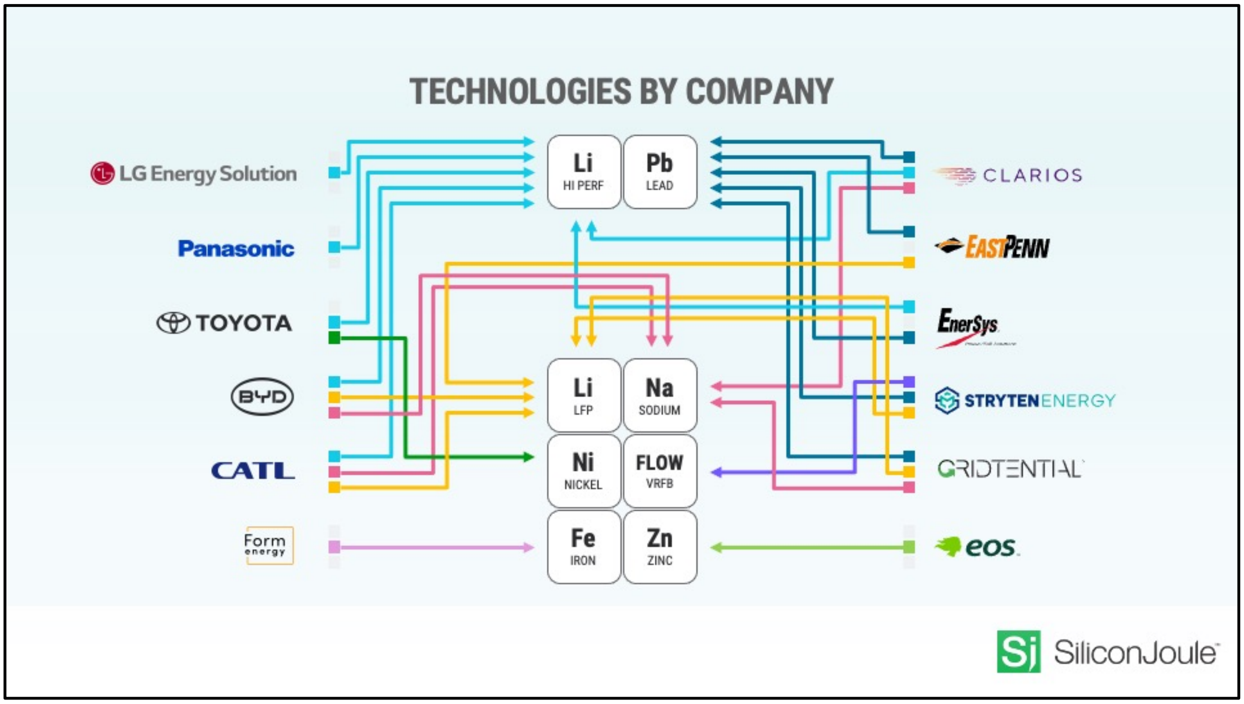
Thank you. I am happy this morning to share a review of innovations across seven electro-chemistries, of course including lithium and lead-based batteries, yet also other solutions contending for slice of the ever-larger global battery market.

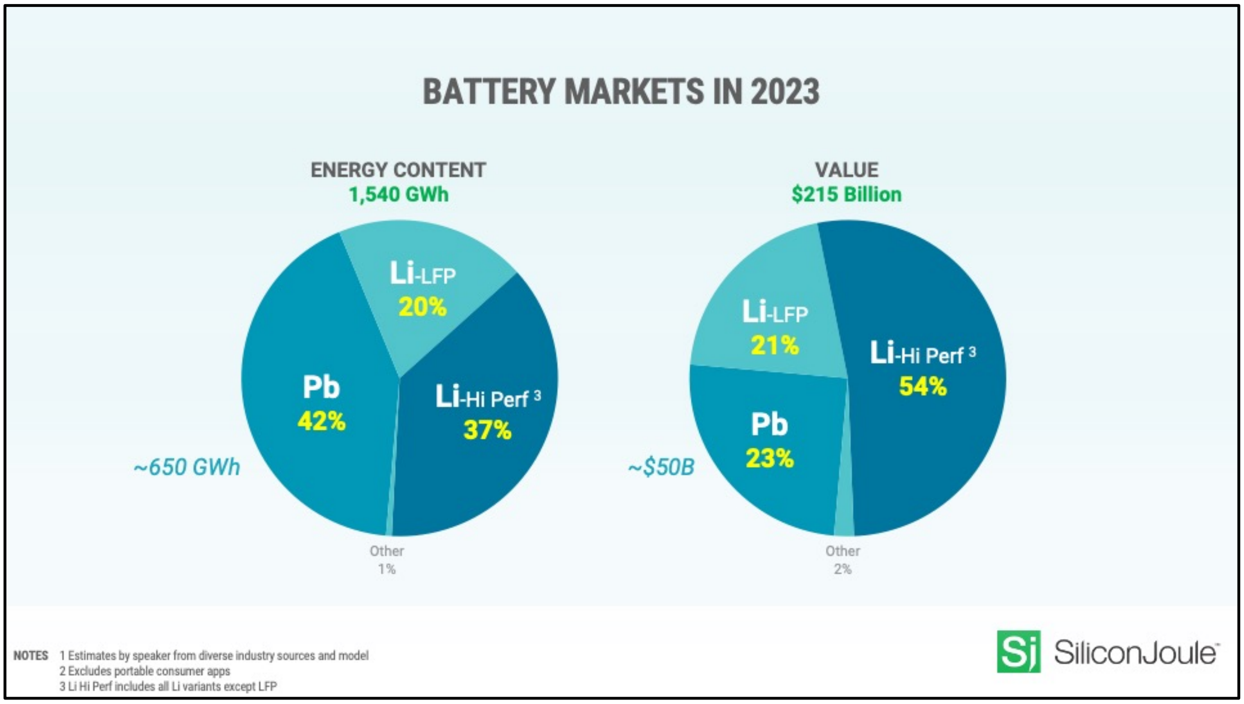
We all see claims and breakthroughs announced weekly worldwide for batteries from companies, universities and institutes, yet vetting them, and estimating which ones will actually achieve the claims and make it to commercialization at scale profitably is a tough assignment for battery leaders, engineers and investors.

The are many possibilities for breakthroughs from the 10s of thousands of scientists, engineers and students working to deliver better and lower cost batteries for the Clean Energy transition, yet I will offer a high-level assessment of each chemistry and forecast of the battery chemistry mix through to 2030.



First, let’s look at where many of the leading battery companies are engaged today by chemistry, whether in commercial sales or development. For this review, I have split the lithium technologies for analysis into the iron phosphate (or LFP) space, and then an ‘all other’ of High-Performance lithium batteries.

As you can see on the left, the world’s leading lithium companies including CATL and BYD already are engaged in multiple chemistry platforms, and the leading lead-based companies are engaged in one or two added energy storage chemistries. And others such as Toyota, LG Energy, and Panasonic or start- ups like Form Energy with Iron, and EOS with zinc, and Gridtential with its diverse chemistry bi-pole platform complete this picture.



Before reviewing what innovations may make it to market at scale across the next six+ years, it helps to reference where the market is today. Shown are estimates of the market in 2023 in both energy content and value. Excluding small consumer applications, the market in 2023 was estimated at over 1,500 Giga-Watt hours of output per year which represented about $215 Billion in sales.

The combined lithium share was about 57% of the total energy content with LFP now approaching one- third of total lithium output. Lead's share at the energy content level was still 42% of total output, yet owing to its lower cost is estimated to have been about 23% or $50 Billion of the $215 Billion in 2023.

And all others; nickel, zinc, flow, iron and sodium represented about 2% of the value in output.

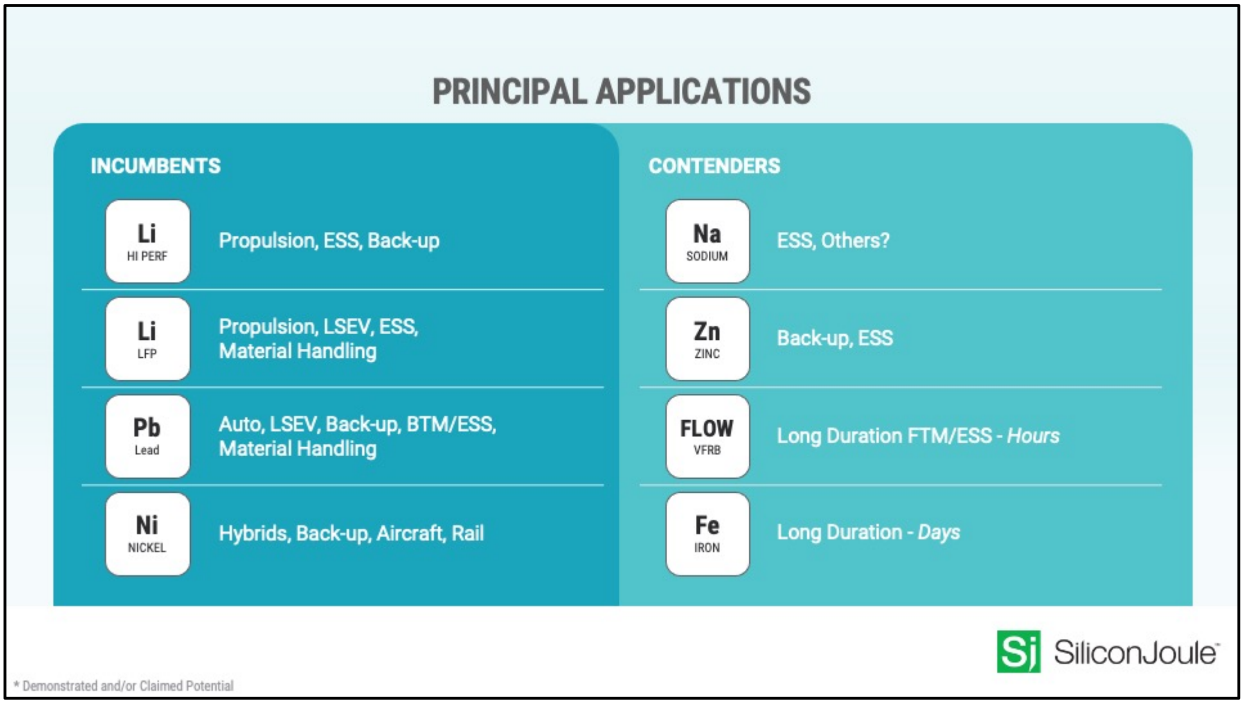
I ask each of you in the audience as we go through this presentation to make your own estimate of what you believe the lead-based market share in value will be in 2030.

