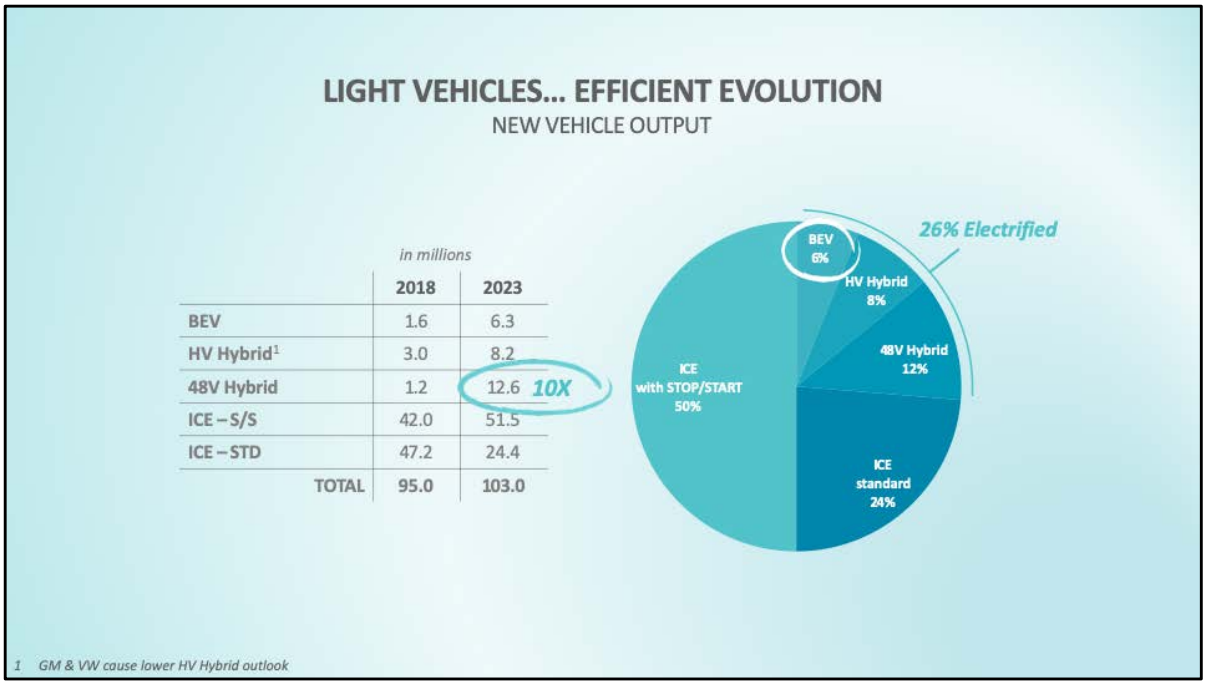
But Porsche's Taycan is only 40,000 vehicles worldwide added to low sales of Jaguar's Ipace and moderating sales of Teslas. Certainly Rivian, Audi and Ford also have some beautiful, high performance, and expensive EVs coming.

Though these products get the headlines, the model assumes continued niche modest sales of these premium pure EV products by 2023, and then possibly up to 2% of the 110 million new vehicles sold worldwide in 2030, and they likely will have the largest battery packs of about 100 kWh for extended range.

Most important to the EV vehicle forecasts, I believe, will be the progress of a whole generation of low, and very low cost EVs, which will vary widely in features by region.

China has their Kandi coming positioned above the Low Speed EVs, Fiat plans its 500e, and India's ubiquitous eRickshaws, shows the diverse range of low cost EVs.

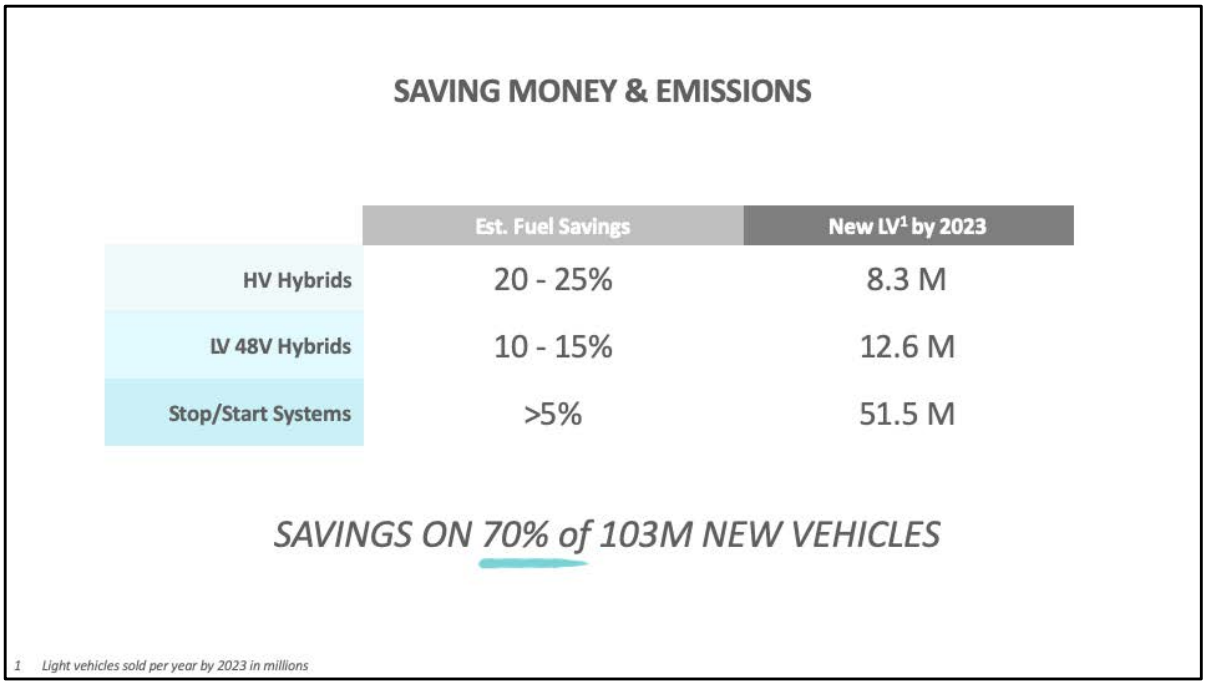
These markets likely will be led from Asia, particularly China and India, aided by incentives and policies, rather than from Detroit or Germany, although VW has some ambitious plans from Zwickau, Germany for their new electric ID.3. The small vehicles will have smaller battery packs suited to their urban range demands.



