San Diego, California, USA • September 22-25, 2021

BCI Yearbook

& Special Pre-2021 Convention Report

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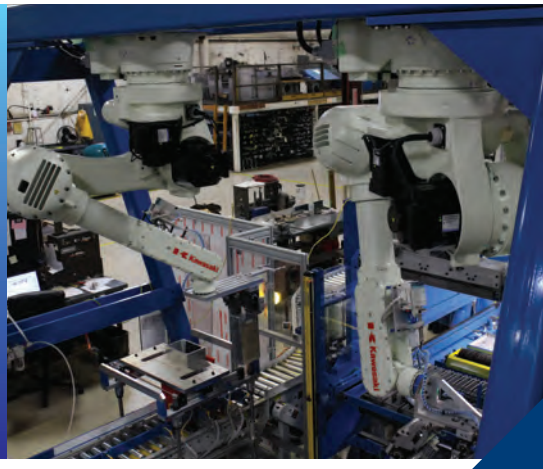

BCI INNOVATION AWARDS 2016-2019 REVIEW

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San Diego, California, USA • September 22-25, 2021

BCI Yearbook

& Special Pre-2021 Convention Report

- San Diego taster: welcome to America's Finest City!
- BCI's Miksad: opimistic over challenges ahead
- Analysis: Kubis, Starita, facing the lithium threat
- Keynote speaker profiles: Mark Mills, Imre Gyuk
- How energy storage helps solve climate change
- BCI vindicated: DTSC accepts lead's importance

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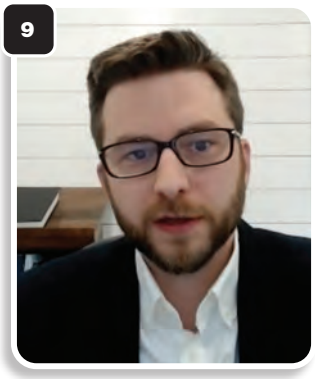
Battery Council International's Convention and Power Mart Expo, looks yet again to be the hottest meeting of the North American lead (and more) battery community this year. With an exciting agenda covering many issues that urgently need to be discussed. The 600 plus delegates heading to San Diego, California should find much to talk about.



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Mike Halls • editor@batteriesinternational.com

Greenhouses gases? They're great for batteries!

Thank heavens for CO_2! That's not something you hear very often as the world lurches into what the media are cheerily calling a climate crisis.

Yes, that pesky carbon dioxide that's been plaguing scientists' nightmares for the last 30 years is creating exciting times for the battery industry — no matter what flavour of chemistry you're working in.

And the reason for it all?

A huge turn-around in our perception of energy storage has occurred.

Although the signing of the Paris Agreement in 2016 was a public announcement that the world was going to get serious about climate change, little seemed — on the surface at any rate — to have happened. Controlling CO_2 levels seemed to drop from mention by the world's media.

So when the former US president Donald Trump announced in June 2017 that he wanted to leave the accord, it looked as if it was all dead in the water.

But, behind the scenes, climate change and decarbonization were never off the agenda.

European governments may have taken their time but they did set out bold legislation to ease out fossil fuels and introduce renewables. In the US, big business happily ignored presidential chatter on promoting the coal industry. Equally importantly two of the largest greenhouse gas emitters — China and India — said they too were going to get serious about CO_2.

Getting serious about CO_2 means getting serious about renewables and their corollary, energy storage.

The announcement in early June by US president Joe Biden that he was going to make a huge commitment to the battery industry has refocused the country, and to a lesser extent the world, on the importance of energy storage.

Early indications that there will be a shortage of everything from raw materials to expertise as the world tries to build some 211 gigafactories (current estimate) means that there will be a demand for all battery types.

This means it's not just good news for lithium but also lead, nickel and a wide range of alternative energy storage devices.

So this September's meetings in San Diego should hopefully be approached in a mood of celebration for some good years ahead. And a better decarbonized future for us all. ■

For the past eight years *Batteries International* has worked with Battery Council International to produce its annual Yearbook, which is distributed to all BCI members and attendees at the annual convention in the spring.

This year, due to the pandemic, parts of the regular annual business of BCI had to be conducted virtually in April and the convention and power mart for San Diego had to be delayed until September.

This is the second draft of the annual Yearbook. The final version will will be printed and handed to delegates when we all get to meet up in San Diego.

I hope that this will whet your appetite for what promises to be a superlative event!

Best wishes until then!

Mike Halls, editor

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to provide homogenous temperature.

Welcome to San

San Diego has great weather, plenty of attractions and no sense of shy modesty — its official nickname is 'America's Finest City'. Hillary Christie gives a potted history of the BCI conference venue.

San Diego was the first area of California where Europeans settled and is often talked about as 'the birthplace of California' (though they still haven't found anyone to blame for that).

Explorer Juan Rodriguez Cabrillo discovered San Diego Bay in 1542, roughly 200 years before Europeans settled the area. The discovery shocked the local Kumeyaay native Americans who had been living in the area for some 12,000 years.

A fort and mission were established in 1769, which gradually expanded into a settlement with various squabbles between the Spanish, the Mexicans and the Americans. San Diego officially became part of the US in 1848, and became part of California when it was granted statehood in 1850. It remained a small town for decades, but grew rapidly at the turn of the century as a support area for the military.

San Diego has long suffered with water supply problems; a lack of natural water sources means the county relies heavily on reservoirs that run dry in times of drought.

In 1915, after weeks without rain, the San Diego City Council hired entrepreneur Charles Hatfield, a self-proclaimed 'moisture accelerator', to summon enough rain to fill the Morena Dam Reservoir, promising a prize of $10,000 should he be successful.

Hatfield built a tower beside Lake Morena to house his secret mixture of rain-making chemicals. On January 5, 1916, the rain fell over the next days, destroying bridges, marooning trains and overflowing several dams. Nearly 30 inches fell in a month, causing damage to property and loss of life.

After a number of trials, the rain was declared an Act of God and Hatfield was absolved of responsibility but also denied his reward from the initial agreement.

The lack of another liquid — in this case wine — caused problems for the city during the Prohibition years of the 1920s.

All four of San Diego's wineries closed indefinitely during this time, but one of them—Bernardo Winery—was saved by quick thinking. Founded in 1889 by a group of five Sicilians, it survived the alcohol ban by selling sacramental wine to the Catholic Church and selling grape juice to passing customers, with a guarantee that it would ferment along their journey.

San Diego became known, at one point, as the Tuna Capital of the World. In the 1930s, the US Navy took an interest in the county's fleet of powerful diesel fishing boats and later converted several 'Tuna Clippers' into minesweepers for the war.

The boats, already equipped with sophisticated refrigeration units, then became the errand boys of the Pacific, transporting supplies, troops, gasoline, ammunition and cargo in the country's efforts to protect the Panama Canal. They even delivered frozen turkeys to marines fighting on Bougainville just in time for Thanksgiving 1943.

Growth was rapid during and immediately after World War II. Entrepreneurs and boosters laid the basis for an economy that makes San Diego the eighth largest city in the country.

Local attractions

All distances given from Hilton San Diego Bayfront

Gaslamp Quarter
– 12 minutes away

This lively entertainment district in downtown San Diego covers over 16 blocks of pubs, clubs and historic buildings.

Wild West gunslinger Wyatt Earp, the deadliest man in the Old West, lived in the quarter for seven years, but you're more likely to see galleries and gastropubs than saloons and brothels these days.

With over 100 restaurants, bars and nightclubs, there's no need to venture much further.

Broadway Pier Ferry Terminal, (access to Coronado Island)
— 6 min by taxi

Take a scenic day trip across the bay to Coronado Island, home of the Hotel del Coronado, a National Historic Landmark famous for hosting presidents, professional sportsmen and Hollywood elite.

Flagship Cruises and Events offers 15-minute rides on the hour across the bay to the Coronado Ferry Landing, where visitors can explore a waterfront marketplace of unique shops and restaurants.

San Diego Zoo
— 10 min drive

A short taxi ride to Balboa Park will take you to the gates of the famous San Diego Zoo, home to more than 12,000 animals kept in open-air, cageless exhibits designed to closely resemble natural habitats.

South Embarcadero Park
— 10 min walk

With views of the city skyline, busy marina and sparkling waterfront, this public green space is perfect for a quick walk or a picnic in the sun. Exercise stations around the park are perfect opportunities to work off the previous evening's networking. Nothing cures a long conference session quite like a lungful of sea air.

Diego!

'AMERICA'S FINEST CITY'

Getting around

San Diego offers many modes of transportation for travelers wishing to avoid car rental. Transit passes can be loaded on to a Compass Card at any trolley station ticket machine, or smartphone users can download the free Compass Cloud mobile ticketing app where you can purchase 1-day and 30-day passes for MTS buses, the San Diego Trolley, North County Buses, the Coaster and the Sprinter.

Taxicabs, Ubers and Lyfts, oh my!
Taxis that depart from the airport have regulated fares, but elsewhere fares will vary with initial flag-drop charges plus per-mile and per-hour charges on top. Uber and Lyft are well established app-based options that provide on-demand and pre-booked options for travel.

The Red Trolley
The iconic Metropolitan Transit System (MTS) provides convenient services from key locations aboard bright red, hard-to-miss trolleys. There are four lines that service downtown San Diego and beyond, running on average every 15 minutes. For maps and trip planning, visit sdmts.com.

One line runs all the way down to Tijuana. Get off the trolley bus in the US, pass through a turnstile and within seconds !Caramba¡ Estamos en Mexico!

Warning. It isn't quite so easy to get back though!

Old Town Trolley Tour
Hop on/off tours throughout San Diego with narration and unlimited free reboarding.
www.trolleytours.com/san-diego

For more transportation options locally and to communities surrounding San Diego, visit: www.sandiego.org/plan/getting-around.aspx

Green Gold

Introduced to California from Mexico in the 19th century, the avocado, also known as the alligator pear, thrives in San Diego's microclimates. The county grows 60% of California's crop of 'green gold'; the fruit boasts more potassium than a banana, more fibre by weight than any other fruit, and a healthy dose of antioxidants.

All descendants of the most common cultivar, 'Hass', come from a single mother tree raised by mail carrier Rudolph Hass of La Habra Heights, California.

Hass patented the tree in 1935 and the year-round crop now accounts for 80% of cultivated avocados in the world.

It could only happen in California

FUR BABY BOOM

Some residents of San Francisco are foregoing children and investing in "fur babies" — a term added to the Oxford Dictionary in 2015.

US Census figures in 2018 reported there are more dogs than under-18s in San Francisco.

One could assume that children are much more expensive to raise than dogs. But walk the streets of the upmarket Presidio or Pacific Heights and there are luxury doggy day-cares, dog gyms and spas, and more artisan dog-treat bakeries than creches.