My outlook will include a base case reflecting current trends and also an OPPORTUNITY case where lead-based solutions could double the share from $50 Billion to $100 Billion. Some may support or disagree with the outlook, but I will offer my best insights on the other chemistries and lead-based batteries to help you make the best decisions on where to invest for the future of your company.

Some might ask if the very high battery growth is still likely given the adjustments the EV markets are currently going through. Yet as an advisor at Roland Berger put it “the train has left the station for electrification”, implying the electrification mega-trend for transportation and batteries continues. Also, the re-emergence of hybrid focus by many vehicle makers offers a high value opportunity for some battery chemistries with properties and costs matching the diverse hybrid vehicle duty cycles.

Additionally, the combination of the dramatic growth in renewable generation with at least a doubling of the forecast electricity demand growth rates in many economies will surely underpin energy storage growth at utilities and also in distributed storage, behind the meter applications.

Commercial, Industrial and Residential applications, along with EV charge buffering are now also likely to exceed earlier forecasts. Simply put, the electrical grid, including the transmission networks, are not evolving fast enough in most developed economies to support the ambitious targets for electrification of transportation, industry and homes.



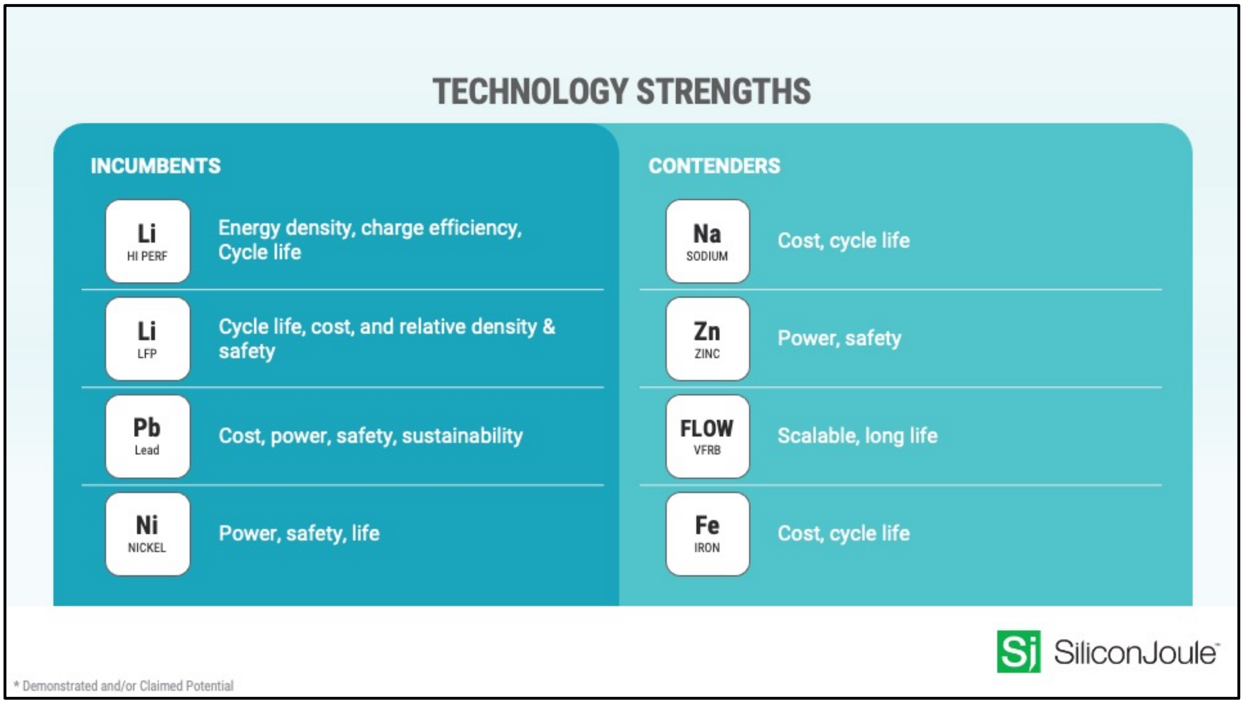
Now let's show how the leading applications match up with both the INCUMBENT battery technologies and what I have termed the CONTENDERS for a share of our growing markets.

The incumbent technologies of Lithium, Lead and to a smaller degree Nickel based solutions dominate today's sales, and the contenders as shown, represented about 2% of the 2023 market.

In assessing the prospects for contending technologies, it surely helps to understand the application focus.

For ESS applications the different primary application for Flow batteries being HOURS vs. DAYS of storage for Iron systems illustrates well the distinct focus of certain companies and technologies.

And many users are now trying to assess the prospect application fit, timing and cost of sodium-based batteries.

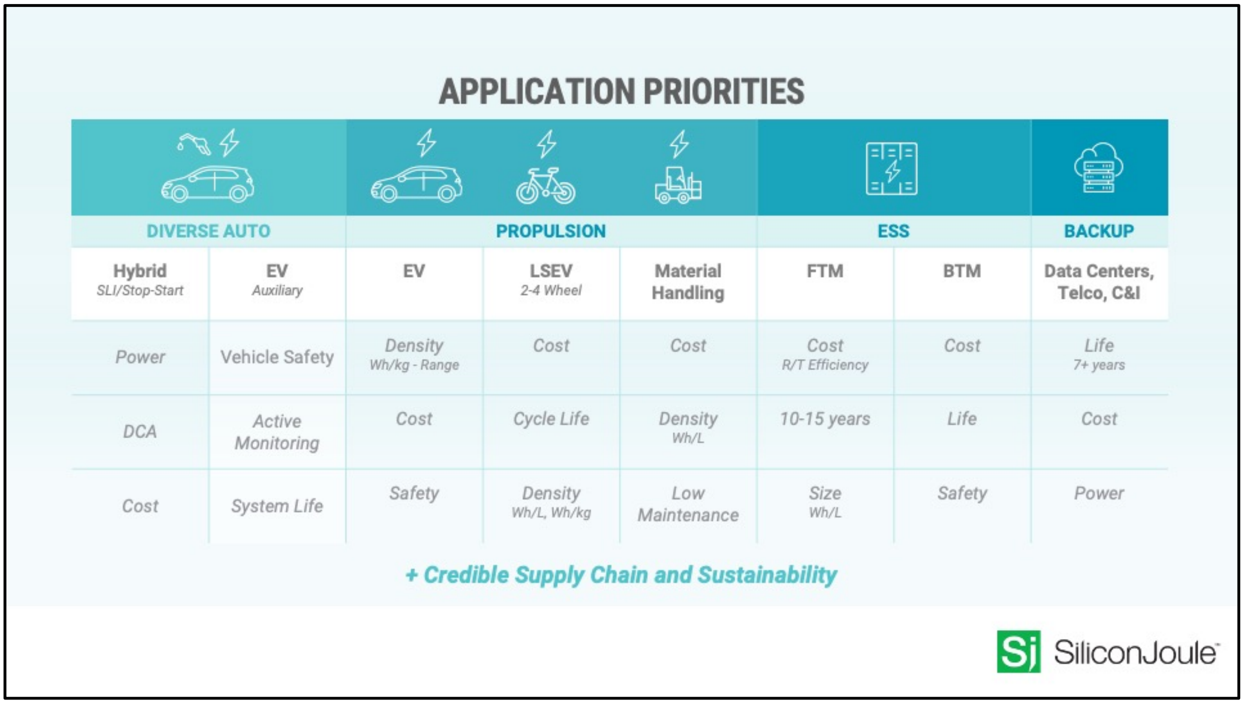


To help us assess the prospects for successful innovation, let's highlight what most would agree are the strengths of each battery chemistry. Some of the claimed strengths have yet to be validated outside of the labs or pilot apps, yet we will cover some innovations in the chemistries which could dramatically shift the potential for growth, or represent a significant substitution threat for other battery designs.

These STRENGTHS have to be evaluated on a relative basis to the alternate chemistries. As an example, LFP is recognized to have lower energy density than other lithium types, yet their relative cycle life, safety and costs vs. higher density lithium solutions is appealing in many apps.

In assessing the prospects both for incumbent and contending solutions in our high growth markets, I would CHALLENGE the often-used phrase that a rising tide will lift all boats. There is so much investment chasing the very high growth, both for innovation and capacity, that I believe attaining and sustaining SCALE PROFITABLY in the battery business is becoming more Darwinian than ever.

Some will prove their challenging technology will work even in large demonstrations, yet possibly not match the important total cost metrics in time, compared to the continued improvements of the incumbent technologies.



Here we take a deeper look profiling the ranked application priorities across a split of 8+ market segments.