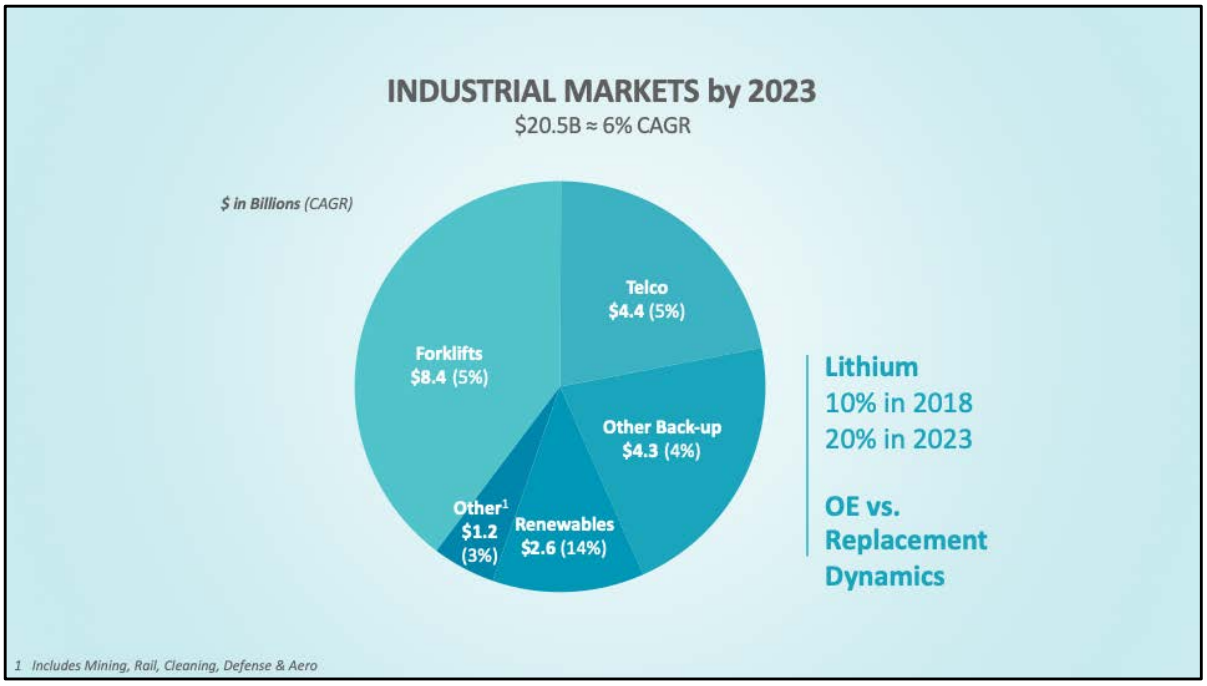
In summary, the forecast assumes 6.3m BEVs, or full battery electric vehicles by 2023, which represents about 6% of the forecast new vehicle sales.

High voltage hybrids, with or without a plug-in option is forecast at a higher 8% of new vehicles, yet recent announcements of VW and GM suggest that Ford, Fiat-Chrysler, plus the Japanese and South Korean producers will lead in this segment.

One of the most important emerging auto technologies for many battery companies is the 48V system to support more electrical demands, while aiding acceleration, fuel economy and emissions. These include 1/2 to 3 kWh high performing batteries which can be either lithium or new bi-polar lead designs.

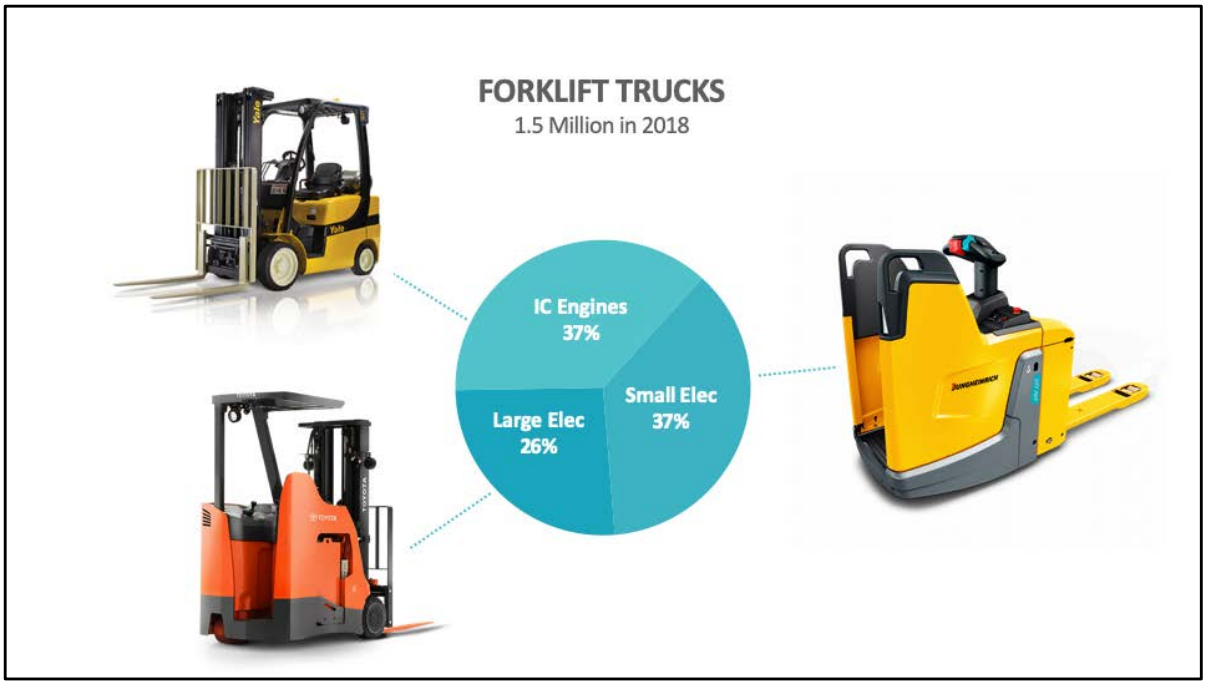


Looking past the headlines covering EVs, it is important to stress that by 2023, about 70% of the 103 million new vehicles are forecast to include impressive fuel and emission improvements aided by better lead and lithium batteries. We must recognize this progress, and push for more efficiency and emission reduction.