I'M DREAMING OF A PINK CHRISTMAS ...

At the foothills of the Sierra Nevada mountains, residents are often treated to a phenomenon known as Watermelon Snow.

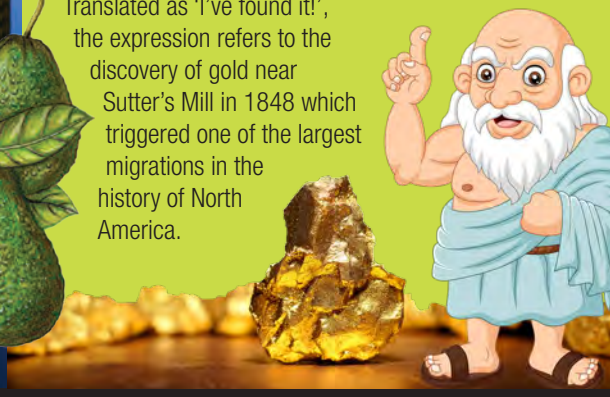
The light pink snow, also known (a bit morbidly) as blood snow, is caused by chlamydomonas nivalis, microscopic algae containing a red pigment that not only changes the colour but can also, reportedly, make the snow smell sweet.

We all know to avoid yellow snow, but add pink snow to the list too — the algae are toxic.

EUREKA!

Attributed to Ancient Greek mathematician Archimedes, 'Eureka'—California's state motto— is an expression commonly used to celebrate a discovery or invention.

Translated as 'I've found it!', the expression refers to the discovery of gold near Sutter's Mill in 1848 which triggered one of the largest migrations in the history of North America.



Batteries International interviewed Roger Miksad, executive vice president of BCI, about his perspective on the changing political and regulatory framework facing North America's lead battery industry.

A busy year gone, a busy one ahead

It's been a very challenging year for BCI and the industry as a whole. You've had a conspicuous success with the DTSC (see separate page) but you've also had a new administration to deal with, a completely different approach to industry regulation, and all this mixed up with the vicissitudes of the pandemic.

So could we start by asking you about BCI's existing workload and what the change of president mean for BCI's workload in the future?

In many ways what we're facing now is the new normal. The struggles and pressures from state and federal OSHA regimes will continue and likely increase. California, for example, will continue to be the leading state for environmental regulation pressures on the industry, and numerous federal EPA and OSHA rulemakings will move forward in the coming years.

President Biden has a completely different approach to environmental health and safety and other regulatory issues than that of the previous administration.

His administration will implement a new set of policies and priorities, and many will have both direct or indirect impacts on battery storage technologies writ large, and the lead battery industry's role to play in those energy storage technologies.

Specifically what are president Biden's policy priorities? And how will they affect the lead battery industry?

The new administration has been upfront about its priorities and goals. Key among them are promoting clean energy and climate change reduction policies.

The president is committed to reducing our carbon emissions to half of 2005 levels by 2030. This is a dramatic and aggressive goal that throws the emphasis on renewables such as solar and wind generation;

Energy storage — for all chemistries — is going to play a critical role if the administration hopes to achieve this. Lead batteries can and will play a critical role in meeting that demand.

As another facet to this, we're also seeing a renewed commitment to environmental justice. This has been a core concept of Democrat administrations for many years, going back to the Clinton years at least.

We also see highly ambitious goals such as those embodied in the infrastructure bills which are currently being debated on Capitol Hill.

What's in there today may not be there in the future — this is going to take a long time to get through Congress — but we see things such as the billions in federal funds dedicated to batteries, battery research and energy storage as being highly important. These are key topics for BCI and this industry to be engaged in — we need to ensure that the lead battery industry is not just recognized, but also an active participant once that funding goes ahead.

What about the personalities associated with the policies in the EPA?

The Environmental Protection Agency has a new administrator, Mike Regan, former secretary of North Carolina's Department of Environmental Quality and an air quality specialist in the EPA.

The president is committed to reducing our carbon emissions to half of 2005 levels by 2030. This is a dramatic and aggressive goal that throws the emphasis on renewables such as solar and wind generation

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Administrator Ragan has taken a couple of clear steps to reorient the policy direction of the agency, and to place environmental justice at the centre of its thinking. For example, he has directed all EPA offices and programs to more fully integrate environmental justice into their planning.

He also has reset the full membership of the EPA advisory committees for clean air and science which were held-over from the prior administration.

This gives him and the new EPA staff the freedom to pick who they want to be on the advisory committee. It likely will dramatically increase representation of environmental justice and climate change advocates.

Meanwhile, the White House has established an Environmental Justice Advisory Committee. As a White House level advisory committee, it will have influence in helping the president and his staff direct the activities of all federal agencies, including EPA.

EPA has long had a policy of integrating environmental justice considerations into rulemaking and other actions. But to see such a clear, upfront and vocal commitment indicates we're going to see something very different.

And the new figure at OSHA?

At OSHA, similarly, we're going to see a dramatic change in the way that this administration looks at its regulatory ambit.

In mid-April president Biden nominated Doug Parker, to lead federal OSHA. Parker was the head of California's OSHA agency, and formerly an advocate for worker safety at Work Safe and at the United Mine Workers of America and a former Obama administration official.

He will bring a different approach than the Trump administration did to OSHA activities. (Although the Trump administration never managed to get a politically confirmed appointee at OSHA.)

Biden has already issued orders for OSHA to increase its inspection tempo. Earlier he promised doubling the number of inspections per year over Trump administration's levels, which were at an all-time low

A revisitation of the federal rules on occupational lead exposure have been on the regulatory agenda since the Obama years, but were untouched throughout the Trump years. Recent statements from OSHA staff indicate that effort will likely move forward during this administration, with the most recent OSHA regulatory agenda suggesting it could start in 2021. In summary, we now expect all or nearly all of the federal EPA and OSHA regulations relevant to lead to come under review in the next few years.

These aren't necessarily Biden administration actions, most of these rule updates have been in the works for some time — some are statutorily required, some are required by court order. But, the Biden administration will certainly bring an approach to these effort dramatically different than prior administrations.

On the table below are probably the most immediate areas to be looked at, which we know agencies are actively working on. They regulate the entirety of the lifecycle of the lead battery recycling and manufacturing cycle, and systems.

The relative regulatory quiet of the past few years is going to change just out of necessity — our industry needs to respond to all of these regulatory actions.

Lead is on the TSCA Work Plan list of chemicals which Congress required EPA to review. Therefore, lead's review under the TSCA programme is a question of when — not if — lead is selected

The US has a similar process to Europe's REACH regulations called TSCA which deals with controlling what chemicals can be used in the country. The REACH process in Europe has been long and convoluted, do you think TSCA will be the same in the US?

The other big toxic substances review programme is the federal EPA TSCA (Toxic Substances Control Act) programme. The next round of chemicals will probably be selected in 2022. It is similar to Europe's REACH process and can take as long as eight to 10 years to reach a conclusion.

TSCA protects health and the environment by authorizing EPA to issue rules requiring the testing of specific chemicals and to establish regulations that restrict the manufacturing, processing, distribution in commerce, use and disposal of chemicals and mixtures.

We're in the middle of EPA reviewing a batch of 20 chemicals. As those reviews finish, they'll start naming the next group of chemicals next year. There are enough chemicals on the EPA's work plan to last them for the next roughly 70 years of work, and that list is not all-inclusive of the 40,000+ chemicals currently in use in the US. So it may not be immediate for some chemicals.

That said, lead is on the TSCA Work Plan list of chemicals which Congress required EPA to review. Therefore, lead's review under the TSCA programme is a question of when — not if — lead is selected.

When that selection occurs, our industry will be required to pay an

REGULATION

EPA

- National Ambient Air Quality Standard (NAAQS)
- National Emissions Standards for Hazardous Air Pollutants (NESHAP)
- New Source Performance Standards (NSPS)
- Toxic Substances Control Act (TSCA) (~2025?)
- Superfund Soil Screening Levels

OSHA

- Federal workplace lead regulations (~2021?)
- State OSHA implementations (California, Washington, Oregon)

A CALL TO ARMS

Is the BCI regulatory workload going to keep climbing in the near term?
Our advocacy efforts inevitably are going to increase in the coming years. We knew that that was happening before the presidential ballot. Certainly the Biden administration's refocus on environmental justice and occupational safety issues is only going to increase the risk of continued activity, and more aggressive regulatory approaches.

We all need to work together. It's critical that members be involved so that we can hear their priorities to ensure those are reflected in our agenda.

It's up to us all to make sure that our stakeholders understand that lead is a well established technology and reputable chemistry. We in our industry are going to be have to be the ones to tell that story. BCI makes an outsized effort to reach key stakeholders and audiences, but individual member firms need to be] active in BCI's work too.

One thing is certain, your competitors are not going to do it for you!

LEAD COMMUNICATION CAMPAIGN

JANUARY

- **Launched new website:** Better user experience, easier resource access, new topics: News release, video, social media
- **Launched Domestic Supply Chain campaign**: Blog, news release, video, infographic, social media, social share graphics, new web page
- **Other blogs:** Essential Insights (Chris Pruitt); DOE Energy Storage Grand Challenge (John Howes)
- **News release:** Biden Administration's Build Back Better plan

FEBRUARY

- Celebrated National Battery Day, February 22: Blog, news release, video, infographic, fact sheet, social media, social share graphics, member toolkit

MARCH

- **Celebrated Global Recycling Day, March 18:** Blog, video, social media, social share, GIF
- Celebrated March 23rdNational Ag Day, & the batteries that help farmers: Blog, social media

APRIL

- **Earth Day Week April 19-23:** Blog, video, social media, social share graphics, GIF, member toolkit.

upfront fee—currently about $1.3 million—and then also be deeply engaged in an intensive scientific effort and representation of the facts.

BCI and the lead battery industry have led the way in improving air quality standards, what is the current EPA position?
EPA has started its review of the national ambient air quality standard. This programme sets the amount of lead allowed to be in the ambient air and the communities surrounding battery facilities. At present, it is set at 0.15µg/m^3, which was reduced in 2008 from 1.5µg/m^3. EPA completed one cycle of review in 2016 — they're required to do them every seven to eight years — and the next cycle was initiated late last year.

In the last review, EPA found that no further reductions to the standard were necessary. However, there were those on EPA's Children's Health Advisory Committee that recommended EPA should further lower their ambient air standards.

Last year the EPA invited industry and other stakeholders to submit studies and data that had been published in the peer-reviewed literature since the last review.

We will likely see the first version of their science assessment, maybe later this year in a very early draft format, but more likely next year as they start to finalize it.

In the next couple of years, they will move towards a decision on whether to change that standard or keep it as is.

Also under review under a related program, the National Emission Standards for Hazardous Air Pollutants (NESHAP), are the emissions and operating requirements for battery manufacturing facilities.