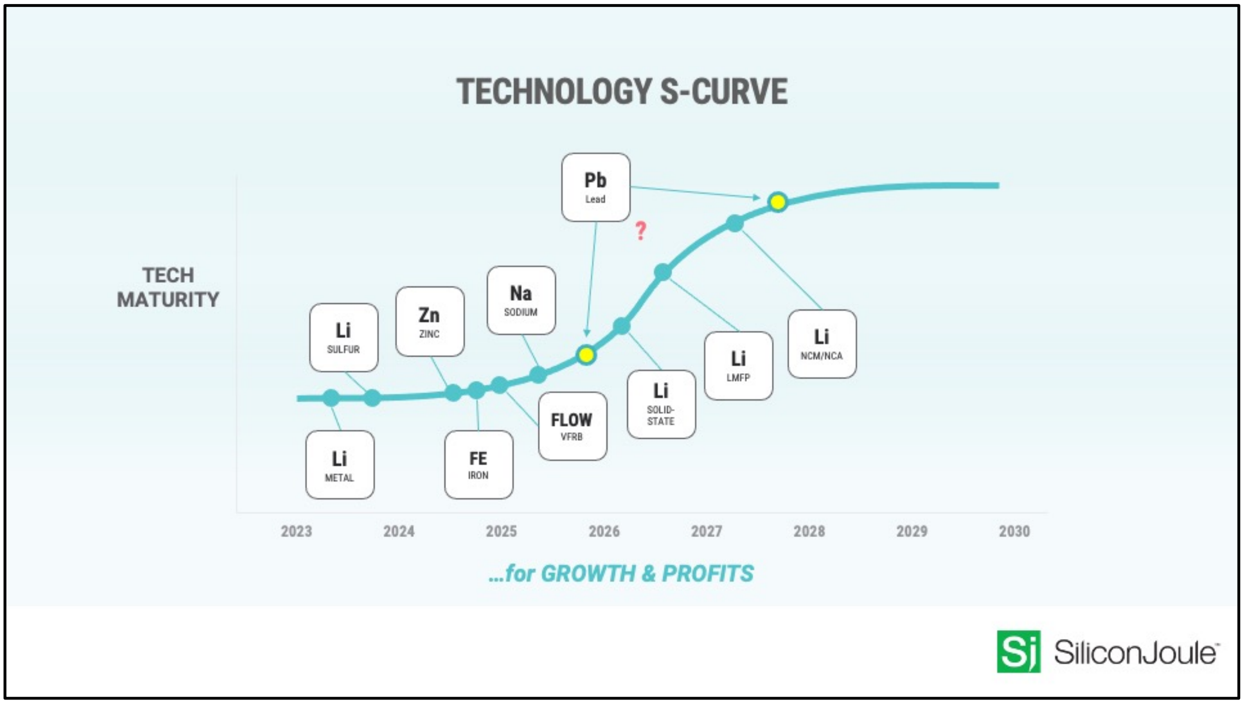
I have further delineated the the broad sectors of transportation batteries, plus the different ESS and Industrial applications. The application priorities for light vehicle EVs with over 200 miles or 300 kilometers of range, is certainly different than low cost, low speed EVs with <50 miles of range with 2, 3 or 4 wheels.

Though cost is key in all applications, the importance of different energy and power density levels, plus charging and recharging rates do vary by application, as this audience knows well.

One example is the high battery value opportunities which can be seen across the broad range of hybrid vehicle applications from the 48v mild hybrids to the Toyota-like solutions already demonstrated with success worldwide in 2023.

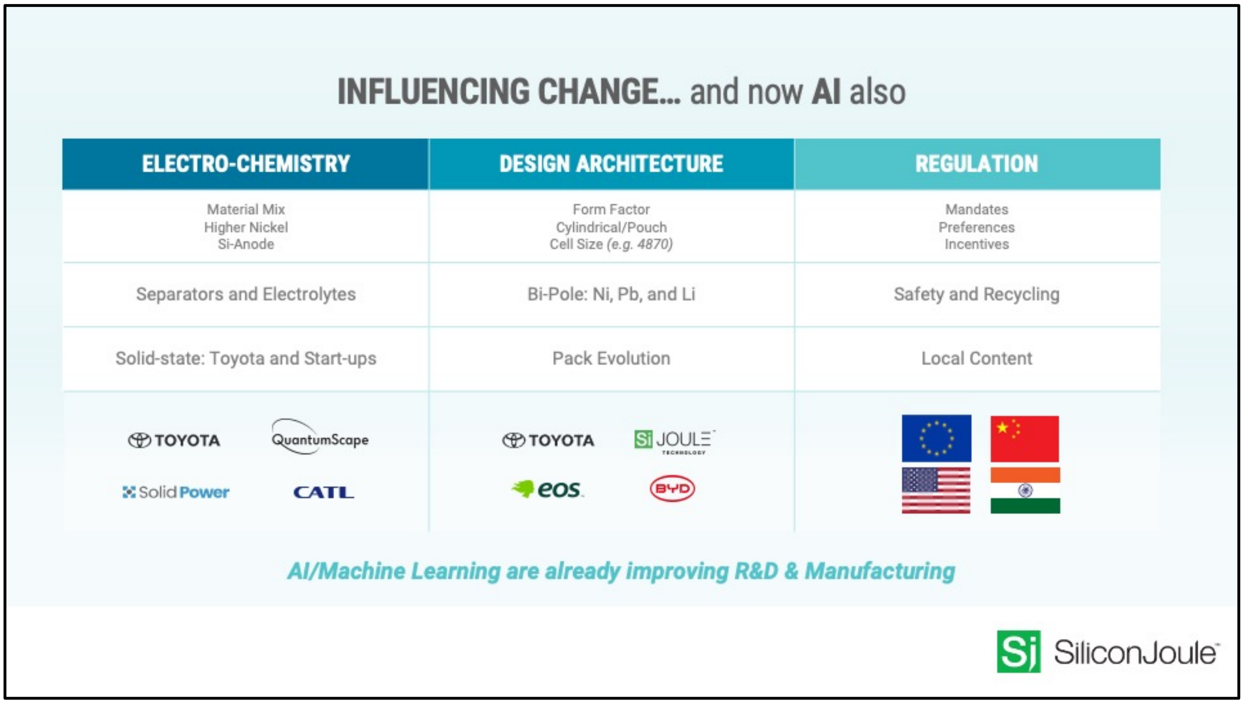
And beyond the range of propulsion batteries, there is the very important EV auxiliary battery, whose requirements for redundancy, life and predictive failure remains an opportunity for an innovative solution. Further innovation in today's lead-based AGM batteries will also be required to assure a continuing role for lead electro-chemistry in this high value EV application.

Beyond the top ranked application priorities, the experience of the last few years has led to a growing appreciation for higher safety, credible local supply chains, and the true sustainability of the energy storage solutions.



Another way to help visualize the competing technologies prospects is to assess where the they sit on an S curve profiling the maturity of the technology. It is unlikely experts would completely agree on any profile of the technologies' placements on such a curve, yet I think this helps managers and investors understand this often-complicated battery world.

Most would acknowledge Li Sulfur and Li Metal have high product performance potential, yet their timing and eventual cost is difficult to project. On this curve I have profiled lead chemistry in two different places considering the very different views of lead as a very mature tech with limited improvement opportunities, or by others across industry, including me, with a view that performance could double or triple in various metrics by driving innovation across long standing technical hurdles and biases.

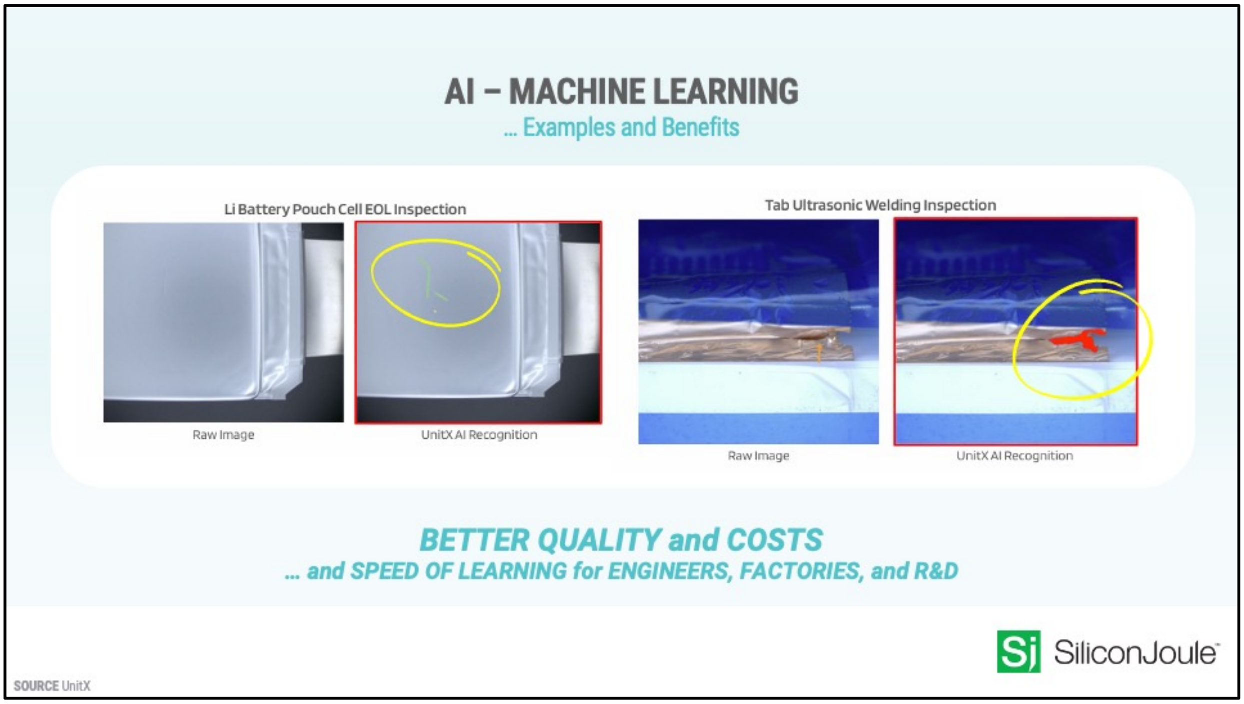


In assessing the prospects by technology we need to synthesize the combined impact of core e- chemistry improvements, plus the design architecture, and of course ever evolving government mandates, preferences and incentives.