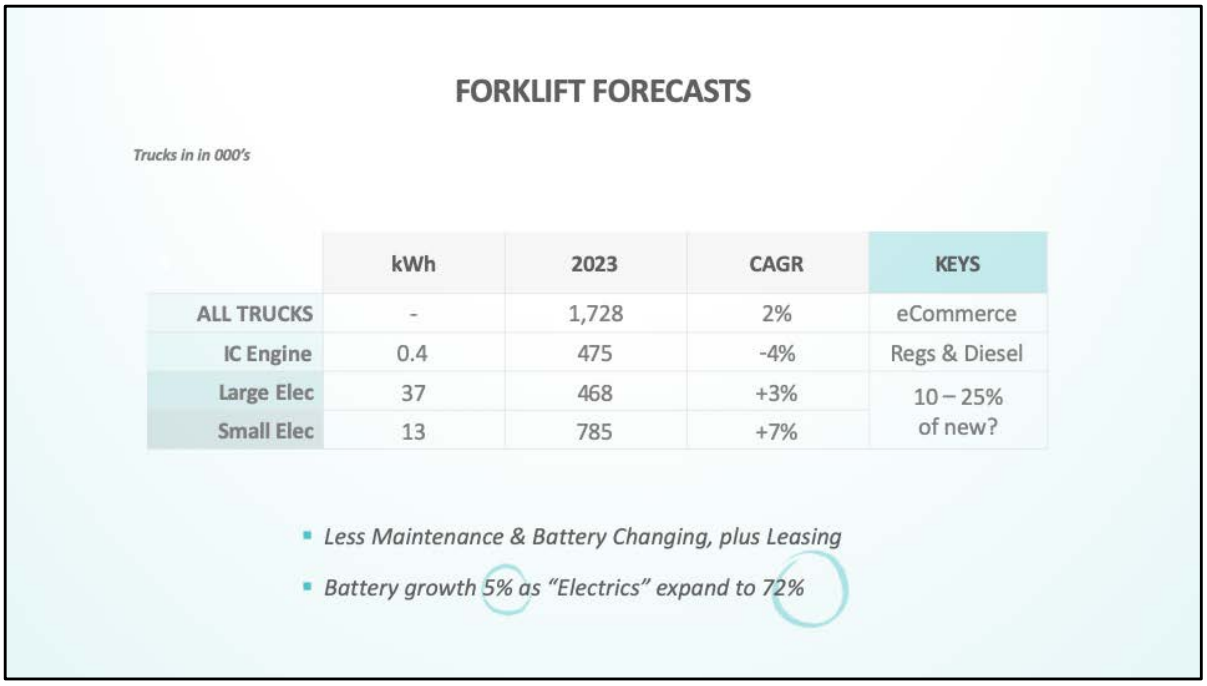
Turning to the Industrial side, there is a notable slowdown in battery demand through July this year in material handling and across some of the telecom/communication sectors.

Yet the five year forecast averages growth of 6% to over $20 Billion for Industrial batteries to 2023. This growth is being led by the higher use of batteries across the electricity generation networks, often with solar. Let's take a look at the demand drivers by sector.



Global sales of forklift trucks reached 1.5 million in 2018 across the three main categories of IC engine trucks, large electric stacking or counterbalance trucks and the smaller powered pallet trucks used in diverse applications.

The last five years to 2018 have been great for global forklift truck makers as Amazon, Alibaba and others built lots of new warehouses to deliver on-line orders quickly.



FORKLIFT FORECASTS

Trucks in in 000's

	kWh	2023	CAGR	KEYS
ALL TRUCKS	-	1,728	2%	eCommerce
IC Engine	0.4	475	-4%	Regs & Diesel
Large Elec	37	468	+3%	10 – 25% of new?
Small Elec	13	785	+7%	

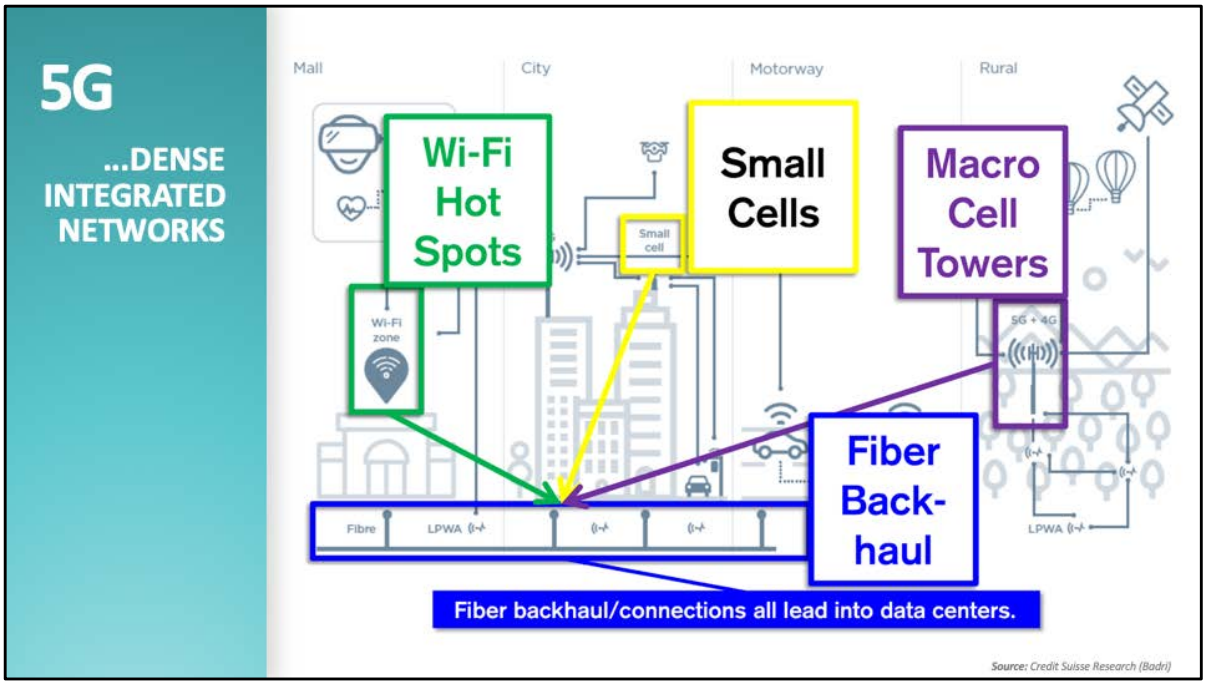
- *Less Maintenance & Battery Changing, plus Leasing*
- *Battery growth 5% as "Electrics" expand to 72%*

After a notable decline in new truck shipments in 2019, growth is forecast to return yielding an average of 2% new truck shipments from 2018 to 2023. However, new regulations, resistance to diesel trucks, and maintenance-reduced electric trucks with lithium and sealed lead batteries, are further increasing the overall share of electric trucks in every major market.

The shift to more electric trucks, along with the large replacement market from strong earlier sales, leads to a forecast 5% growth rate for batteries. This value could be even higher, as some industry leaders especially from Europe and China believe lithium batteries could reach up to 25% of new trucks or more by 2023, as compared with the 10% global estimate I have included in this my forecasts.