BCI HAS THREE KEY REGULATORY AND ADVOCACY GROUPS

The EHS steering group is the key committee.

These members and their representatives provide guidance to the BCI staff, and outside consultants and legal teams on how BCI should approach these regulatory challenges and advocate on behalf of the industry.

BCI also has an **Energy Storage Systems Initiative Committee,** which is implementing a specific project the BCI launched two years ago, to seek to continue to promote the use of batteries for use in energy storage systems, as well as advocating for increased research dollars in funding an activity at the Department of Energy's National Laboratories, utilities and other places.

This committee will be taking a significantly increased role in reacting to the new administration's desire to strengthen the supply chain and battery capabilities in the US.

BCI's core communication program is the **Advancing Lead Batteries Communication Initiative.** This is headed by Lisa Dry who is based in Washington. Its job is to advocate to regulatory stakeholders and legislators the whys and wherefores of the use of lead batteries and the impact of lead battery manufacturing and recycling on the wider society.

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EPA is also required to review these periodically. So there's not necessarily any indication that there's a problem with them. But we do know that EPA is looking to make updates to various elements of the rule.

So the OSHA view on air lead levels is different and depends whether you operate as the state OSHA or the government one?

OSHA regulations focus on worker exposure, and therefore focus on indoor air lead controls. Over the past few years, we have seen a handful of states (California, Washington, Michigan and Oregon) start work to update their state versions of the federal OSHA regulations.

With federal OSHA looking to revisit the nationwide rules, those state efforts likely will be a starting point for the federal effort.

Air lead control technologies are highly capital intensive. California is pushing to move the indoor air limit (termed the Permissible Exposure Limit or PEL) from 50µg/m^3 down to 10µg/m^3 — regardless of whether you're wearing PPE or not —and this will require significant capital investment to comply.

For example, when we were working with California on a proposal in 2016, the California facilities estimated that moving lead from 50µg/m^3 to 10µg/m^3 in just six key areas of the plant could consume 50% of company profits every year for 10 years of implementation.

This result triggered the economic feasibility considerations that OSHA agencies are required to take into account in rulemaking. In California and in Washington state (which is looking at similar updates), both regulatory bodies have developed draft rule concepts which provide facilities the flexibility to designate certain areas as requiring greater PPE and hygiene protections where additional air controls would be infeasible.

Our focus has been to recommend that OSH regulators focus on those measures which are most effective at controlling worker blood lead levels, which in many instances can be more feasibly—and very effectively—controlled through measures other than facility-wide air lead controls.

Now with the federal OSHA rule-making effort forthcoming, that conversion will move to Washington, DC.

BCI has led the way in lowering blood lead levels — anticipating legislation ahead of the regulators — could you tell us more about this and what the present discussions will be focused on?

BCI members have been successful in the voluntary blood control programmes. In 1997, this industry signed a five year agreement with federal OSHA to seek improvements in the blood lead levels across the

BCI members have been successful in the voluntary blood control programmes. In 1997, this industry signed an agreement with federal OSHA to seek improvements in the blood LEDs across the industry.

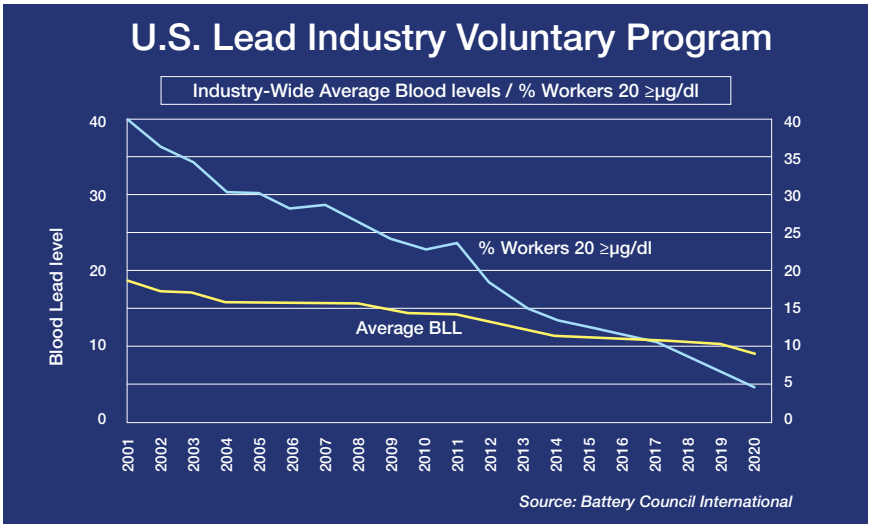
industry.

The industry agreed to move from the federal removal of 60-50µg/dL and drop that 10 points to 50-40µg/dL.

Based on the success the industry saw with that first five-year effort, the industry committed to continuing the voluntary program. Over the course of the past 20 years, the industry has regularly lowered the targets to drive continuous improvement across the industry.

The current program sets a target of having all workers below a blood lead of 20µg/dL by 2025, and we are well on our way to meeting that goal with more than 95% of the US workforce below that level today.

As state and federal OSH regulators look at revising the occupational lead standards, BCI and our members' efforts pay dividends in demonstrating to regulators the industry's commitment to worker safety and how our shared goal of keeping workers healthy can be achieved. ■



DTSC recognizes importance of lead in vindication of BCI campaigning

Lead-acid batteries have been removed from the California Department of Toxic Substances Controls' list of potential 'Priority Products', it was confirmed in late April.

The action is a major victory for BCI, which has been campaigning for the past five years to make sure lead batteries were not included on this list and a huge boon to the future of the industry.

"BCI's efforts were founded on key aspects of the industry — most notably the demonstrated safety of the product, the lack of viable alternatives, and the breadth and depth of the existing regulatory regime for manufacturing and recycling," says BCI Executive Vice President Roger Miksad

"So we're very proud of that work. Our advocates in California have dug deep over the last couple of years to make sure DTSC had all the information they needed.

"DTSC has recognized the importance of batteries and the inappropriateness of inclusion in that program."

'Priority Products', listed under the DTSC's Safer Consumer Products Program, must undergo an Alternatives Analysis process whereby manufacturers have to evaluate other options to find fewer toxic chemicals to use in their products.

Lead-acid batteries were added to the DTSC 2015-2017 Work Plan for consideration as a potential Priority Product because they contain three 'Candidate Chemicals': lead, arsenic and sulfuric acid.

"Lead exposures to workers and neighbouring areas may occur during recycling and manufacturing operations," the Work Plan said. "Lead exposures are known to cause neurological as well as other effects, and arsenic is a carcinogen. Lead exposure to children is especially of concern since there is no known threshold concentration for neurological effects."

But among other arguments against the potential move, put forward by the industry, is that the sector is already extremely tightly regulated and poses no harm to consumers.

After a rigorous evaluation of potential life-cycle impacts, current regulations and product innovation, the DTSC has now agreed to exclude lead batteries.

Miksad said the key facts that BCI also stressed were the breadth and depth of the existing regulatory regime and also the ongoing R&D going into new battery and recycling technologies.

In a nine-page letter to the DTSC in March 2018, the council said: "Prematurely mandating that California consumers and businesses switch from a proven safe, economical and proven battery technology to new and unproven battery technologies with known significant environmental and public safety risks, and unknown long-term impacts, would not meet the agency's statutory mandate.

"DTSC action on lead batteries may also have the unintended consequence of reducing the value of recycling for lead batteries, upending the current closed-loop life cycle.

"This could perversely cause more lead batteries to wind up in landfills or with less responsible processors, a result nobody wants to see."

In its final Priority Product Work Plan for 2021-2023, the DTSC concluded that 'listing lead-acid batteries as a Priority Product is not likely to further enhance protection to human health'.

"This outcome is the right one and recognizes that lead batteries are critical to meeting America's energy storage needs and are already well regulated," said Miksad.

"The industry's highly successful closed-loop recycling system and investment in new technologies and innovations also means that lead batteries hold the promise of delivering safe, sustainable energy storage in the future." ■

Battery Council International has warmly welcomed the passage of a package of measures that include $7 billion for the battery industry — with no chemistries ruled out.

BCI helps direct $7 billion boost for batteries to lead

Passed by the US Senate on August 8, the Infrastructure Investment & Jobs Act is the culmination of months of negotiations across both parties, and it authorizes $1 trillion in total spending on a raft of initiatives, such as roads and bridges, water, broadband, electric vehicles — and batteries.

BCI and its members have been working tirelessly behind the scenes to have some influence on the scope of the provision for batteries.

"We are very encouraged that Congress has recognized the importance of domestic manufacturing of battery technologies of all sorts," said Roger Miksad, executive vice president and general counsel at BCI. "Congress's significant investment in American battery manufacturing will pay absolute dividends to the country for decades, and lead batteries are rightly one of the key industries in which America should invest."

Thanks to BCI and its members, the spending on battery-related provisions will include all battery chemistries, which means lead technologies can apply for some of the $7 billion in incentives to develop manufacturing and recycling capacity.

"What our work has done is help to inform the conversation on Capitol Hill," says Miksad, who said conversations were always being held with policy makers and legislators to ensure domestic legislators recognized the importance of the existing domestic lead battery industry and the work being done by American manufacturers and American consumers.

"Legislators that have facilities in their districts we find are well informed on lead battery manufacturing and recycling. Certainly, in the public press, lithium batteries get much of the attention, but when stakeholders like legislators and other regulators are informed of the benefits of lead batteries we find them to be very excited by the promise of domestic manufacturing satisfying those energy storage needs."

Lisa Dry, BCI vice president of strategic communications, has been instrumental in conceiving and promoting Essential Energy Everyday, a website that BCI manages on behalf of its members.

Lisa Dry: "Change doesn't happen in a vacuum. Our members have been right with us since the launch of our communications programme in 2017"

"Change doesn't happen in a vacuum," she says. "Our members have been right with us since the launch of our communications programme in 2017, and for nearly four years they've also been investing, and helping policymakers know more about lead batteries, their benefits, their future, things like that."

Need for secure supply

Miksad says there are three major factors that are helping the lead battery industry in the US: the recyclability of lead batteries; the low cost; and the domestic nature of the American supply chain, which provides a secure supply chain in a globally competitive environment in the face of global disruptions like Covid or other things that may come in the future.

"Certainly, Covid has meant we have had supply chain impacts like everyone else," he said. "But what we have seen is that we were insulated from the international supply chain disruptions that have shuttered factories in other industries given our domestic sourcing for most of the lead, plastic and sulfuric acid."

The same could not always be said for other battery industries, such as lithium-ion manufacturing in the US.

Miksad said that while BCI 'loved all batteries' and fully supported a lithium-ion manufacturing base, it doesn't exist yet and there have been significant supply chain issues with it over the last two years.