The core material science work is happening worldwide, faster than ever by very large companies and startups. The design architecture work, whether cell formats, like the proven cylindrical format now expanding to 4870, or advanced prismatic cell blocks, and the maturing bi-pole designs across chemistries, and pack evolution, all must be considered.

Change is now likely to progress faster, even with the stubborn inertia of adopting new energy storage. This is because of powerful machine learning or AI which is accelerating improvements in manufacturing control and R&D worldwide.

I view these tools as better enabling what Industry leaders have been talking to us about for years, like Tim Ellis advocating advanced material specification control and 4, 5 or 6 sigma, or TBS with its continuous, highly controlled active material mixing, or Norbert Maleschitz, advocating manufacturing 4.0. Getting better and longer life batteries faster means profitable growth, or possibly simply survival in the competitive race across technologies.



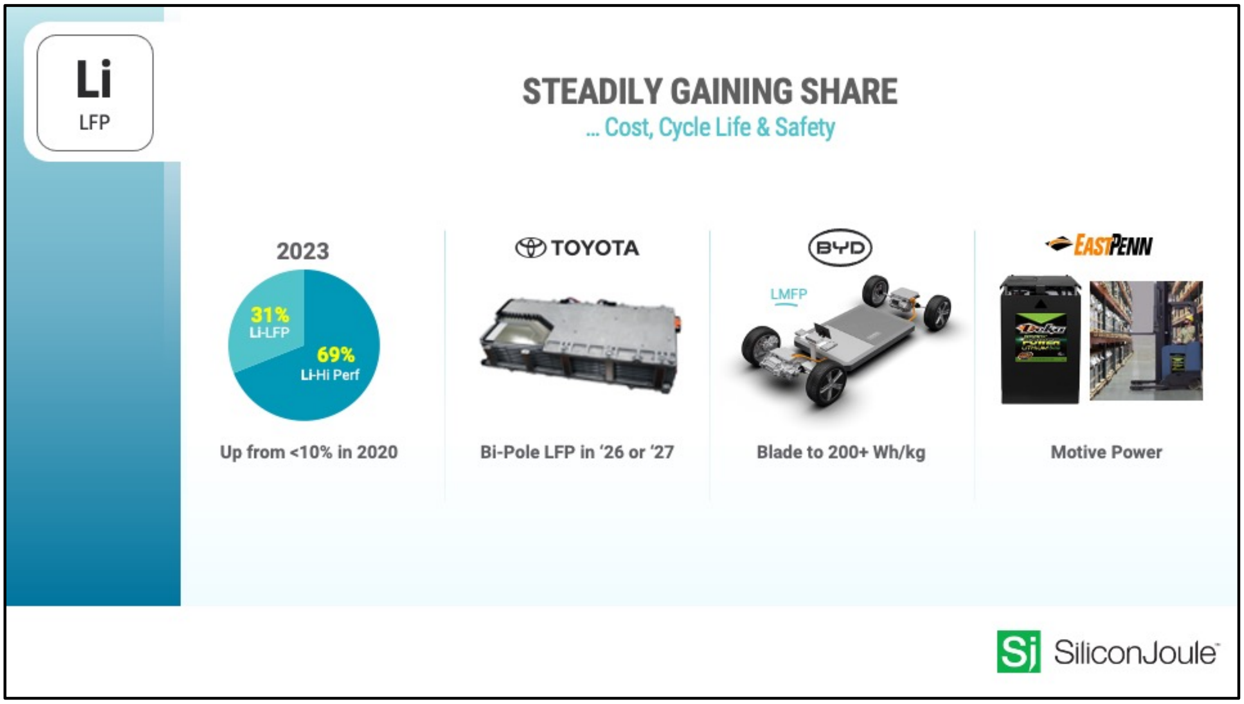
Let's talk about a practical AI/Machine learning example rather than the headlines we hear these days for AI.

On the left of this slide is an example of high-speed inspection enabled by advanced imaging of a lithium electrode. This level and speed of inspection, aided by machine learning was not possible even a couple years ago. This is happening now across industries including the lithium and lead battery businesses improving quality and productivity.

And the feedback loop such systems give to engineering and R&D with thousands of data points collected hourly, daily or weekly can enable more consistent components which means longer life and lower total cost batteries for vehicles and energy storage systems.

We need to deliver an EV Auxiliary battery to match the life and warranty of the EV propulsion battery and drive to the US Department of Energy's levelized cost of storage (LCOS) goal of $0.05/kWh for ESS. Much more consistent components, batteries, and systems can help differentiate your company to grow faster and profitably.

Gone are the days that designers can build in extra buffers of active material or specify shallow discharges to achieve long battery life.



I will now focus individually on the seven electro-chemistries.

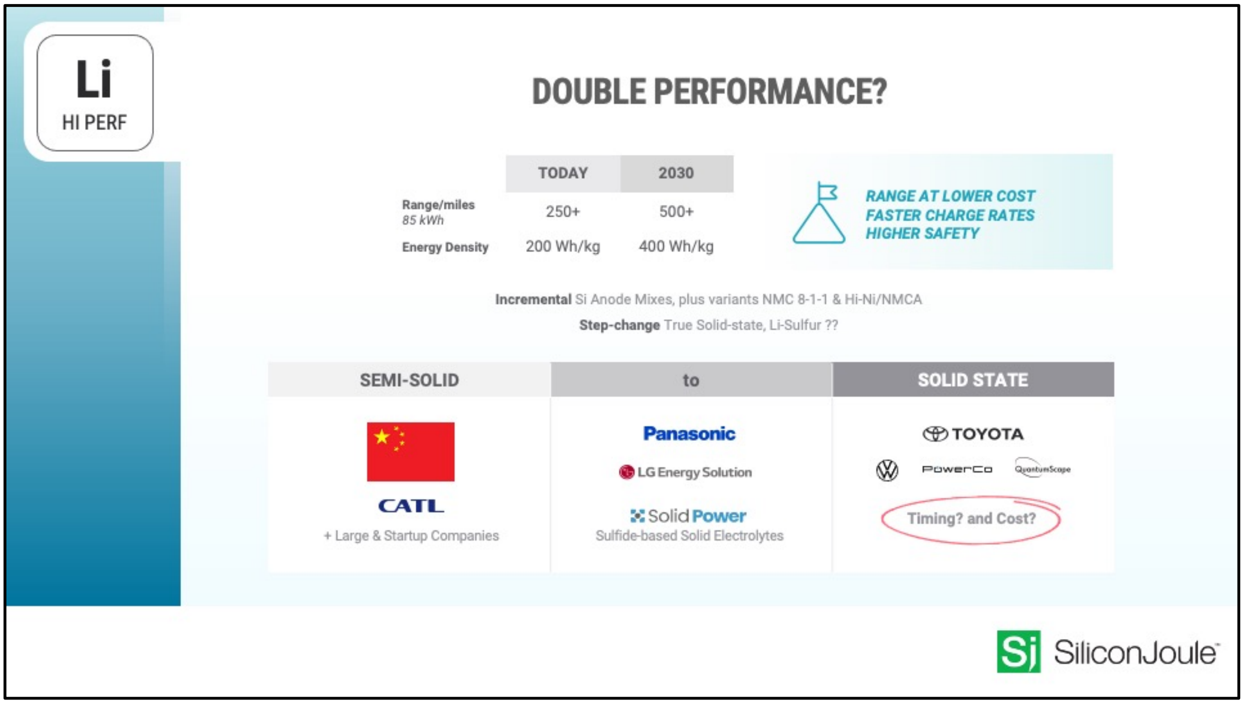
The tech platform currently with the most momentum is LFP as its share keeps growing across multiple applications to nearly a third of all lithium share from under 10% only a few years ago.

It's relative safety and cost vs. higher density lithium options, and improving density has supported the growth.

BYD, already very strong with LFP, is claiming the LMFP enhanced chemistry mix with manganese will achieve a potential doubling of energy density.

Toyota's tech roadmap includes an LFP based bi-pole design to significantly enhance performance for multiple hybrid applications targeted for 2025/2026.

And here in the US, East Penn has successfully progressed an LFP material handling or motive solution to complement its lead-based solutions, like many producers in Europe and China have done.