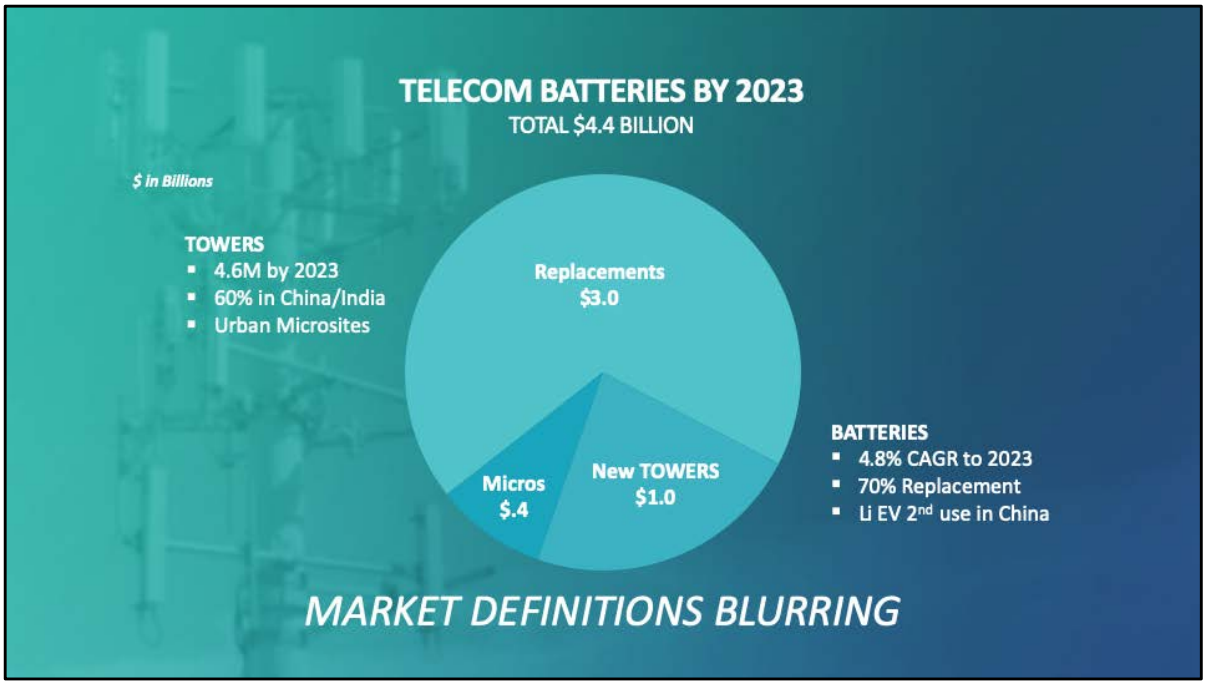
One risk to emphasize here is that some truck makers are redesigning their trucks to take advantage of smaller and lighter batteries, and going back to lead batteries could prove more difficult, regardless the progress in performance of lead batteries or issues with lithium.
So again, timing of innovation is critical.

As we have seen in the golf cart market, equipment producers have been creative offering more than maintenance and energy savings, including no battery changing and innovative lease terms to offset the much higher initial lithium battery costs.



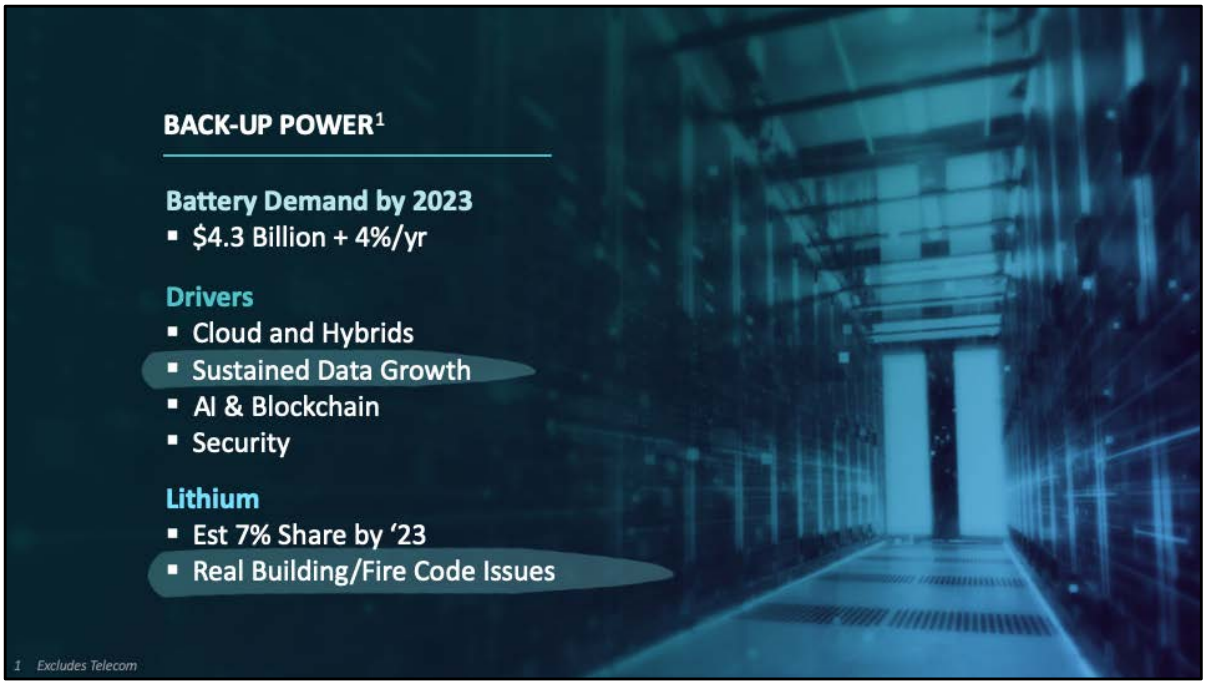
5G networks and applications dominate the discussion across the Telecom markets. Yet, capital spending for network upgrades including batteries for 5G has been mixed so far. This is partially due to possible mergers like Sprint and T-Mobile, plus content acquisitions by AT&T and others, and simply the availability of phones and applications matched to the new networks.

This schematic by Credit Suisse's analyst helps paint the picture of the broad integration of networks to handle a tremendous increase in amount and speed of data enabled by 5G. This includes many industrial applications, autonomous driving, and yes, faster video downloads.