Miksad said one of the key technological innovations on the drawing board was the deployment of semi-local battery storage in the form of large lead batteries providing storage for a group of homes or a recharging facility at a petrol station. This would help support the electric grid when facing the very erratic delivery curve that electric vehicles would have on the grid.

"If you look at the projects for the true electrification of the vehicle fleet in any major developed country, current electric grids are not going to meet the electricity demand – they're just not built for it," he said. "So the grids will have to be upgraded, and integrating them with large-scale storage facilities and even local ones, all of those applications are going to be critical for ensuring the grid can meet future demand."

The industry will be free to apply for the incentives however they choose since Congress's function stops at granting federal agencies the authority to invest in technological areas, but not which specific projects they should fund.

"One of the key sections of the bill directly deepens a government incentive programme to incentivize industry investment in manufacturing and recycling capacity," said Miksad. "We don't know how the relevant agencies will implement it, but they're setting aside most of the $7 billion to manufacturing and recycling capacity building.

"Absolutely at the foundation of Congress's goal is to help make the States less reliant on foreign-sourced critical technologies." ■

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Ray Kubis, chair of Gridtential gave a presentation in April on how the transportation sector will shape up as the electrification of transport heats up. This is a summary of his views at this year's BCI virtual conference held on Earth Day. A link to the full paper can be found at the end of this article.

Bright spots in an overcast future

The logic was formidable, if challenging for the lead battery market. Lithium batteries will dominate the automotive market as the pace of electrification of transport continues to accelerate. That said, lead batteries will continue to have a future role and their immediate outlook is far from bleak.

This was the forecast by Ray Kubis, a veteran of some 40 years in the lead battery market having held some of the most senior positions at Johnson Controls (now Clarios) and EnerSys in the past 20 years.

The overall picture was of a now-familiar landscape — phrases such as decarbonization, climate change and net zero emissions are part of the new vocabulary of scientific opinion. All this was put into the context of transportation batteries and a market sector recovering from the pandemic.

Kubis early in his talk set the context for the new EV revolution, powered by lithium batteries, and where the market was inevitably heading.

"Tesla's $700 billion market value exceeds the value of the 10 largest car companies combined in mid-April," he said. "QuantumScape and others have the cash and multi-billion dollar valuations backing their lithium battery improvement plans.

"There are at least 100 other battery, vehicle and charging start-ups receiving hundreds of millions of new investments from governments and private investors, and now also from special public acquisition companies."

Kubis said: "It's safe to say with so many researchers with so much more money behind them, we will get better, cheaper and safer lithium batteries, even if the timing and costs of the improvements are difficult to call. However, I am sceptical of claims to $50 or $75 per kWh in lithium. Advancing science is helping, yet this is still material science, not electronics, so Moore's law does not apply."


Ray Kubis

Kubis reckoned that further reductions in lithium battery costs of 3% per year were possible — "not the 10% or so, some may claim",

Looking away from the rise and rise of the electric vehicle and hybrid market — which can be found in full in his paper — here are some of the major projections.

Kubis split the forecast into two major groupings to illustrate the impact from the changes in vehicles and batteries.

The SLI and Stop/Start segment includes the OE and replacement batteries for vehicles with combustion engines, plus auxiliary batteries, and specialty uses for marine, RV, utility and motorcycle applications.

"The unit and energy content for this group is forecast to grow 3%/year, increasing by 100GWh to 659 GWh by 2025 with 97% of the power and energy coming from lead and advanced lead batteries," he said. "The value is forecast to increase at an average of 10% per year due to the rapid growth of better higher performing AGM and EFB batteries, and also bipole batteries."

The second grouping of batteries is for all versions of electric and hybrid transportation applications from the smallest eBikes to the large eBuses, and all vehicles in between.

"Across the five years to 2025 both the energy content and value increases by approximately four times to nearly 900GWh of demand and a value of $172 billion. By then some 94% of these batteries worldwide will be lithium-based technologies," he said.

"Low cost lead-based batteries will continue to offer value in some low speed EV type applications from golf carts, to tuk-tuks to eMopeds in many countries.

"Combining the battery applications in the forecast, we have a compound growth of 15% or a doubling of the global demand by 2025 to over 1,500GWh or 1.5TWhr. The actual capacity in energy will be split nearly 50/50, while the value of batteries sold will be about three times as high for lithium batteries at $166 billion.

However, lead-based batteries are still forecast at $52 billion, as continued improvements in performance sustain many transportation applications.

"Yet, don't write off lead batteries with their low cost and perfect example of an infinitely recyclable solution. This is because advanced lead batteries are on multiple complementary tracks also to improve performance, life and cost by two or three times or more," he said.

"This is thanks to the efforts of the research consortiums including CBI, LBSRP, and some companies who are driving better active materials and bipolar formats.

"Lead-based batteries are not going to power 500 mile range light vehicles, yet their potential to aid and accelerate the clean energy transition to net zero is significant in so many transportation and ESS and industrial applications that it should not be overlooked. The technology has a proven and unique track record for a circular economy, along with its demonstrated low cost and safety.". ■

To view the entire presentation slides and content copy or type this link into your browser: https://secureservercdn.net/166.62.114.250/tz2.6ba.myftpupload.com/wp-content/uploads/2021/05/041921.Gridtential.Ray_Kubis.BCI_SuperchargedNotes.pdf

New initiatives, same goals

As the race in EV sales accelerates, low-voltage advanced batteries will play a prominent role, writes Mark Wallace, president & CEO of Clarios.

President Biden recently announced new emissions standards with a target that 50% of vehicles sold in the US by 2030 will be electric. It's an ambitious number, surpassing previous forecasts, and among other issues the American public will take some convincing to adopt the technology: however, the goal that has been set is definitely achievable.

Already in Europe and other parts of the world, where consumers' tastes are evolving, some environmental plans include banning internal combustion vehicles by 2035.

The European Union's 2050 climate neutrality mandate further spotlights the trend toward EVs and hybrids. To the auto industry, already wrestling with both global disruption and transformation, President Biden's announcement could be perceived a few different ways — a challenge to some, an aspirational goal to others, and a reality check to the rest.

The Clarios team has been anticipating this transformation. For everyone else, I would emphasize that this administration's EV announcement is simply confirmation of renewed optimism across the battery industry.

No matter the vehicle type, 12V batteries play an important role — both now and in the future. They are predictable, reliable and sustainable. Critical systems in both EVs and hybrids are powered by low-voltage batteries.

Critical role

As autonomous vehicles take a greater share of the marketplace, the critical role of low-voltage batteries will become even more important in powering their state-of-the-art electrical and safety components, including ADAS, LIDAR, RADAR and advanced computing systems.

Long-term, healthy growth of low-voltage batteries and the smart energy storage sector also coincide with a growing populace. The 2050 prediction that the global population will expand by two billion people has long been known.

In 2035, not only will there be a population boom, the purchasing power of the middle class will increase and there is an estimated need for more than 200 million additional batteries.

On top of the functional and practical need for low-voltage batteries going forward, our industry serves as a world-class example of a functioning circular economy. Up to 99% of the materials in conventional car batteries can be recovered, recycled and re-made.

This allows us to produce not only environmentally friendly products, but also ones that are cost-efficient versus other technologies.

At Clarios, we focus on the right chemistry for the right application across the life cycle, and that is also a sentiment I believe should be shared across the marketplace. No matter how our battery technology evolves, life cycle stewardship cannot be taken for granted.

Influencing the influencers

Even as we reflect on the growing opportunities, there is still work to do to educate our policymakers in Washington, DC on the need for low-voltage batteries and the benefits they provide.

I applaud industry leaders like BCI and others for reaching out to both sides of the aisle to relay such important facts, as batteries from our industry represent 60% of the worldwide rechargeable battery storage capacity and there are 90,000+ battery-related jobs from our industry in the US alone.

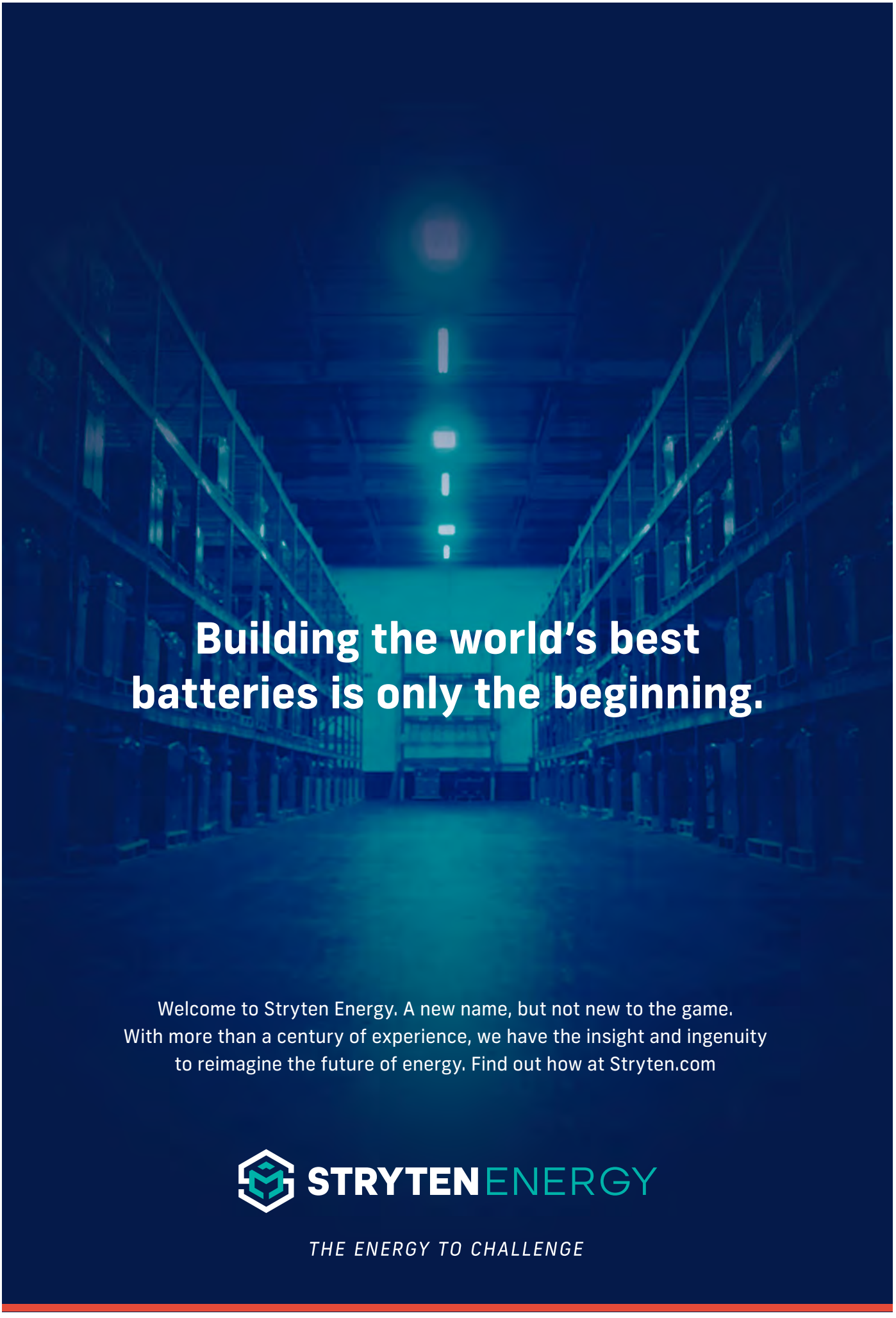
It may take time to alter public perception on the role batteries play in the US car parc and abroad, however, aligning with lawmakers is an ongoing priority and an area where progress is being made.