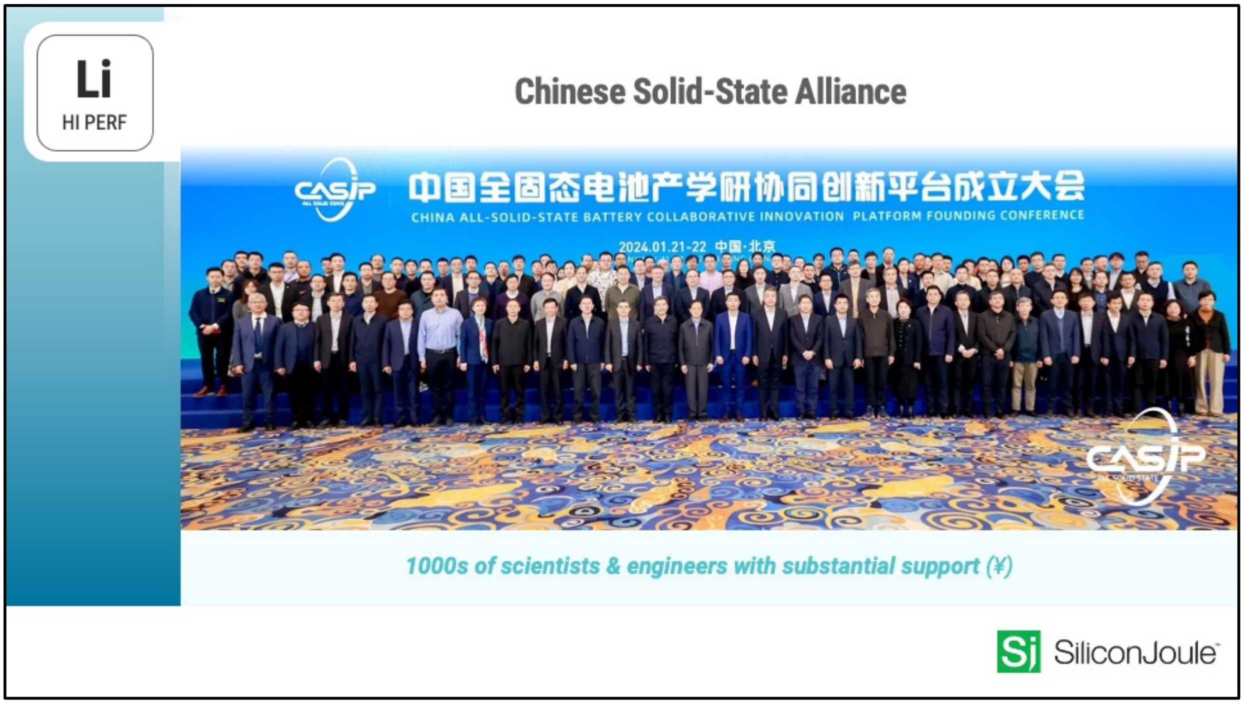
The innovation landscape for what I have called high performance lithium is more complicated.

Silicon anode and alternate chemistry mixes like NMC 8-1-1 are progressing to incrementally increase energy density aiding the range and/or cost of today's solutions.

So-called semi solid-state developments are exactly that, part way to solid-state, and offering somewhat safer high-performance batteries.

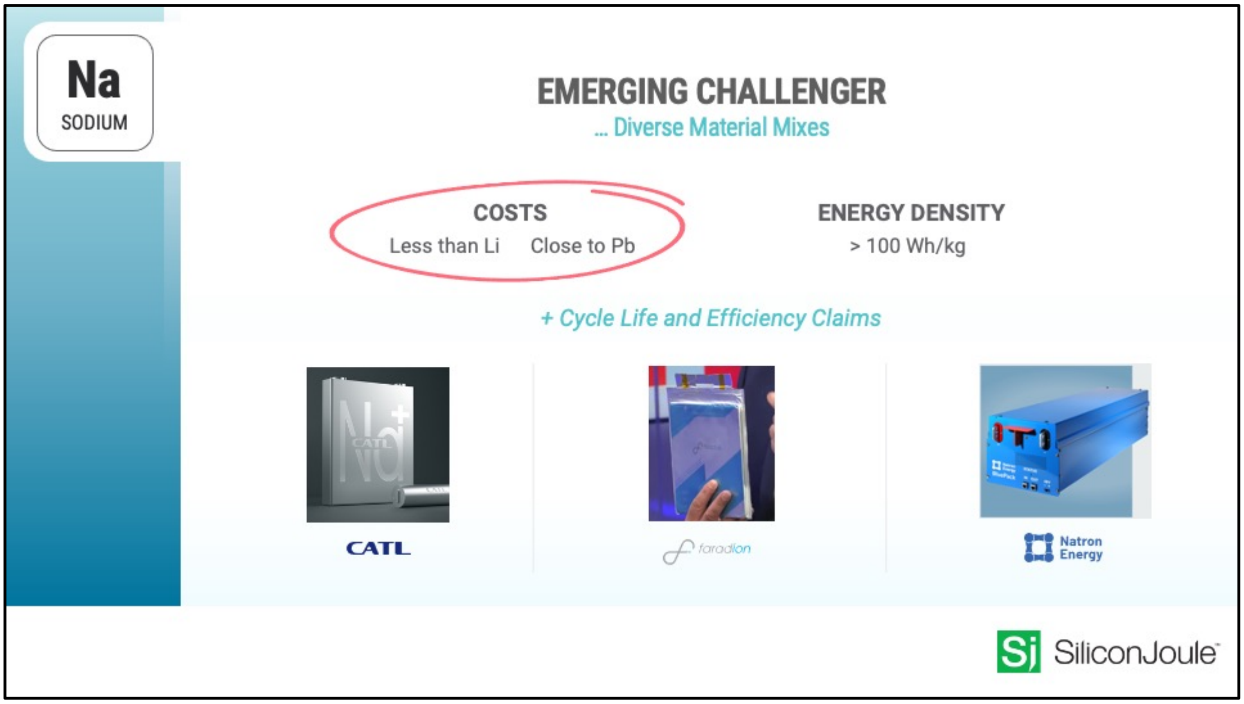
But most would agree that true solid-state offerings represent the potential step change performance and safety improvement by 2030, with reduced electrode spacing among the design attributes to potentially double energy density, while increasing safety. I would respect Toyota's published technology roadmap by 2030 as the most credible, yet I would not underestimate the potential of CATL, or the leading Korean companies, and even some US startups.

In summary, solid-state lithium is possibly the MOST DISRUPTIVE development coming, even if the costs and breadth of application by 2030 is uncertain.



As this new joint Chinese industry Solid State Battery initiative supported by the government suggests, the opportunity and/or threat from a true Solid State lithium battery is very important to the leadership Chinese producers have in lithium batteries.

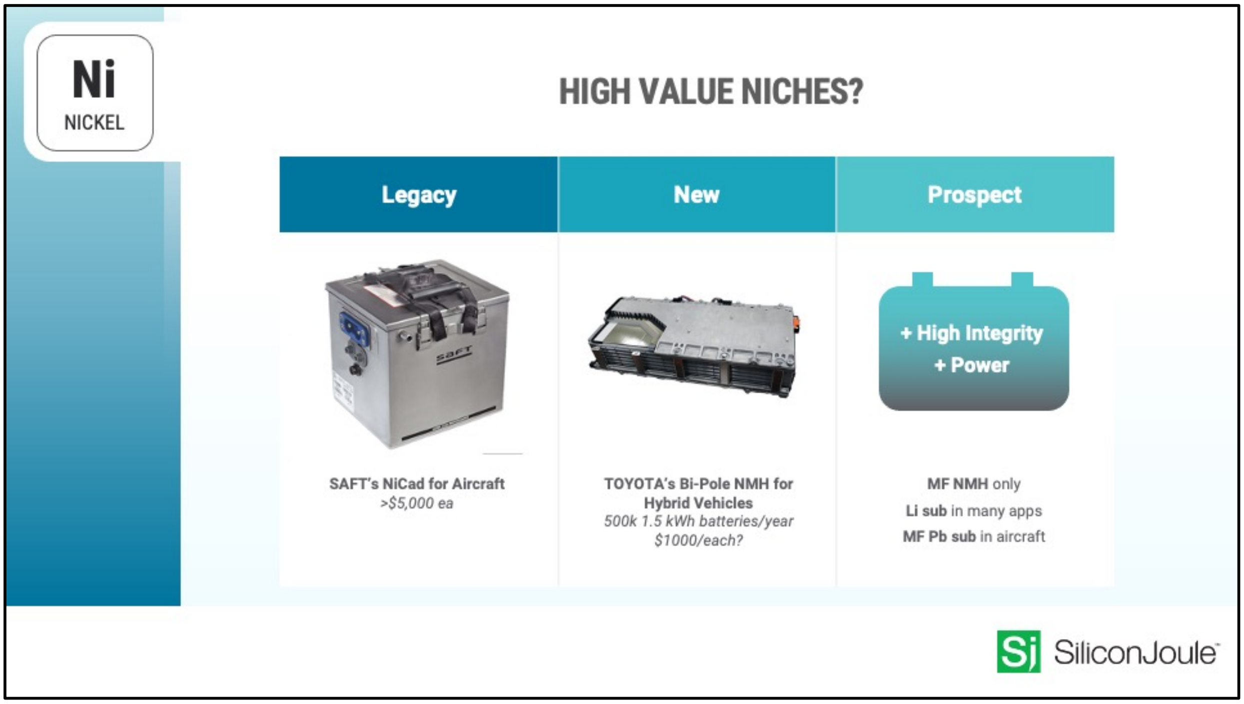
This alliance with CATL, BYD, many other companies, and thousands of engineers was launched in January 2024. It can possibly be compared to earlier joint industry initiatives in semi-conductors in the US, or for commercial aircraft in Europe which led to Airbus' development.



Sodium-based solutions are not new, having been pioneered by Aquion and others in the past. Today variations of these solutions are planned worldwide. Many Chinese companies have launch dates and capacity commitments to now exceed 100 GWh.

Like many emerging battery solutions, low costs, long life and high performance are claimed, yet as we have seen over the last three to four decades, the real-world deployment to scale of new batteries often takes longer than supporters and investors claim. And similar to other challengers for energy storage market share, recycling and safety questions may need to be answered before broad use.

However, the current investment support for sodium-based solutions is high, and if the costs vs lithium and lead claimed are proven, combined with a validation of targeted life and energy density, these solutions could prove very disruptive to many technologies and companies.