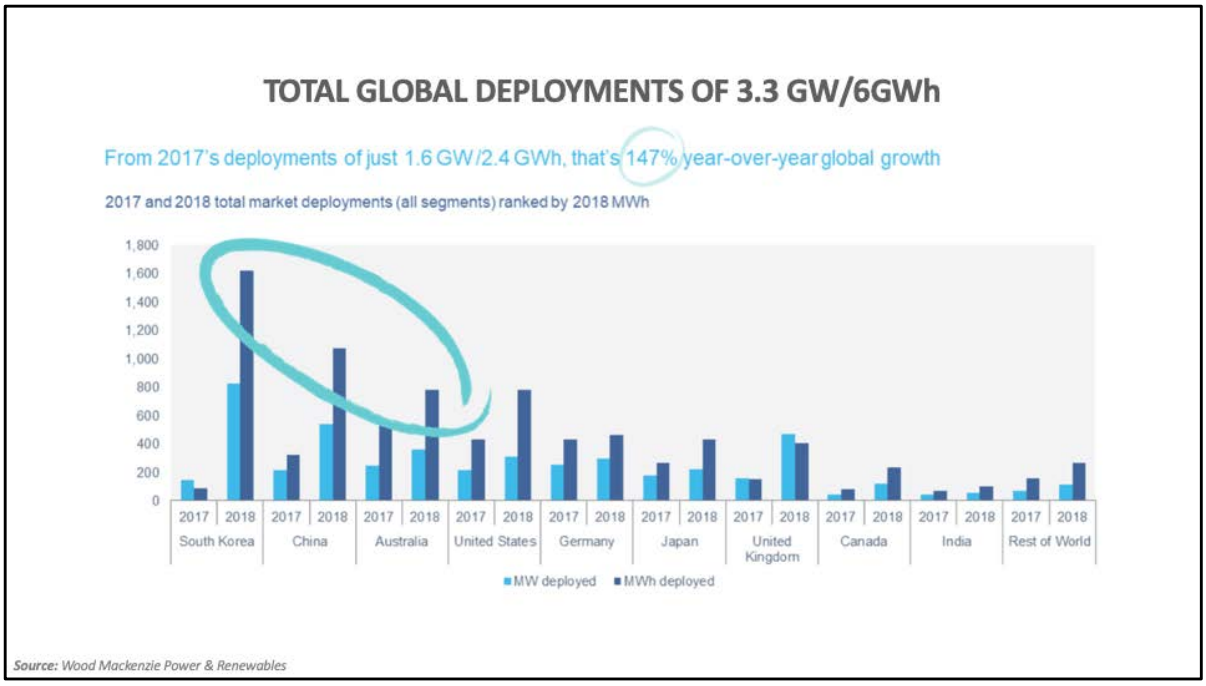


The major use of batteries for telecom providers today are at the 4 million radio base station towers worldwide. The number of towers will continue to grow at an estimated 3% per year. For 5G deployment, there will be millions of micro transmission sites across cities and in large buildings linked to the towers and fiber networks to reduce latency and improve data transfer speeds.

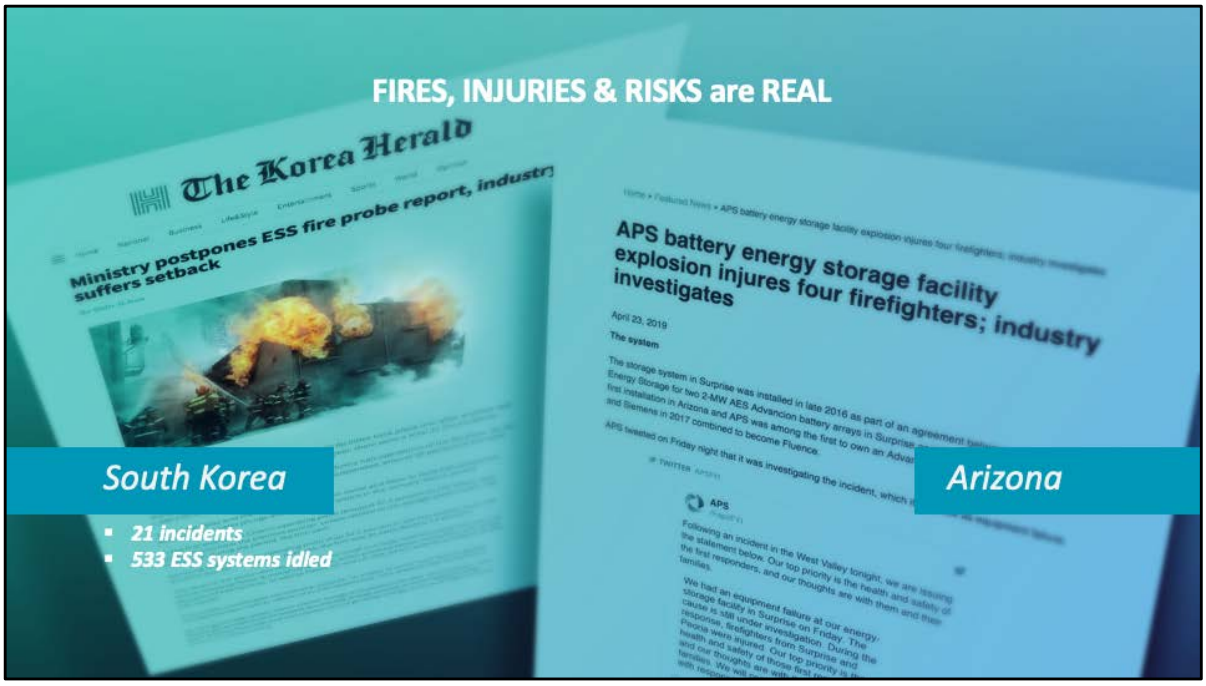
Many of these will have small 48V backup batteries which are likely to be lithium, although improving lead batteries also have a chance with lighter, efficient 48V block designs. The most significant battery sales by value within the $4.4 billion forecast will be the replacement of the large capacity 48V maintenance-free lead-based batteries at tower sites. China's new regulation promoting the 2nd use of EV lithium batteries into telecom sites has begun with a pilot program.



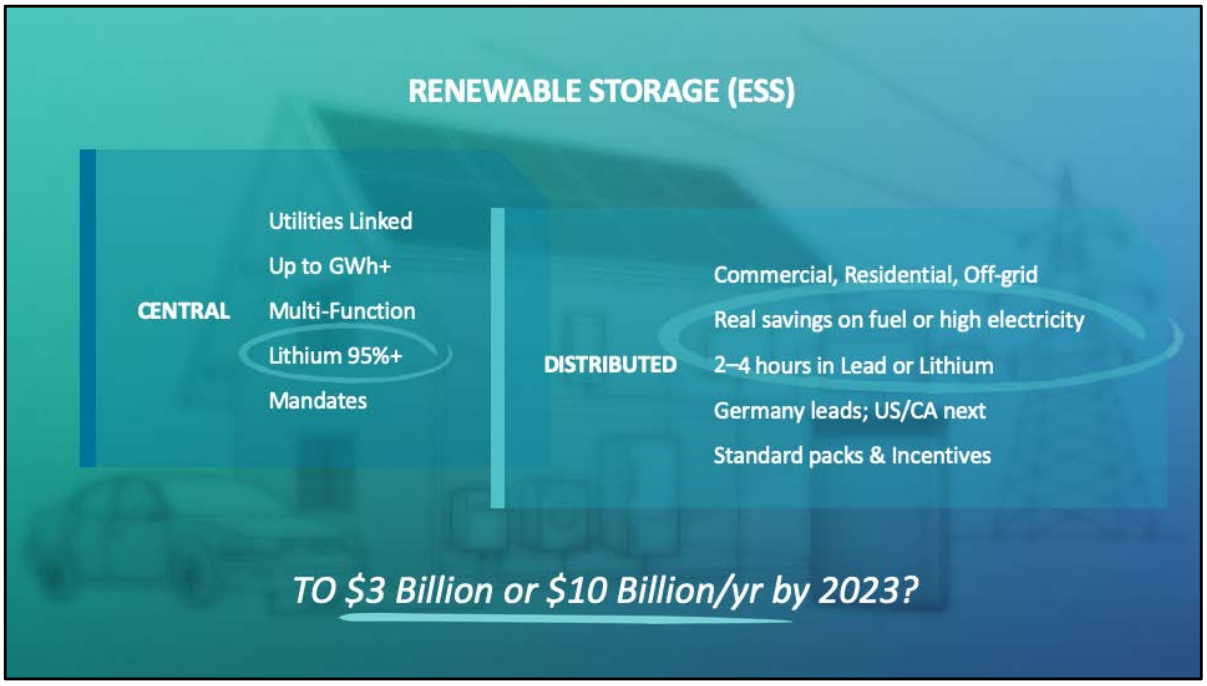
Demand for back-up power batteries other than telecom are forecast to grow at 4% per year to $4.3 Billion by 2023 as the cloud and hybrid cloud computing continues to expand worldwide to handle the sustained high growth in data collection, transmission and analysis. AI (automated intelligence), along with power-hungry blockchain technology and many security applications including cameras across our cities and businesses are sure to require secure power including batteries for any kind of interruption.