Whatever initiatives are proposed in Congress, we must seek alignment with the sustainable goals of smart energy technology while communicating the dynamic and domestic infrastructure in place for batteries.

Our industry is so strategically positioned to thrive with these upcoming demands. The resounding fortitude we showed through Covid-19 gives me confidence that we will be able to pivot to overcome virtually any obstacle.

As the US joins the rest of the world in accelerating the adoption of electric vehicles, I know you will join me in setting the bar even higher for responsible innovation. ■

Long-term, healthy growth of low-voltage batteries and the smart energy storage sector also coincide with a growing populace. There may be an extra 2 billion people on the planet by 2050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THE ENERGY TO CHALLENGE

Nick Starita, president of the Energy Solutions Division at Hollingsworth & Vose delivered his forecast for industrial battery market for 2021-2023 at the BCI virtual conference this April. Hillary Christie reports.

Cautious but hopeful for the next three years

Starita presented aggregated data from BCI reporting members on the effects of the pandemic and what sectors are poised for a strong recovery. His talk looked first at the motive power and stationary market segment before moving on to look at grid storage.

BCI members' forecasts show that, despite the setbacks in 2020, segments of the lead battery market are still showing growth and have potential.

Opportunities include Telecom's preparations for 5G expansion, a majority share of the stationary market's predicted 3.8% annual growth rate through 2023 to $855 million.

There is also the slow but steady overall compound annual growth rate of the motive power industry at 2.4% for 2013-2023 with an estimated $1.2 billion in 2023.

Some areas of the market suffered from the uncertainty and disruption caused by the pandemic, though key stationary applications proved essential and had relatively minor slowdowns. Others, such as motive power and telecom, saw delays and setbacks that are now beginning to recover as the economy bounces back and companies work through the pent up demand.

The motive power market, driven primarily by the industrial truck segment with smaller mining and rail segments, declined by about 10% to $1 billion compared to 2019 figures. The compound annual growth rate since 2013 is 1.3%, though Starita explained that, pandemic aside, the market has grown steadily at about 3%.

BCI members forecasted CAGR over the next three years with the motive power market growing 5.1% to $1.17 billion and the stationery market to grow at 3.8% to $850 million.

The pandemic hit the hospitality industry hard, affecting food delivery to restaurants, hotels and schools, and also lift truck rental activity related to outdoor events. Contrasting this was the boost in grocery delivery, ecommerce warehouse and big box material handling, all of which fared well as people stayed home and opted to have goods delivered.


Nick Starita

During economic turndowns, ICE truck applications, port activity, construction, etc. are worse hit than electric truck applications such as retail food and groceries. The long term trend for motive power battery units declined by about 6.4%; truck units were down by about 6.7% to 135,000 electric trucks.

Looking at the trends in Starita's reports, typically-electric truck applications are growing faster than typically-ICE applications, and annual electric truck shipments have grown by almost 50% as ICE shipments remained stagnant.

This 'electric dominance' is largely driven by ecommerce and productivity. Where goods and materials are being moved indoors, the fast charging and maintenance free electric trucks and material handlers tend to be favoured over ICE models.

Another factor in widespread electrification is the introduction of new regulations. In California, the 2035 Emissions Free Executive Order will heavily influence the conversion from ICE to electric. Starita believes other states could follow suit.

ICE to electric industrial truck conversion is where lithium tends to dominate and Starita quotes experts' that say lithium makes more sense in purpose-built fleets and conversions.

Starita reported an overall slow decline of -3.2% from 2013-2020 in the tationery market, though the sector was slightly up in 2020 to $765 million. Growth in this market is primarily sustained by the communications and telecom segment, though stationary is also made up of switch gear, UPS and miscellaneous standby segments.

Telecom and data weathered the pandemic by nature of their essential services. Telecom alone saw an 8.7% growth to $330 million in 2020, with the majority of growth in monobloc batteries.

There is activity in the field of 5G, particularly in replacement batteries from the dot.com boom installations 20 years ago. Changes, upgrades and new installations supporting the expansion of the 5G network have increased the need for power to the sites, which in turn creates a need for more backup and increased power density requirements for batteries.

One segment of the market still opting for lithium, despite a higher dollar per kWh price tag, is UPS, which declined by 5.1% to $244 million in 2020. New data centre builds are choosing lithium for its longer life, better data integration and smaller space. However, mostly, lead is still being replaced by lead — there is little return on investment by converting an existing lead battery UPS system to a lithium.

Associations throughout the US have set targets in the transition to renewable energy. ESA's previous goal of 35GW by 2025 has increased to 100GW by 2030, and four clean energy associations have committed to a target of 50% of US electricity to be generated by renewable sources by 2030.

Starita said that 98% of these installations are using lithium, and therein lies the biggest challenge to the lead industry. However, the enormous amount of interest and investment proves there is still opportunity for lead to make an impact in the green energy transition.

Starita thanked American Power Systems, CBI, Critical Power Solutions, Crown Battery, East Penn, EnerSys, Eternity Technologies, GS Yuasa, ITA, MPINarada, SAFT and Stryten for their help in compiling the information. ■

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DuraLife+ is the latest development by Daramic to improve performance of enhanced flooded batteries.

Addressing the challenges of enhanced flooded batteries

Daramic, the global separator firm, has been a consistent nomination for BCI's innovation awards coming up with a stream of high quality products designed to advance lead battery performance.

In particular, the firm, a subsidiary of Japanese chemical giant Asahi Kasei, continues to keep pace with the demands of a rapidly changing automotive market. Since the turn of the last century international regulators have tightened the pressure on automotive OEMs to increase fuel efficiency and limit tail-pipe emissions.

The result has been the rise of stop-start cars. The pressures on batteries that have to stop the engine and then turn it on seconds later is immense. The average flooded battery — still the more or less standard for stop start cars — can last for about 30,000 starts and till a decade or so ago the only batteries capable of doing several times more than this were the more expensive AGM ones.

Daramic was one of the early pioneers in pushing out the capabilities of enhanced flooded batteries — these were adaptions to flooded batteries that improved performance without costing the earth. As an approximation an EFB should be able to achieve around 85,000 starts.

For Daramic a set of complex, inter-related problems needed to be solved — charging and discharging while the battery was in a partial state of charge, water loss, a major factor in early battery failure, limiting dendrite formation and generally extending battery life. These were all issues that had to be addressed.

All these problems were ones that Daramic had been researching for some time.

Its R&D research team for years had looked at three particular areas in boosting the performance of polyethylene separators: adjusting the separator profile, improving the separator formula; and how additives, notably carbon, boost performance.

Solutions to many of these had already been found. One way of improving the separator profile had been achieved by adjusting the ribbing running through the separator.

As early as 2014 Daramic had developed a revolutionary product, DuraLife, for high performance batteries that used cross negative ribs.

DuraLife, launched in 2014 in Asia and the rest of the world in 2016 in particular is already sold in high volumes (particularly in hot climate countries) as it mitigates water loss and grid corrosion.

Over the years further improvements have been made. The most recent separator launched by Daramic goes even further.

"With an optimized formula design building upon the success of DuraLife, this new product is able to maximize the electrical performance and dynamic charge acceptance while keeping the advantages and benefits of reducing water loss and grid corrosion, especially under hot temperature working environment — known as DuraLife+ it is designed specifically for the EFB market," says the firm. ■

DuraLife+ attributes	
Water loss (g/Ah)	0.7
Electrical resistance (mΩ-cm^2)	50
Oxidation resistance (perox, 40 Hours)	175
Leachable organic carbons (ppm)	150
Runnability (% envelope rejects)	X/2

ADVANTAGES AND BENEFITS

Advantages

- Excellent for high under-hood temperature applications
- High puncture and oxidation resistance
- Patented formulation with enhanced water loss technology
- Patented negative cross-rib design improves PSoC life and enveloping
- Optimized formulation to maximize electrical performance
- Available in a wide range of product profiles
- Approved for use in aftermarket and OEM battery applications

Benefits

- Improved overall battery electrical performance and PSoC life
- Extends battery life by up to 25%
- Battery water loss reduced by over 20%
- Lower risk of battery failures associated with dendrite shorts especially in EFB designed for high power and narrow plate spacing
- Improved enveloper runnability; rejects reduced by up to 60%

For Daramic a set of complex, inter-related problems needed to be solved — charging and discharging while the battery was in a partial state of charge, water loss, a major factor in early battery failure, limiting dendrite formation and generally extending battery life.

Women in the Lead Battery Industry Networking Reception

Thursday afternoon
September 23, 5.00-6.00 pm

This is much, much more than a sociable drink for the female attendees at the convention. Part of the networking reception will announce the creation of a new group, tentatively named Women in the Global Battery Industry (WGBI), to promote and develop the growth of women working in the battery industry. This should be launched next year.

"The organization is to bring women in similar industries together to derive benefit for themselves and their companies through relationship building, education, and shared knowledge," the group says. "The group's programs and activities will be intended to enhance members' skills and experience, address challenges confronting the industry, and promote members' career growth with the ultimate goal of increasing the number of women employed in the battery industry."

BCI is a proud supporter of women working in the lead battery industry.

The event is sponsored by Calpine Energy Solutions.

BCI Golf Tournament

Wednesday
September 22 — 11.30 am

It's back to the first principles of US conferences. Where any two or three battery men (or women) are gathered together at a convention, a golf event is obligatory. And why not the day before the serious work begins?

BCI conventions wouldn't be the same without a chance to wield your putter in the sunshine and thrash your business rivals in an oh-so-friendly game of golf.

The event, sponsored by ENTEK, requires pre-registration.

Opening reception

Wednesday afternoon
September 22, 6.00-7.30 pm

This is the ideal time to slip into conference mode and catch up with industry colleagues and friends over light snacks and alcohol.

Power Hour reception

Thursday afternoon
September 23, 4.00-5.00 pm

The end of Day One is always worth a celebration and what better place to wander around — drink and snack in hand — than the exhibit hall and checking out your industry shopping requirements. Or what your rivals are up to!