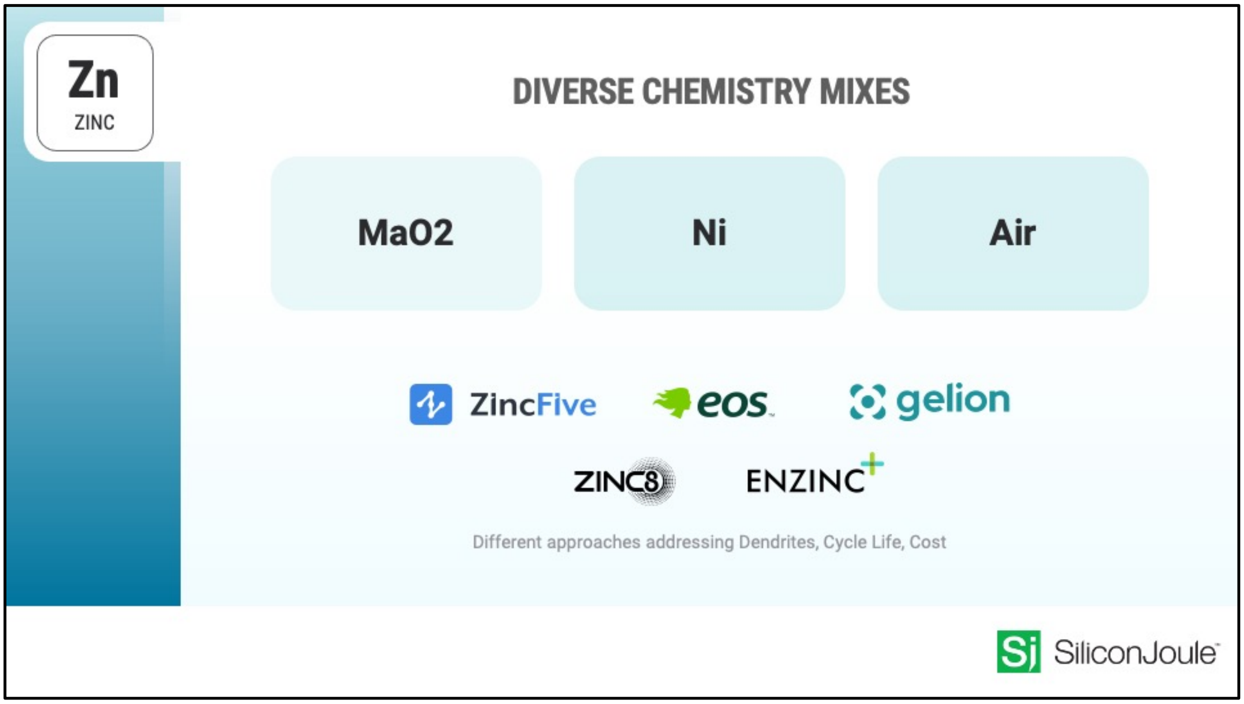


Turning to Nickel based designs, these proven high-performance solutions, especially where high power and wide temperature tolerance are required, are often ignored in many forecasts.

SAFT's expensive aircraft solutions are still used widely, as are many nickel-based variants across rail applications worldwide, and off-shore back-up power applications.

Toyota, as often the case, went against popular convention and developed and deployed across much of their current hybrid vehicle range, a high performing bi-pole Nickel Metal Hydride solution notably increasing vehicle mileage and efficiency to save money and reduce emissions.

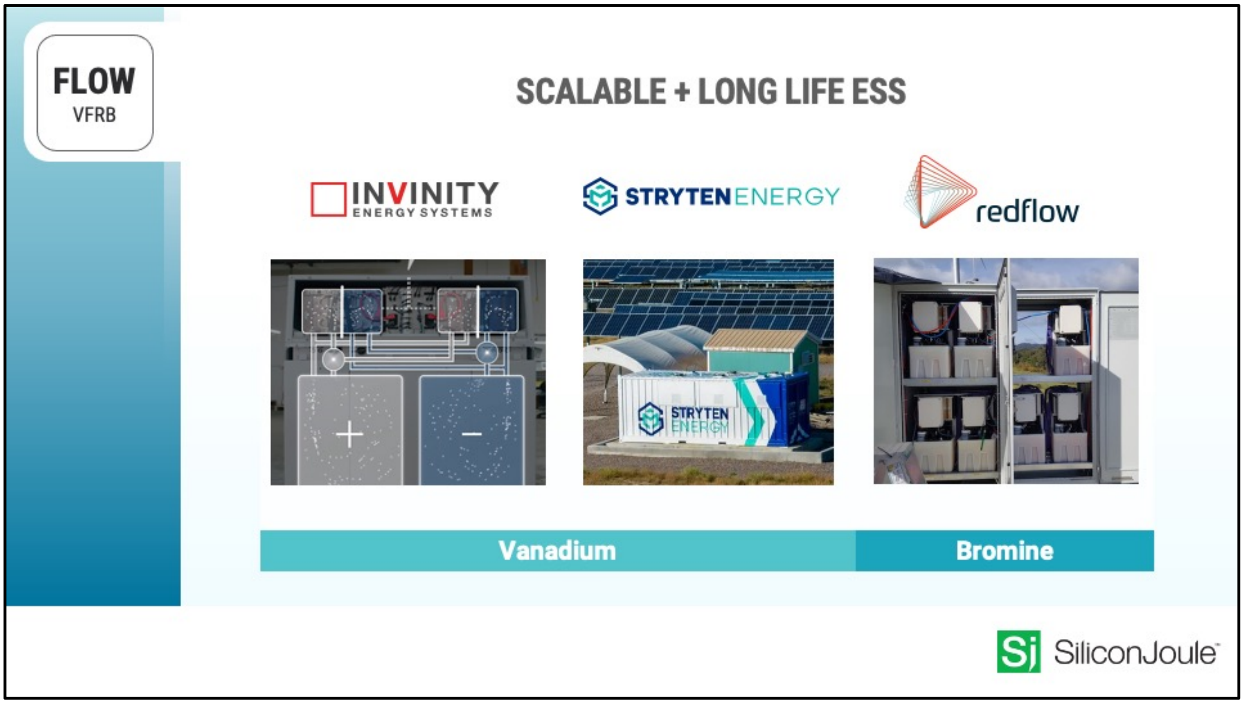
Looking forward, challenges by maintenance free lithium and AGM based lead solutions are taking share from nickel options in many applications. Yet, safe, long life, high integrity solutions, even if expensive, may do better than most forecasts suggest, especially if they are the maintenance free type, with innovations like Toyota's bi-pole format NMH.



Zinc based batteries have long been present in niche applications, and there are diverse chemistry mixes claimed by developers to solve some of issues, like dendrite shorts, which have heretofore blocked the scaling of these technologies to a more significant share.

Some of the marketing and engineering materials supporting new investments are really impressive, but I might borrow a phrase that it is 'show time' to scale, before the larger e-chem platforms drown out challengers like the zinc-based options.

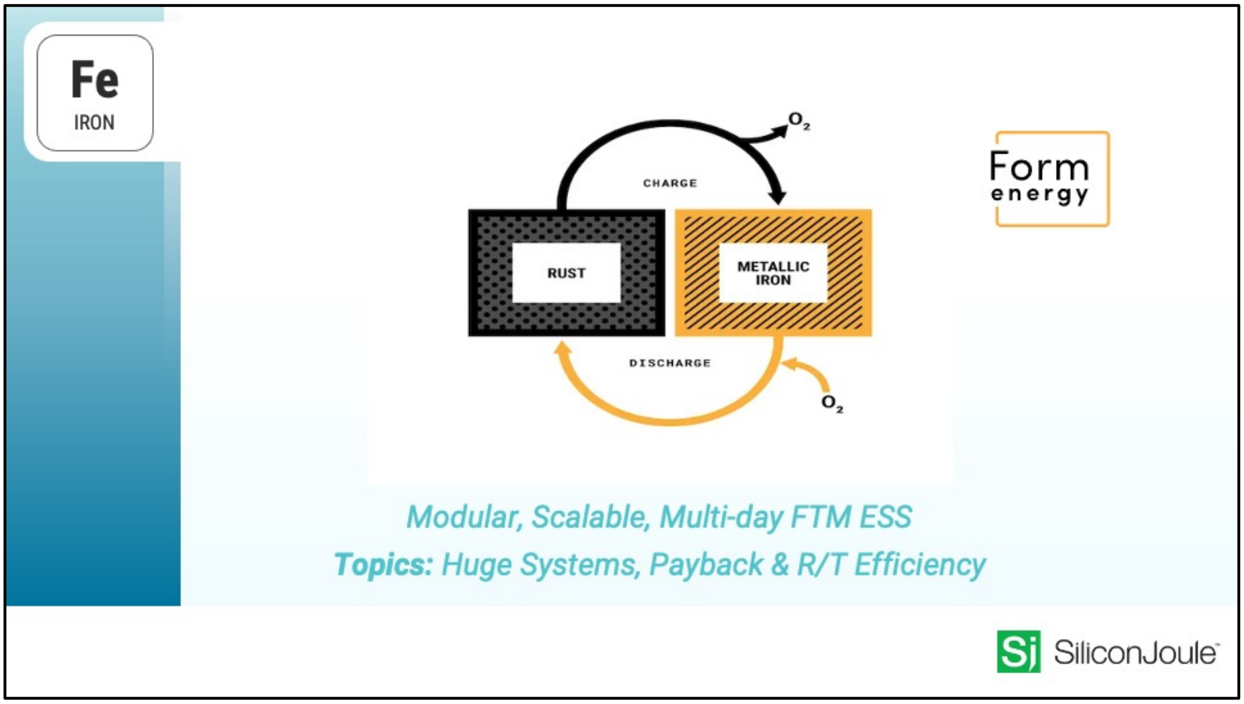
EOS has pioneered their zinc-based solution in a bi-pole format, claiming the similar performance lifts we see across other chemistries, including a notable lift in power density.



Fighting for a share of the fast-growing ESS markets, flow batteries are expanding with small and large-scale pilot installations worldwide to challenge lithium and other solutions.

These systems are clearly scalable, and the developers and promoters, including Stryten are working to drive costs and adoption of the most popular variation, that being the Vanadium based flow batteries.