Until 2018, the new battery uses across our electricity grids or off-grid were principally in high visibility pilot projects or on islands and places where electricity was very expensive or not available or reliable from a central source. However, led by Asian and Australian projects this sector more than doubled in 2018 reaching a total global deployment of about 6 GWh as estimated by WoodMacKenzie's analysts.



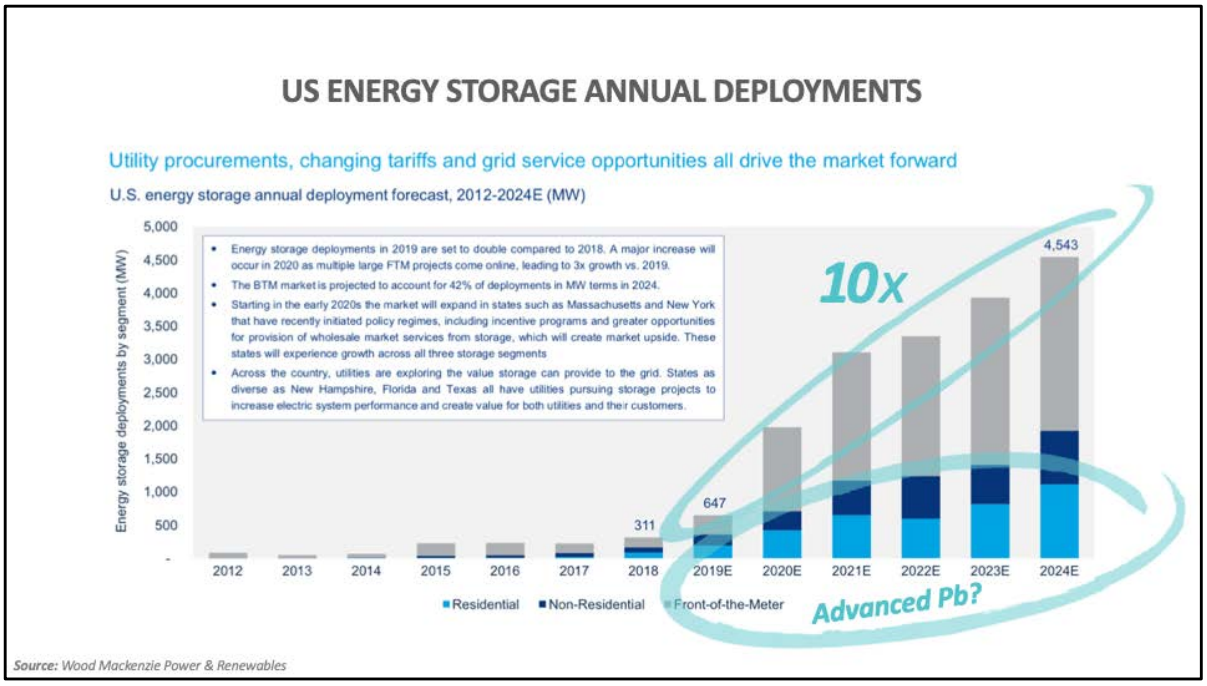
However, there were some big issues, including the 23 fires in S. Korea which idled 533 new sites, and a large fire with injuries in Arizona. These events certainly have been studied closely, and will lead to some changes, yet the growth of these applications will continue due to diverse pressures on utilities for stable power delivery, even while integrating ever larger amounts of intermittent solar and wind generation.



It is helpful if we split this sector of battery uses into the LARGE central, utility linked deployments which are described as “Before the Meter”, and a wide range of Distributed applications for Commercial, Industrial and Residential use.
The utility deployments can be very large, and are over 95% lithium today.

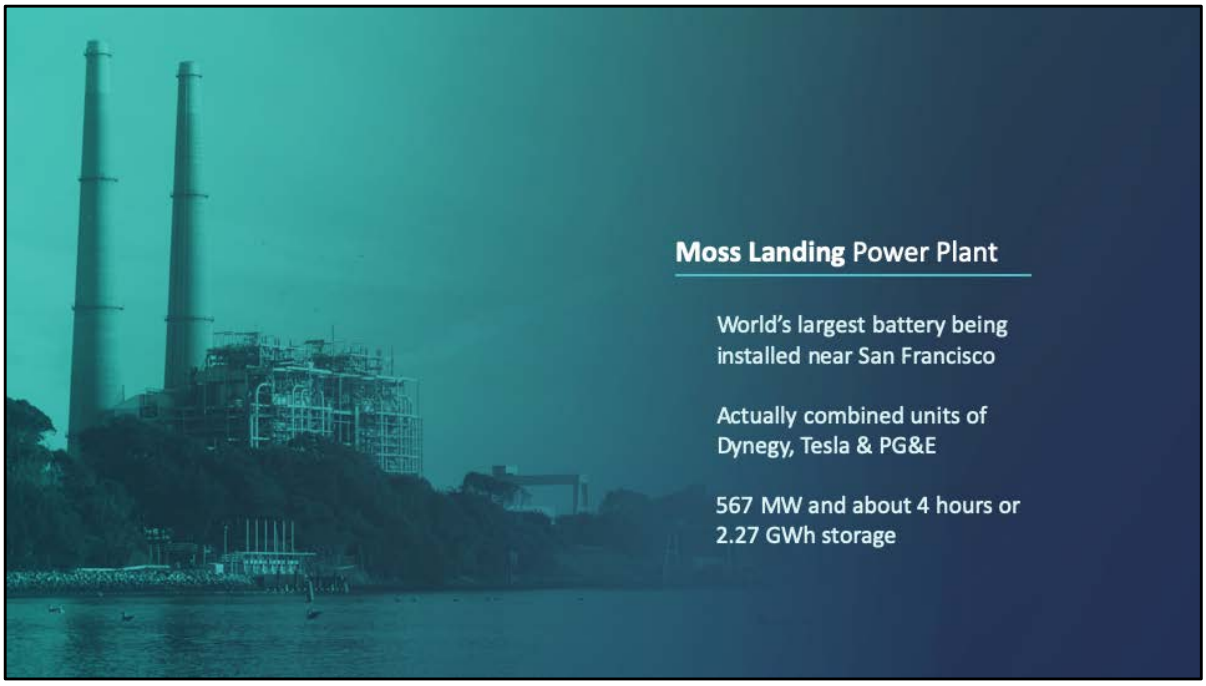
The distributed applications are typically 2-4 hours of storage and will be a mix of lithium and advanced lead solutions.