The closing reception will be held on USS Midway

Unmissable. That was the consensus of BCI delegates after visiting *USS Midway* for the opening ceremony of the 2014 convention.

Friday evening
September 24, 6.30-9.30 pm

"It was fascinating — a huge slice of American military history combined with the romance of flying and one of the best venues that we've had to kick off the event," said one delegate.

And it's going to be unmissable again, as the closing venue for the conference and exhibition. That's Friday evening September 24 from 6.30-9.30.

The ship — which entered service a week after the Second World War ended — has played a key role in many parts of world history and has been on active service from the freezing colds of Arctic winters to the torrid heat of the South China Seas.

The ship has been both an active military striking vessel — playing a key role in Operation Desert Storm in 1992 after Iraq invaded Kuwait — but has also been a place of refuge during calamity.

Over a chaotic two days during the fall of Saigon in April 1975, *Midway* was a floating base for large USAF helicopters that evacuated more than 3,000 desperate refugees during Operation Frequent Wind.

The rush to escape Vietnam was also the foil for one of *Midway's* strangest rescues that same April. Buang-Ly, a Vietnamese major worried about the fate of his family as the North Vietnamese took control, crammed himself, his wife and five children into a two-seat Cessna in a desperate bid for freedom.

Buang evaded enemy ground fire and headed out to the South China Sea. He was now beyond the point of no return, his life and that of his family depending on finding the *Midway*. Finally he found her. He began to circle overhead with his landing lights on. *Midway* unsuccessfully tried emergency frequencies to contact him. Just then a spotter reported that there were at least four people in the two-seater — ditching into the sea was no longer an option.

Finally — on his third pass — Buang managed to drop a note on to the deck saying: "*Can you move the helicopter to the other side, I can land on your runway, I can fly for one hour more, we have enough time to move. Please rescue me! Major Buang, wife and five children.*"

Captain Larry Chambers, the ship's commanding officer, called for volunteers, and soon every available seaman was on deck to help. They cleared the deck of helicopters — some that could not be safely and quickly moved were even pushed over the side.

With poor visibility, rain, and gusty wind, it would be a difficult landing. Chambers ordered the ship to sail at 25 knots into the wind. To complicate this, five more UH-1s landed and cluttered up the deck. Without hesitation, Chambers ordered them scuttled as well.

It all ended well. The Cessna bounced once and came to a stop abeam of the island, amid a wildly cheering, arms-waving flight deck crew.

The crew of *Midway* was so impressed that they established a fund to help Buang-Ly and his family get settled in the US.

The ship has also been the scene of accident and near accidents in its almost five decades of active service.

The flight deck where the reception will be held has been expanded three times in the history of the carrier as the sophistication, speed and striking ability of the fighter planes has developed.

But this same deck has also seen crashes, near misses and some extraordinary feats of piloting skills. Don't forget to visit the restored aircraft and helicopters on the flight deck and below in the hangar deck.

The *Midway* was decommissioned in 1992 and opened as a museum in San Diego in 2004. It's a glorious piece of American history and an exciting site for hopefully the closing night of another exciting BCI convention. ■

***USS MIdway* when active, left, and onboard as a museum since 2004**

Happy days revisited: the opening ceremony of the 2014 convention

Introducing the keynote speakers

Mark Mills

Thursday morning, September 23

Keynote speaker one at BCI in September is Mark Mills, senior fellow of the Manhattan Institute and co-founder of the Montrose Lane energy-tech venture fund. His presentation, 'Mines, Minerals and "Green" Energy: A Reality Check', will be given on the opening day of the convention.

Mills began his career as an experimental physicist on the back of his BSc in physics from Queen's University, Canada. He went on to earn several patents at Bell Northern Research in Canada, and at the RCA David Sarnoff Research Center.

As well as writing for publications including *Wall Street Journal, Forbes, USA Today* and *TechCrunch*, Mills has a number of books to his name, including one that was praised by Microsoft billionaire Bill Gates.

The Bottomless Well, co-authored in 2005 with Peter Huber, was 'the only book I've ever seen that really explains energy', Gates said. In it, Mills and Huber talk about how demand for energy will never drop, and how much of what is widely presumed about energy is in fact myth.

The book describes the power grid as 'the worst system we could have except for the proposed alternatives', and predicts that in the automotive sector, gas prices will matter less and less as hybrid engines lead to cars propelled by the grid.

"Expanding energy supplies mean higher productivity, more jobs, and a growing GDP," says the Manhattan Institute, where Mills is a senior fellow, and which reviewed the book. "Across the board, energy isn't the problem, energy is the solution."

Other books by Mills include *Digital Cathedrals: The Information Infrastructure Era* in January 2020; *Work in the Age of Robots* in 2018; and about to come out, *The Cloud Revolution: How the Convergence of New Technologies will Unleash the Next Economic Boom and a Roaring 2020*s.

Mills holds a number of senior positions, including president of Digital Power Technologies, which he co-founded 20 years ago. In 2007 he chaired and took the company's subsidiary, ICx Technologies, public in an IPO. Before that he had worked in the White House Science Office under former US president Ronald Reagan. He has worked in fibre optics, solid-state devices and defence. ■

Imre Gyuk

Friday morning, September 24

The second keynote presentation will come from Imre Gyuk, director for energy storage research with the US Department of Energy. His presentation is 'Energy Storage for the Future Grid' and will be delivered on the second day of the convention.

Gyuk has worked for the DoE for 32 years, and for the past two decades has directed its energy storage programme, which funds work on a range of storage technologies for different applications, including advanced batteries, flywheels, supercapacitors and compressed air energy storage.

He has supervised the $185 million stimulus funding for grid-scale energy storage demonstrations and is partnering states on projects for grid resilience.

Gyuk's research has looked at materials, devices and systems, as well as funding work on analytics, policy, finance and social equity. One such programme was called 'Long Duration Storage and Storage for Social Equity'.

To date his work has led to 12 awards for R&D, two EPA Green Chemistry Challenge Awards and Lifetime Achievement Awards from the US Energy Storage Association and NAATBatt.

His first degree, a bachelor of science, was gained at Fordham University. He then worked on superconductivity at Brown University as a research assistant to Nobel Laureate Leon Cooper, who developed the BCS theory of superconductivity and co-developed the BCM theory of synaptic plasticity.

Gyuk's PhD was in theoretical particle physics from Purdue University in Indiana, after which he became a research associate at Syracuse, then taught physics, civil engineering and environmental architecture at the University of Wisconsin.

Gyuk then became associate professor in the Department of Physics at Kuwait University, and he remained in the Gulf for six years, organizing an international workshop on the environment of the Arab Gulf and becoming a member of the Emir's Taskforce on Technology and the Future of Kuwait.

That was when he moved back to the US to join the DoE to manage the Thermal and Physical Storage programme.

Gyuk's research interests include the theory of elementary particles, metallurgy of non-stoichiometric alloys, non-linear groundwater flow and architectural design using renewable energy and passive solar techniques. ■

Batteries International reviews the highlights of this year's nominations — and reflects on previous times.

Turning the key to unlock a brighter battery future

One of the most talked about features of recent BCI meetings has been the Sally Breidegam Miksiewicz Innovation Award. This was set up in 2016, as a tribute to East Penn's CEO following her untimely death in June 2014.

The award celebrates innovation in equipment, processes, services and products that advance the lead battery industry.

The range of innovations set up as candidates for the award has been startling.

Some have been as simple as a better design shape for a marine battery; others have embraced the latest technological advances in our understanding of the lead battery.

Some of the nominations have been breakthroughs in the laboratory but struggled to be commercialized. And yet others — think of advances in EFBs — have been quickly embraced as a new standard in an emerging marketplace that continues to grow exponentially.

But be they large or small, these innovations matter.

For the last decade a tonne of investment has been flung at developing better lithium batteries while lead research has been side-lined.

The revamp of the ALABC and its replacement by the Consortium for Battery Innovation is putting the lead battery back in the spotlight. Clear advances are on their way and credit must go to CBI to pulling it all together.

That said credit must also go to a generation of lead researchers that have remained in the background — think RSR, Hammond, East Penn, Daramic and many others — that continue to shape the lead battery industry.

The innovation awards have been listed by the overall winners each year and then alphabetically for simplicity's sake.

2021 NOMINATIONS 28

Overall winners 2016-19 35

Innovation Awards 2016-19 46

"Innovation is the thing that gives you the opportunity. It's the promise of our future."
Sally Breidegam Miksiewicz

2021 SALLY BREIDEGAM MIKSIEWICZ INNOVATION AWARD

This year there were nine nominations for BCI's Sally Breidegam Miksiewicz Innovation Award. They were:

- **Abertax Technologies,** for further advances to its battery management system
- **Aqua Metals,** for further improvements to its AquaRefining process
- **CAM,** for customizing a ball mill process creating 100% litharge
- **Customized Energy Solutions,** for developing a fast charging system for lead batteries suitable for E Rickshaws
- **Green Lead Project,** for offering an energy efficient solution to grid manufacturing
- **Hammond Group,** in finding a promising cure for acid stratification
- **MSE International,** for pioneering a lead/lithium hybrid that can be used as a model template for the future
- **Mojtaba Hosseini** has developed a more efficient lead recycling process
- **Nanoramic Laboratories** for advances in battery nano-technology

The judging panel consisted of industry experts: Dick Amistadi, Boris Monahov, Geoffrey May and Don Karner.
The winner of the award will be announced the first morning of the conference.

BCI INNOVATION NOMINATION: ABERTAX

Further improvements to battery monitoring systems are always welcome. Here is the Abertax Master Control system.

Further refinements for a better BMS

Battery monitoring systems for lead acid batteries have been around for a number of years. Tirelessly gathering important information on the core battery parameters, BMSs give a detailed picture of the state of the battery.

The Abertax BMS and e2BMS monitoring systems can identify battery abuse in terms of temperature limits, watering intervals, depth of discharge, voltage imbalances and, by means of clever algorithms, use the sensor data to estimate remaining battery life under the current conditions.

Traditionally, such monitoring systems have relied on the use of PC-connected dongles and a PC software package to download and process the data from the devices. These systems work well and have served the industry for many years.

Nowadays, particularly due to the advent of connected things (IOT) and technologies such as industry 4.0, users expect to have data collected automatically, in the background, and have this data accessible at any instant, from anywhere.

A cloud-based system is one of the most widely adopted solutions for this. Cloud based means the data is stored on a server, somewhere, and that it is accessible 24/7 through the internet.