The modular bromine-based flow batteries from redflow is a different approach. My experience back in the 1990s with the former Johnson Controls (now Clarios) will attest these systems can also work, yet assuring safety and competitive costs will be important for its prospects.



The Form Energy battery solution capturing the 'rusting cycle' of iron for energy storage is probably the most NEW of the developing e-chem platforms. Form Energy now has an expanding order backlog and is developing a large-scale factory in West Virginia in the US aided by the US Dept. of Energy funding.

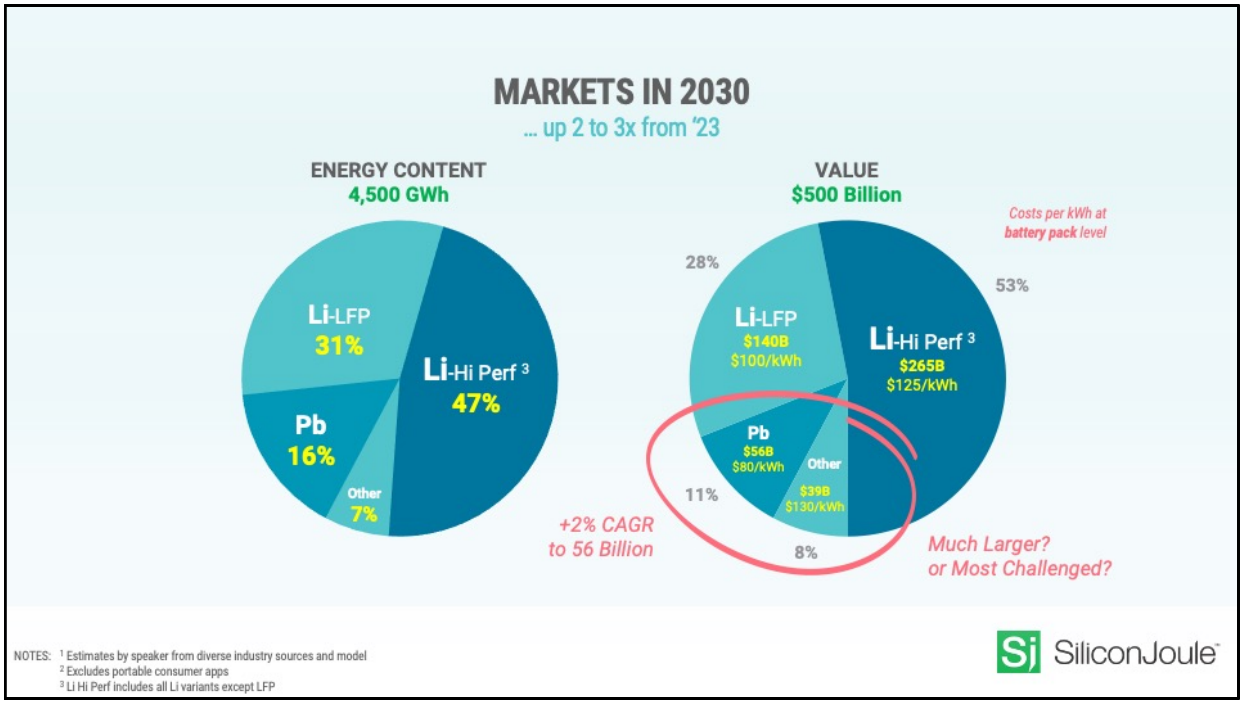
Low cost materials always are critical in energy storage as lead-based and lithium LFP batteries have proven, and this is a key claim for iron-based batteries due to the multi-day energy storage solution targeted.

As always there are performance claims to be validated with real life data including round trip energy efficiency, which is a high priority in energy storage solutions.

Before covering lead-based innovation prospects and the technology share by 2030, I will now ask the audience by a show of hands to followup on my earlier question. Recall that lead-based batteries represented about 23% by value of the 2023 market.

By show of hands, how many believe lead will represent less than half of this share or less than 12% by 2030?

And now, how many believe lead-based solutions will represent more than 12% by 2030?

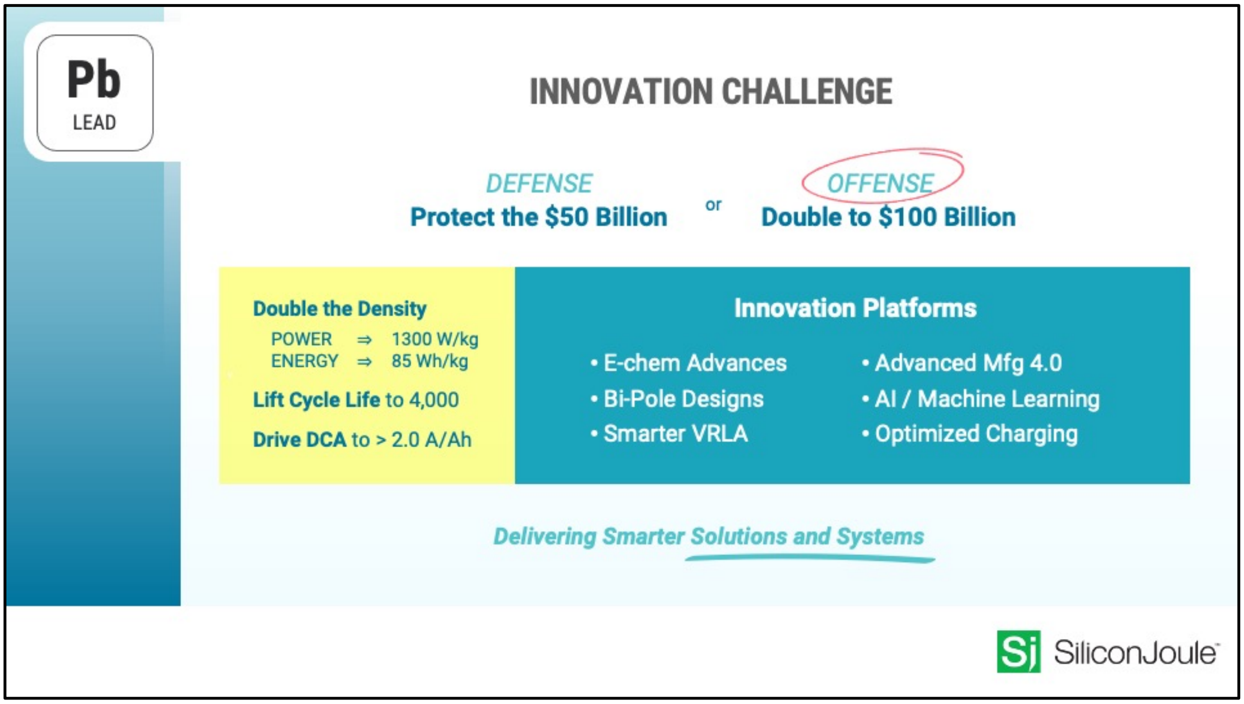


Here is my estimate of the “base case” with today’s trends in lead batteries. This shows a 2% annual growth rate to $56 Billion by 2030 aided by higher value AGM batteries.

Though I believe the opportunity is much larger for safe, recyclable low-cost lead-based solutions, that $56 Billion would only be about 11% of the forecast market. And respecting the innovations in sodium, flow and other batteries, all together they are forecast here to represent 8% or at $39 Billion of the forecast market.

A fair question we should consider is: Without significant validated performance and cost improvements, how do any of the non-lithium designs sustain a profitable growth?

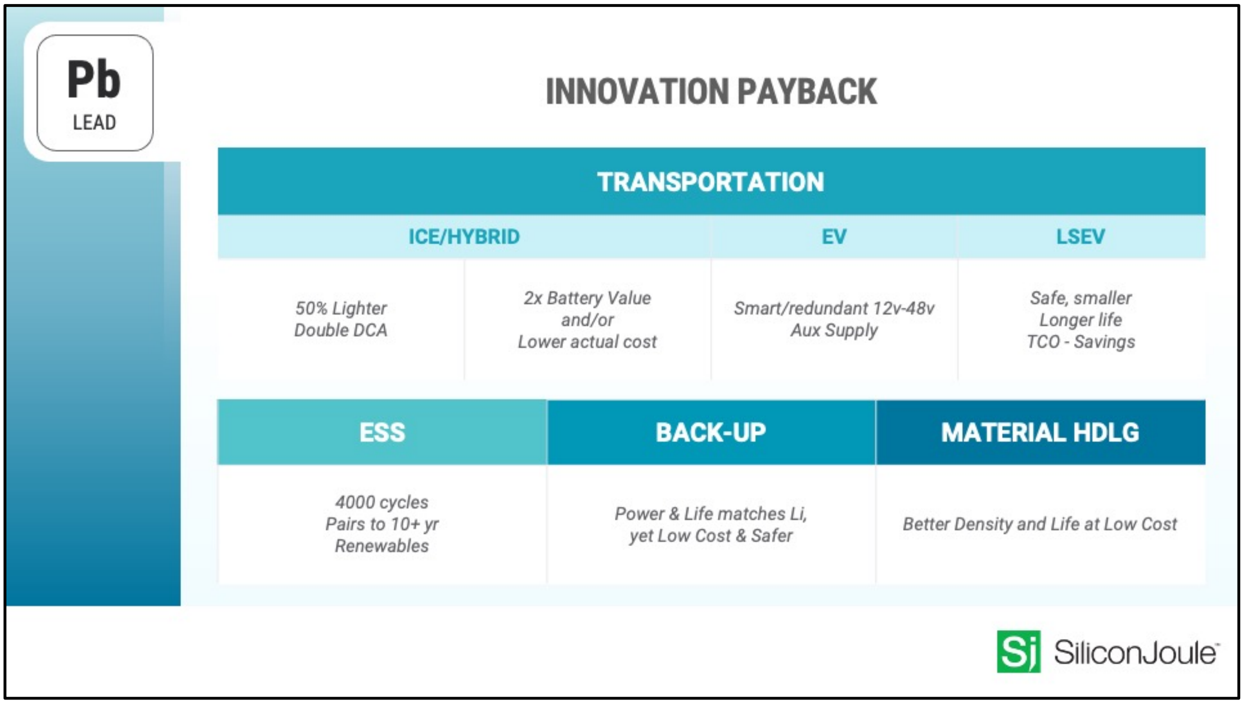
Lithium platforms will have high cash flows driving further improvements with over $400 Billion in annual sales. This requires investment *now* to innovate and improve performance and cost.