Germany has led the industry so far in deployment of the distributed systems combining batteries with solar generation. This is due to both supporting policies, and simply the better payback with their very high electricity costs of over 30 Euro cents per kWh.



WoodMackenzie has forecast significant growth of energy storage through 2023 led by China and the US. They forecast US battery use expanding 10X to over 4 GWhs by 2023 led by large utility linked systems.

The growth of the distributed systems, colored in light and dark blue in the graph represent the modest scale systems (typically 5 to 500 kWhs) across diverse commercial applications and residences. These systems represent a unique chance for high growth by advanced lead battery providers. California regulations and new pricing policies which can have some electricity costs at over $.40 per kWh will also likely spur many installations.



The best example for high US growth in the integration of batteries is the Moss Landing project now beginning near San Francisco. It will be the largest battery installation in the world, featuring a combined 567 MW of power for about 4 hours from 2.3 GWh of batteries.

Following are three company examples of the distributed, modest scale, energy storage systems, typically linked with solar generation.

First, is an Ecoult system from East Penn supporting an oil company reduce its remote use of diesel fuel with their advanced lead, Ultra batteries.

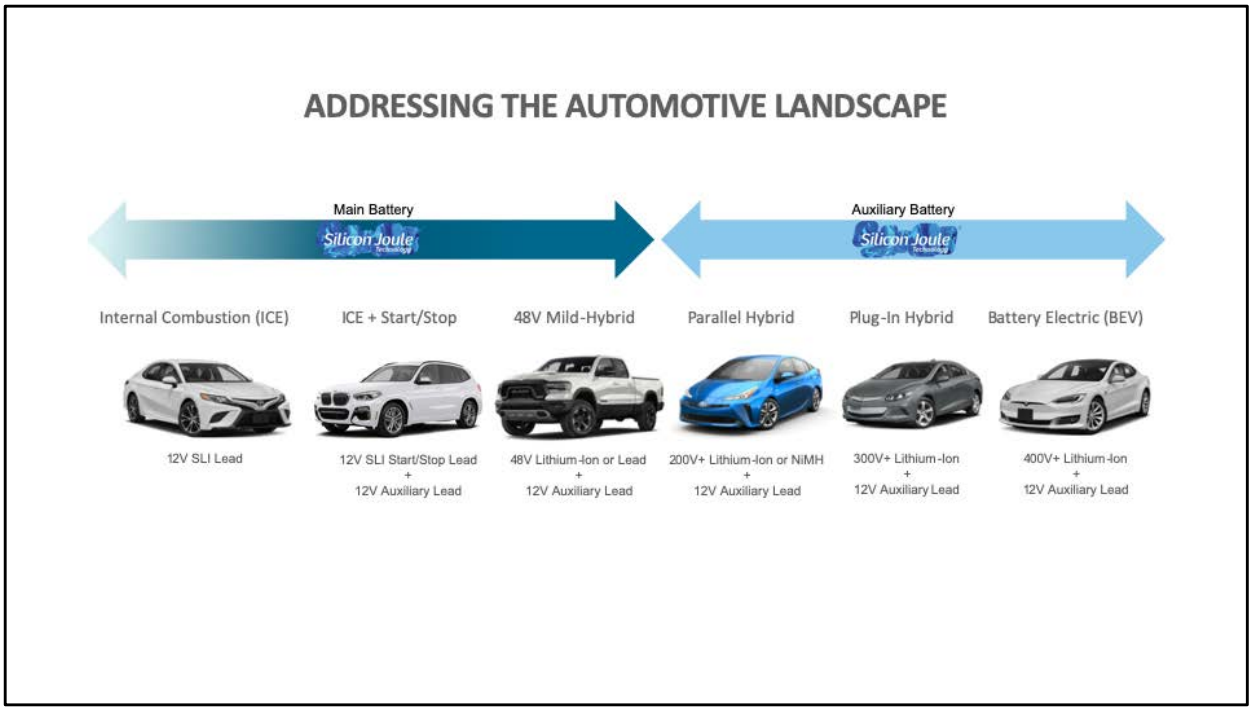
Hoppecke **Packaged Power**

Next is a lithium packaged power solution from Hoppecke which can be matched to multiple applications.

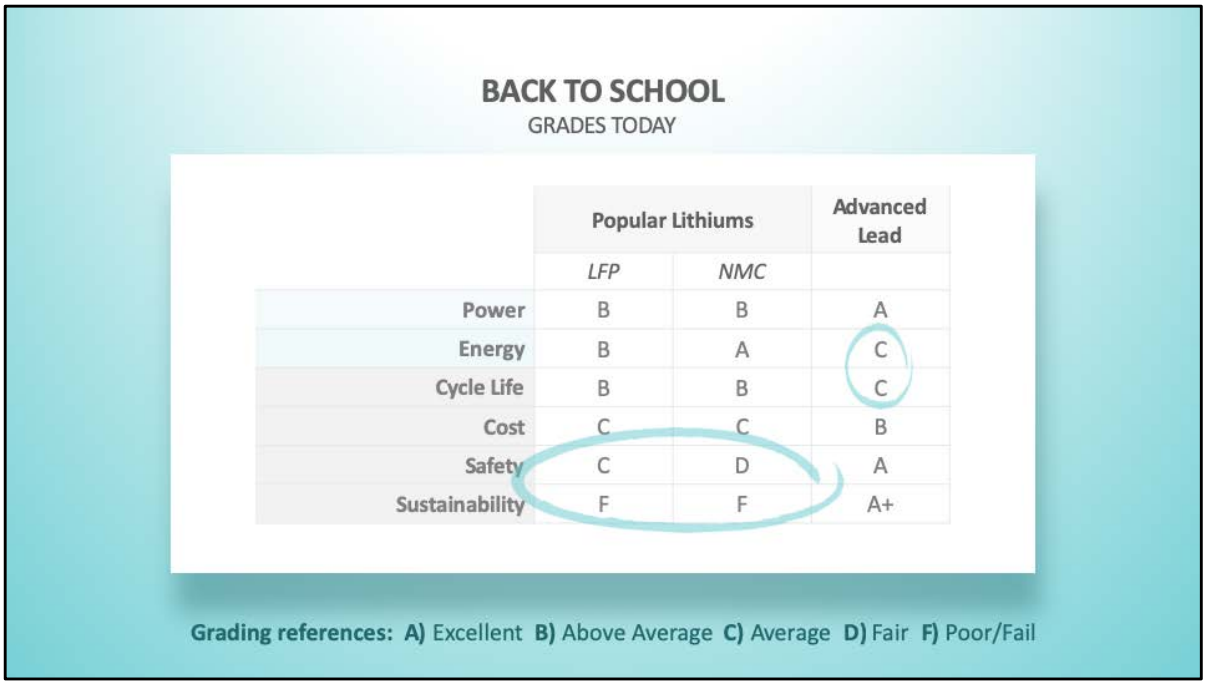
And lastly, an application, complemented with a nice human interest story, is a cost-effective advanced lead solution matched with solar generation. It is helping older Native American Indians receive electricity and clean water in their remote, off-grid environment.