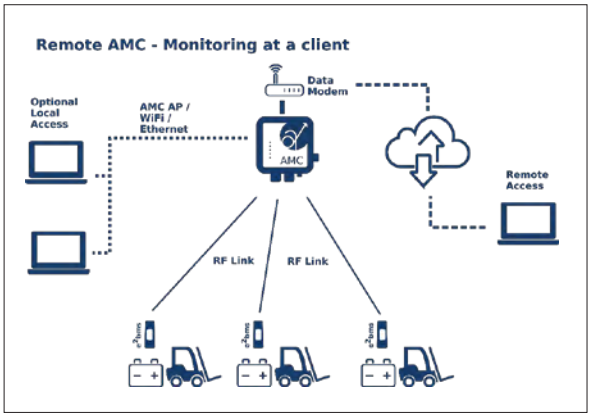
For the data to reach a cloud-based server where it can be stored, processed, and eventually viewed, it needs a communication path between the BMS collecting the data and the data server. In many cases, lead acid batteries are leased to operators, either as single batteries or as part of an entire vehicle, and the BMS is already installed by the battery owner. Warehouse operators are typically not too keen on allowing the monitoring system to access the internet via their own infrastructure; another solution is required.

To meet all possible solutions, the R&D team at Abertax developed the AMC, the Abertax Master Control system. The AMC is a hardware device combined with powerful software modules that allow multiple configurations, resulting in a flexible system guaranteed to meet any practical scenario.

The heart of any data collection system is the database, the place where all the collected data resides. In the AMC, this database can reside:

- Directly inside the AMC hardware! (No internet access required!)
- On a local server within the company (with or without internet access!)
- On a remote server (for example, at a datacentre)
- Integrated within a customer's existing cloud service

The software modules can communicate with each other wherever they are in the world! ■



CAM has made patented modifications to its ball mill production techniques that control the temperature while making leady oxide and so only creating tetragonal leady oxide.

Making the perfect lead oxide

CAM, the Italian industrial automation engineering company, was nominated for the innovation award on the basis of advances it has made with its CAM MOP 30 ball mill which is capable of making 100% tetragonal leady oxide.

There are two basic leady oxides.

The first is α-PbO known as litharge. The crystalline shape is tetragonal. This shape is important in the pasting process in defining the output of the finished battery. The colour is red, (but not to be confused with red lead).

Then there is β-PbO known as massicot. The crystalline shape is orthorhombic. The colour is yellow.

Litharge is considered by the industry to be a better oxide in lead battery manufacturing as the paste adheres perfectly to the grid. (That said massicot is extensively used for all battery types.)

Detchko Pavlov in his classic work in Lead Acid Batteries wrote that β-PbO …" has a layered structure, the layers are built of infinite Pb-O chains. The surfaces of the layers are composed of Pb2+ ions and each oxygen ion is surrounded by four lead ions. The chain layers are stabilized by van der Waals bonds. Therefore, the orthorhombic-PbO crystals are prone to flaking."

The importance of CAM's work is that their modification of the ball mill process allows only a mix of pure lead particles and tetragonal oxides to be created.

"CAM MOP ball mills are the only ones that have an internal cooling system using water spray," says the firm. "This system has been studied in detail: it is controlled by certain process conditions and when the ball mill needs cooling, the nozzles spray molecules of H20. These molecules of H20 are sprayed at a certain pressure inside the mill drum so as to not permit instantaneous contact with the oxide bed.

"The water spray cooling system of the CAM ball mills has been patented by CAM and is a fundamental aspect of the CAM Method, which, together with the other aspects such as the lead shaver and the Steam Cure curing chambers, have the purpose of producing lead battery plates with a guarantee of long life and high cranking power.

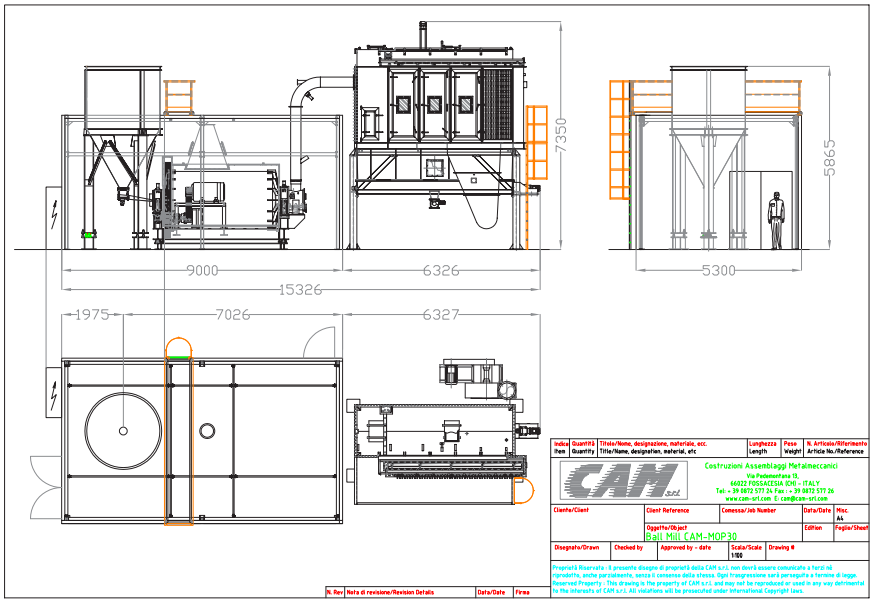
"This is done to control the temperature inside the mill in a direct manner, so that you never have peaks of temperature which could cause the formation of orthorhombic crystals which are damaging for batteries. This is the only way to achieve 100% tetragonal oxide.

Earlier this year leady oxide from its CAM MOP 30 ball mill was tested by the University of L'Aquila's department of chemical engineering in Italy. The test results showed 87.8% tetragonal litharge [red lead], and 12.1% of [the unoxidized] lead, the firm said.

"These results were sensational," said Francesco Marfisi, electrical manager at CAM at the time. "The first thing that jumped out at us was the complete absence of orthorhombic oxide — this is fantastic because it means that batteries produced with this oxide will be more reliable over time, with consistent performance."

The university testing was done under the auspices of professor Giuliana Taglieri and research fellow Valeria Daniele. ■

"The first thing that jumped out at us was the complete absence of orthorhombic oxide — this is fantastic because it means that batteries produced with this oxide will be more reliable over time, with consistent performance."



CES has produced a clever solution in maximizing the output of lead batteries by a clever charging giving it economic leverage over its better-performing but more expensive lithium rivals.

In search of a better charger, charging regime

The product is based on creating a special form of fast-charger suitable for regular lead batteries. CES initiated a project in 2018 to investigate what the new charger's requirements would be and how to solve them. It integrated the team of professors and post-graduate students of Pimpri Chinchwad College of Engineering and engineers from the client company, M Chhabi Electricals of Jalgaon through this R&D process.

The concept started from the fact that commonly used lithium ion three and two wheeler batteries require 2-1/2 to three hours to fully charge. So a lead acid battery can be fast-charged to at least 80% capacity in three to 3-1/2 hours, it will be a strong contender for E Rickshaw operations at a much lower cost.

In addition, this charger needs to carry out an 'opportunity' super-fast charge in one hour — say during lunch time — to add another 35km to the range of the vehicle. The ordinary E Rickshaw chargers take three to four hours to do the same.

Lead acid E Rickshaw batteries tend to lose capacity progressively due to the daily-charge-discharge cycle leading to lower range per charge. The battery has to be replaced after nine months to a year. This charger then, should have a service charge facility once in a week, which enhances the capacity and range of the depleted battery and leads to much longer range and life.

Although the charging power input to the battery is extremely high, it should not damage the battery by high charging voltage or high charging temperature.

Any fast and super-fast opportunity charge requires a very high powered charger which will work at the charging station at E Rickshaw roadside stands. Also the cost should be such that, it is recovered by providing charging as a service at rates that allow investment recovery in one year.

"The laboratory model with all the required characteristics was successfully developed by early 2019 and hundreds of life cycle tests were carried out to prove that the charger maintains the batteries healthy at 95% of their original capacity even after 180 cycles," says CES.

This charger also needs to carry out an 'opportunity' super-fast charge in one hour — say during lunch time — to add another 35km more to the range of the vehicle.

"The laboratory model was beta-tested at Rajarhat, Kolkata in the spring of 2019 when more than 40 E Rickshaws were fast charged in seven days to their full satisfaction."

The first production models were fabricated in 2020 and further tested at Baharampur, West Bengal under the banner of Geetanjali Solar Enterprises (the distributors for West Bengal_. Here, around 50 E Rickshaws were opportunity charged for one hour at a rate of Rs45 ($0.61) per hour of charge and each of them obtained an extra 30-35km of extra running. This showed that investment in the charger was paid off within a year.

"Since then the charger has been further reduced in size, weight (we have a wall hanging model now) and most importantly it's at a much lower price. The first batch of manufactured chargers are on the way to distributors as of now," says CES. ■

Hammond Group research team, Marvin Ho, Maureen Sherrick, Jason Trgovich, Gordon Beckley and Thomas Wojcinski, have come up with a new way of mitigating the destructive effects of acid stratification within the battery.

Lead silicate as a performance additive for lead acid batteries

Modern battery applications demand robust performance under adverse external conditions and rigorous duty cycles. One factor affecting performance and service life is stratification of the battery cell electrolyte.

Acid stratification has been a known issue which affects battery life, especially for batteries under heavy cycling or PSoC cycling applications. The increased concentration of sulfuric acid at the lower portions of the battery active material plates promotes the formation of a surface layer of passive lead sulfate and reduces plate activation.

Stratification produces inflated open circuit voltage measurements, reduced battery performance and unequal charge across the plates, each of which can lead to reduced battery life.

Ideally, the electrolyte should be a homogenous mixture of water and sulfuric acid. Due to the exchange reactions of the charge/discharge cycle, a flow of sulfate (SO4-) and hydrogen (H+) ions occurs between the active material surface reaction layer and the bulk of the electrolyte. During the charge/discharge cycle of the battery, acid is absorbed and released by the active material.

The mobility of the H+ ion can cause an increase or decrease in acid concentration (specific gravity).

Under ideal recharge conditions, evolved gasses will properly mix the electrolyte on a frequent basis. During insufficient recharge or extended periods of inactivity, the denser acid will settle to the bottom of the cell creating a density gradient.

Stratification produces inflated open circuit voltage measurements, reduced battery performance and unequal charge across the plates, each of which can lead to reduced battery life.

PUTTING IT ALL TOGETHER

Through experimentation with novel lead compounds, Hammond Group Inc has developed a new lead acid battery additive for both the positive and negative electrode active materials. This lead silicate additive has been shown to react with acidic compounds such as the sulfuric acid battery electrolyte to form both gel-like domains of Si-OH (silane) as well as lead sulfate.

Cells constructed with the additive demonstrate electrical performance similar to the controls, except for an increase in the overall cell voltage during formation and cycling, a decrease in capacity at increased additive loading, and a slight increase in CCA seconds to 1V per cell.