Moving to lead batteries, I would frame the innovation challenge as either driving to "better" defend and protect the current sales of $50 Billion worldwide, or drive innovation aggressively toward a doubling of the business share to $100 Billion. Some might question the will to invest to double the existing capacity of the lead-based battery business worldwide. Here I would challenge our leaders rather to focus on the strengths including global factory capacity of over 600 GWh, and drive to deliver better, longer life, higher performing batteries as a path to sustained profitability and returns.

Aligning with expert views from CBI, also Tim Ellis and others, the metrics will need to, and can potentially achieve more than double the energy density, cycle life and DCA. And note some of these metrics are only 50% of the theoretical potential of the chemistry.....while retaining the uniquely low cost and proven sustainability metrics with near 100% recycling and reuse.

The improvement platforms cited here all complement each other. We also need to do a better job of delivering smarter solutions and systems, charging and controls with predictive diagnostics on performance, rather than the legacy practice of just shipping block batteries for others to integrate and design around.



Some lead-based battery companies, still enjoying good cash flows and profits continue with low R&D outlays for lead, as they are unsure how and where the innovation payback can be achieved.

Though many innovation payback potentials are profiled here, I would highlight three significant improvements that stand out as achievable and valuable.

1. Extending deep cycle life to 3,000 and 4,000 80% DOD cycles especially with a Maintenance Free design would dramatically increase the growth opportunities in ESS, LSEVs(2) and many industrial applications.
2. Doubling today's energy density, which is possible with both e-chemistry advances and design architectures including the bi-pole versions available, would be another big winner across many transportation, industrial and ESS apps.
3. And extending the already high-power performance, complemented with flexibility in voltage solutions to match the system needs across transportation and backup power (telco, data centers & broadband) offers the prospect of directly competing with lithium battery performance.

Also, these innovations further improve the cost advantages the lead-based solutions provide. And it is not just good business. The proven unique sustainability credentials with nearly 100% local and efficient recycle and reuse is unlike any other battery chemistry, which of course is good for the planet and communities.

If you are still skeptical of the risks to invest toward the $100 Billion market opportunity for lead-based electro-chemistry, let me share two examples of engineering leadership with the right support that delivered highly profitable innovation in the lead battery business.

In Milwaukee in 1992, a plan was developed to move from general purpose VRLA backup power designs to separate products matched to use in Telco, Broadband and new high power UPS designs, all at once.

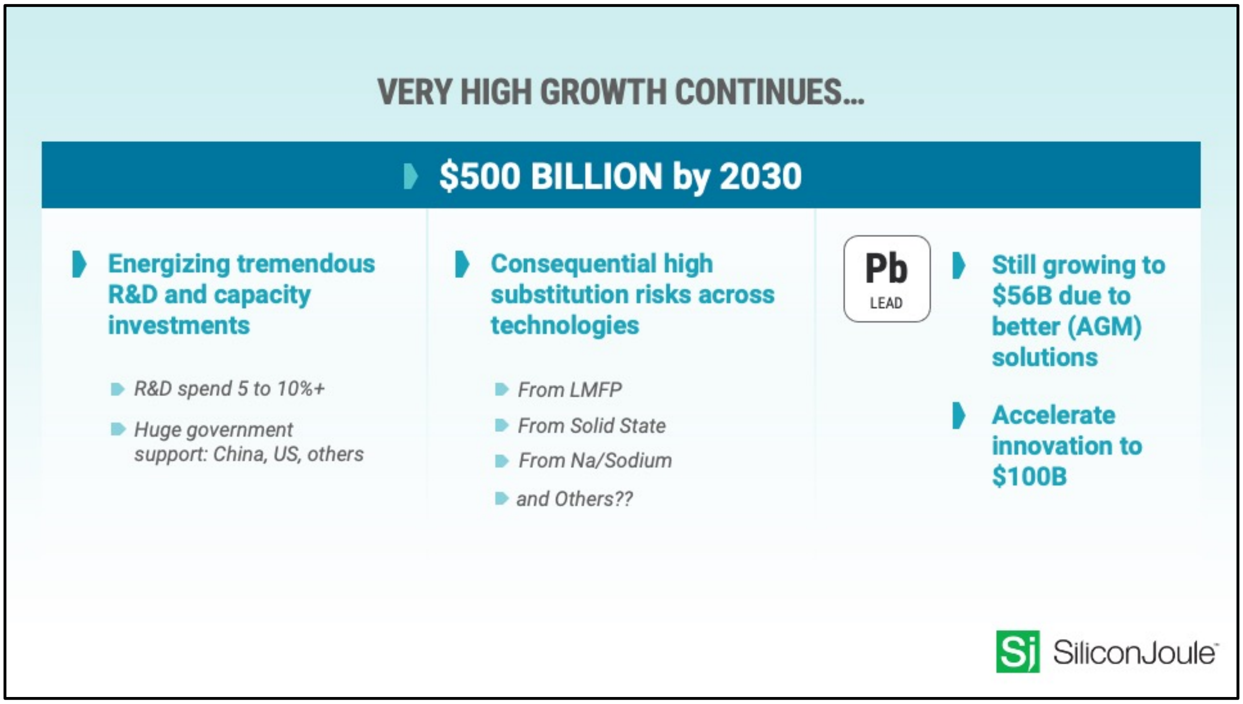
This work was led by Bob Gruenstern and Scott Gerner plus marketing, manufacturing and corporate sponsors. Overcoming the inevitable bumps and inertia, that Dynasty division doubled its sales, quite profitably in three years.

In France about 2010, another innovation plan was led by Gery Bonduelle and Laurent Debrue to design and build large pure lead two volt cells for backup power and deep cycle applications. Notably different product and manufacturing designs were required, even if building on the heritage of the former 12 volt block batteries. Teamwork across the specialties in engineering, marketing, outside equipment providers, including Wirtz, and even French unions succeeded, opening the market for much larger, high value maintenance free and cycling AGM solutions.

These examples enabled significant customer value, hence high sales growth and profits, building on core lead electro-chemistry. You can see other examples today progressing from companies like Hammond and ArcActive, in addition to my own company with Silicon Joule bi-pole technology to name a few. And in many of your companies I am sure you have other examples, yet we have to play both defense and offense better and faster with innovation across lead based technology.

Sure some investment is required as you adapt processes and supplement capacity, but not billions for giga-factories, where the risks would be dramatically higher. And your building on core electro- chemistry, where you, your application engineers and your customers will trust quicker than with new chemistries where costs, safety and recycling are often evolving at best.

(2) LSEV is Low Speed Electric Vehicles with 2, 3 or 4-wheels including scooters, e-Bikes & golf carts



Summarizing, our industry is blessed and challenged with the continuing VERY HIGH growth in the demand for energy storage, prospectively toward a half trillion dollar annual market by 2030.

That growth is driving both companies and governments to drive investments in capacity and R&D none of us would have guessed only a couple years ago across China, the US and Europe.

Though many science and engineering advances are likely, I believe those most likely to disrupt industry are the further advancements in lithium iron phosphate, solid state lithium, potentially some sodium-based solutions, and if we move now, for advanced lead batteries.

For lead based chemistry and companies, a tremendous opportunity remains to be seized. We have the opportunity to double the markets for our solutions, which seems far more enjoyable and profitable than being marginalized to a small slice of this huge global market.

With only a marginal slice of this huge market, the prospects for profits and the continuity of great companies built over the last 50 to 100 years may be very different than today.

We need to invest and innovate faster than is our industry's legacy approach. Please join with me at Gridtential and others committing to make this happen.

SOURCES & THANK YOU

The opinions and forecasts are derived as a synthesis of the speaker's model and public reports, press releases and claims by 50+ companies many referred to herein.

In addition, the speaker's comments have considered the professional reports of these highly credible organizations worldwide.

- **US Dept of Energy, Office of Electricity** "Storage Innovations 2030" (07/2023)
- **Roland Berger** "Sodium Ion brief to North American Battery Show" (09/2023)
- **Roland Berger & RWTH Aachen University** "Battery Monitor 2023" (12/2023)
- **Volta Foundation** "Annual Battery Report" (2022, 2023)
- **Fraunhofer** "Benchmarking Int'l Battery Policies" (01/2024)

Special thanks to the following for their insights and counsel

- ***Dan Kubis*** *(Roland Berger)*
- ***Tim Ellis***
- ***Matt Raiford*** *(CBI)*
- ***Alistair Davidson*** *(CBI)*

CONTACTS

John Barton
CEO, Gridtential Energy, Inc.
John.Barton@gridtential.com

Ray Kubis
Chair, Gridtential Energy, Inc.
Ray.Kubis@gridtential.com

Gridtential Energy, Inc.
3350 Scott Blvd.
Building 14
Santa Clara, CA 95054
gridtential.com

SiliconJoule™

A special thank you for insights and counsel from Tim Ellis, Matt Raiford, Alistair Davidson & Dan Kubis.

Also referenced are some of the recent global reports I carefully reviewed in preparing this brief:

- *The Volta Foundation*
- *The Fraunhofer Institute*
- *Roland Berger's briefs on sodium batteries*
- *Annual Storage Report for 2023, and the Innovations report by Patrick Balducci from the Argonne National Labs, which is part of the US Department of Energy*