Though I have touched on these areas already, here is a summary of the segments and applications I believe represent great opportunities for those companies with the really advanced lead batteries.

Another way to look the opportunities, is that I believe advanced lead can compete in almost all the transport and industrial markets except for the extended range pure EVs and the long duration utility linked Energy Storage apps of 5 MWh to GWh scale. In those applications, the energy density at scale of lithium solutions that proves decisive. Yet, that leaves a lot of opportunity.



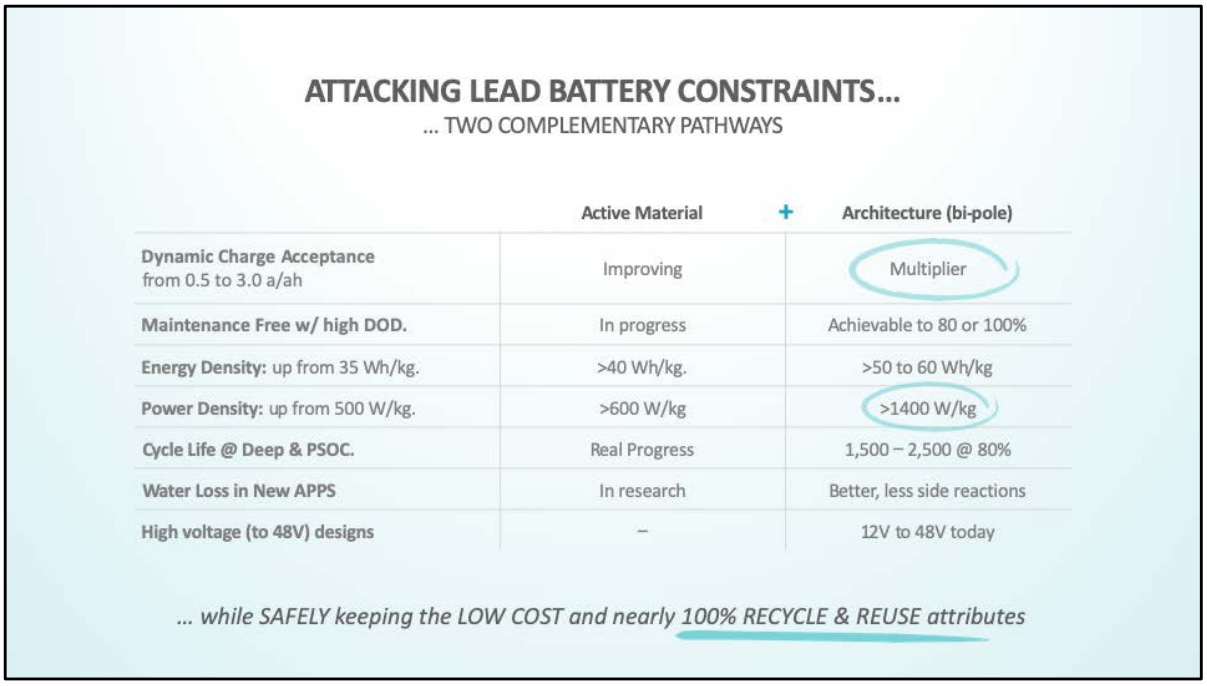
A more detailed view of the opportunities across the auto industry is depicted in this slide which we use at Gridtential to explain where we believe advanced lead batteries with a silicon bi-pole can compete, ranging from stop/start, to 48V systems, to the auxiliary battery in EVs and high voltage hybrids.



At the extremes today, some believe either lithium's risks on safety and sustainability will severely limit their potential as more events occur with predictable regulation and lawsuits to follow. Others believe the future of lead batteries is poor. And this impacts many forecasts and business plans.

With so many millions of children going back to school around the world this week, let me offer a simple school grading summary for battery systems from A being excellent, to F being poor, as described on the slide.

In short, at a high level, lithium types still rate low on safety and very low on sustainability, and advanced lead rates low on energy density, DCA and cycle life.



ATTACKING LEAD BATTERY CONSTRAINTS…

… TWO COMPLEMENTARY PATHWAYS

	Active Material	+	Architecture (bi-pole)
Dynamic Charge Acceptance from 0.5 to 3.0 a/ah	Improving		Multiplier
Maintenance Free w/ high DOD.	In progress		Achievable to 80 or 100%
Energy Density: up from 35 Wh/kg.	>40 Wh/kg.		>50 to 60 Wh/kg
Power Density: up from 500 W/kg.	>600 W/kg		>1400 W/kg
Cycle Life @ Deep & PSOC.	Real Progress		1,500 – 2,500 @ 80%
Water Loss in New APPS	In research		Better, less side reactions
High voltage (to 48V) designs	–		12V to 48V today

… while SAFELY keeping the LOW COST and nearly 100% RECYCLE & REUSE attributes

To address the lower grades noted for lead batteries these are the key areas for improvement the best companies are working hard to address individually, and or through initiatives like the CBI (Consortium for Battery Innovation) and the CRADA in the US with our Argonne National lab, and surely in the Science Institutes in China.

My added perspective is that the combined potential of the many initiatives to improve the active material performance is multiplied by especially the game changing power density (>1400W/kg) and higher voltage (to lighter 48V blocks) enabled by bi-pole batteries.

And of course we must sustain our low cost position, and our unique sustainability story of not just 100% recycle, but nearly 100% reuse....infinitely, as the world's very best example for any material in the circular economy. Sure, there are legacy problems with lead in other applications, yet in batteries our story is truly unique and positive for our planet.

If you want to survive and thrive in the advanced lead battery business, I heartily suggest you accelerate your focus and investments in the sweetest spots you see for improvement, and do it now, not in 3 or 4 years.

I also want to thank these companies for helping me in data collection and perspective in analyzing the products, markets and technologies.