Most importantly, results from full-scale battery testing show that an increase in the additive loading level impacts the degree of acid stratification observed during duty life. It is hoped that further optimization of the additive will achieve greater benefit in the ability to control or reduce acid stratification.

This ultimately leads to reduced battery performance through unequal charge across the plate, increased corrosion, sulfation, and active material loss at the bottom of the plates.

Currently accepted methods to combat acid stratification include the addition of "equalization" charges where the battery is charged at a voltage above the gassing limit (2.43V) to induce the electrolytic formation of hydrogen/oxygen gas bubbles. Similarly, air can be mechanically bubbled through the cell to mix the electrolyte.

Alternate VRLA battery architectures such as AGM or gel batteries seek to prevent stratification through immobilization of the electrolyte.

In both architectures, the normally free electrolyte is trapped in either a porous glass fiber matte or transformed into a silica-sol gel by the addition of silica to the sulfuric acid. The silica reacts with the hydrogen ions of the acid to produce a gel network of O-Si-O bonds.

Compared to flooded batteries, VRLA architectures have some disadvantages including increased vulnerability to thermal runaway during abusive charging and the inability to diagnose life-reducing improper charging via electrolyte hydrometer testing.

Overcharging a VRLA battery leads to premature failure and a much shorter service life compared to a properly maintained wet-cell battery. Additionally, AGM and gel batteries are typically twice the cost of flooded batteries.

Hammond's additives

In search of an innovative solution to the problems of acid stratification, the Hammond R&D team has recently patented the use of novel lead silicate additive compounds in the positive and/or negative electrodes

to improve the retention and distribution of H+ ions within the active material.

These additives provide numerous benefits through the following mechanisms:

- A network of silica gel (structure) is created inside PAM or NAM,
- Mass transfer of acid from the active material to the electrolyte is reduced during charging

The additive material consists of a Pb-Si glass frit. The frit is formed by melting silicon rich quartz glass (sand) and incorporating lead oxide molecules in the form of low metallic yellow litharge (PbO) into the structural lattice.

Pure silica has a tetrahedral structure, and in its crystalline form, silica molecules directly bond to each other via oxygen atoms located at the corners of each tetrahedral pyramid.

Introducing PbO to molten silica causes the partial breakage of the original direct silica interconnections. The resulting lead silicate combines the properties of the two materials and allows the battery's active material to exhibit the acid-absorbing properties of Si.

Key material characteristics include a high composition of PbO relative to SiO2, similar material density to lead oxide, and low levels of harmful impurities. These properties make the material suitable for use as an additive to lead acid batteries.

Additionally, and most importantly, is that in acidic aqueous solutions such as battery electrolyte, the previously mentioned "chain disruption" of the tetrahedral silica molecules by Pb ions deteriorates the chemical durability of the material.

This allows the H+ ions to replace the modifier cations (Pb+) in the glass network, forming Si-OH (silanol) groups which behave like fumed silica. The additive therefore binds with acid protons in the active material creating pockets of silica-acid gel and combating stratification. The by-products of this reaction are harmless, common chemical species typically found in the battery's active material such as lead sulfate.

During development of this additive, Hammond's research team characterized the interaction between lead silicate and the acidic electrolyte solution. Examination of the material's ability to react with and retain sulfuric acid were carried out in the laboratory. Lead silicate was tested for solubility in both deionized water and 1.4 sg sulfuric acid.

Test results showed lead silicate is negligibly soluble in H2O, however a considerable amount of weight gain (~22%) was observed after reaction with acid. This weight gain was theorized to be caused by the retention of acid in a silica-gel structure and by the formation of lead sulfate.

Examination of the additive before and after acid treatment by SEM-EDS using a Phenom Pro benchtop instrument identified a change in the overall morphology of the starting material as shown in Figure 2.

In the image, one can see the formation of fine granular lead sulfate crystals and smooth greyish regions of exposed silica that occurs after the material reacts with sulfuric acid. EDS probing of these new morphological formations confirms the presence and absence of silicon in each formation.

Electrical examinations

To confirm the findings of the material characterization analysis

The 2V test cells were tested at Hammond's R&D laboratory for electrical performance characteristics and compared to a control. Four replicate cells of each variable were constructed and tested with the results of the electrical testing comprised of an average of these four cells.

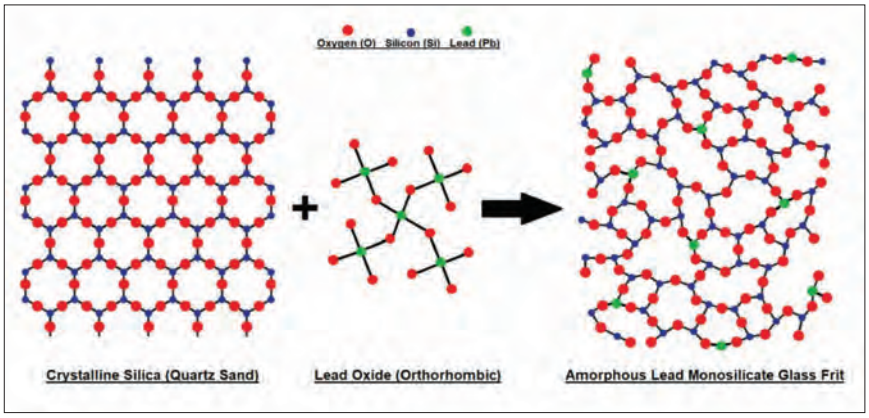


Figure 1. Illustration of the formation of lead silicate

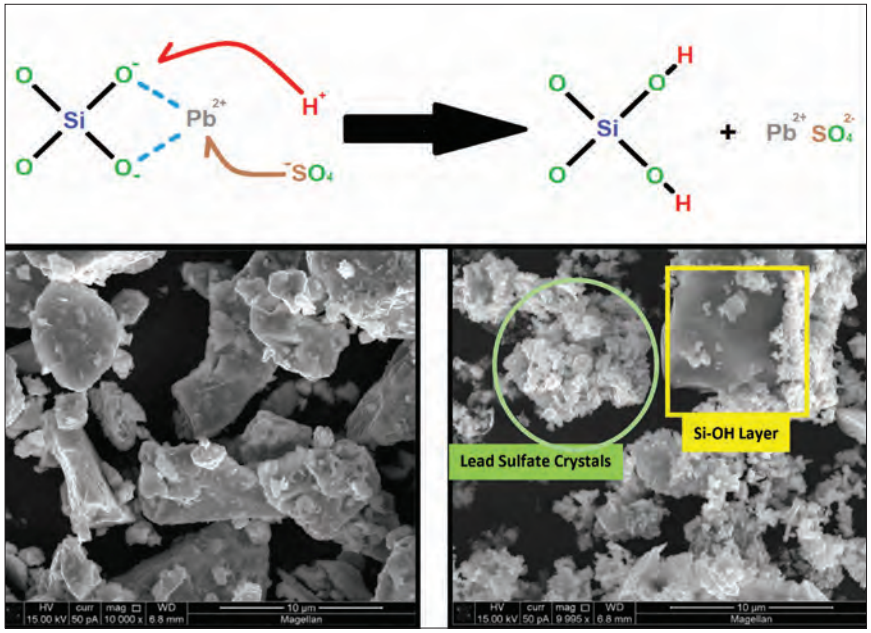


Figure 2. Chemical reaction and SEM images of lead silicate before and after reaction with sulfuric acid

an experimental test plan including several 2V cells were constructed at Hammond's research center as well as a full sized group of 27 batteries made with an industry partner. These cells and full-scale batteries were built to evaluate the lead silicate additive in both the positive and negative electrodes both in performance and in the degree to which acid stratification is mitigated.

The additive was added to both the positive and negative electrode pastes in a range of between 1% to 3% versus leady oxide. It was noted that the additive modifies the crystal morphology of both the positive and negative active material during curing, reducing the amount of tetrabasic lead sulfate produced in the positive and slightly increasing the amount of tribasic lead sulfate produced in the negative.

These changes also effect the BET surface area of the dry cured electrodes.

The 2V test cells were tested at Hammond's R&D laboratory for electrical performance characteristics and compared to a control. Four replicate cells of each variable were constructed and tested with the results of the electrical testing comprised of an average of these four cells.

The following electrical testing regime was employed to examine the additive: Reserve Capacity & 20-hour Capacity followed by Cold Crank (-18°C). Results of the reserve capacity and 20-hour capacity tests show that at higher loadings of the additive in either electrode there will be a slight decrease in initial capacity at both high and low rates.

Examination of the additive before and after acid treatment by SEM-EDS using a Phenom Pro benchtop instrument identified a change in the overall morphology of the starting material.

However, at lower additive loadings the results of the capacity tests at both high and low rate are comparable to the control.

Cold cranking measurements were performed on experimental cells with the results of these tests showing a slight improvement (+10%) in the "Seconds to 1 Volt/Cell" in both positive and negative electrode variables containing lead silicate. These results confirm there is little detriment of the additive to overall cell performance at these loadings.

The effect of the additive upon acid stratification was examined in full-sized Group 27 flooded batteries.

Table 1 presents a summary of the stratification evaluation results conducted on these batteries. Note that stratification was considered to have occurred in the batteries if the difference in specific gravity between top and bottom of the cell was greater than 0.015 (15 points).

The control battery shows acid stratification after the C20 and C100 discharges. The recharging profile of 115% charge returned + 15Ah boost charge is not sufficient to mix the acid well enough in these two cases. As can be seen, the impact on the acid stratification reduction is as follows: Additive in both PAM and NAM > NAM only > PAM only > Control. Based on the discharge data, lower capacity was observed if lead silicate was added to the PAM only, which agrees with prior cell testing data discussed above.

The height of the plate in the Group 27 batteries is 5" (12.7cm). Tall industrial sized battery types will typically see more serious acid stratification and potentially greater benefits from use of the lead silicate additive to reduce this issue. ■

These cells and full-scale batteries were built to evaluate the lead silicate additive in both the positive and negative electrodes both in performance and in the degree to which acid stratification is mitigated.

Table 1. Results of acid stratification measurements during cycle life of Group 27 batteries

Group 27 Flooded Battery (w/ plate height: 5")	Control	PAM w/ 1% PbSiO3	NAM w/ 1% PbSiO3	Both PAM and NAM w/ 1% PbSiO3
Battery #	D3	A10	B2	C6
Acid stratification after C5* discharge and recharge** (Δ S.G. between top and bottom)***	0.012	0.005	0.006	0.001
Acid stratification after C10* discharge and recharge** (Δ S.G. between top and bottom)***	0.014	0.010	0.007	0.004
Acid stratification after C20* discharge and recharge** (Δ S.G. between top and bottom)***	0.022	0.013	0.008	0.002
Acid stratification after C100* discharge and recharge** (Δ S.G. between top and bottom)***	0.035	0.024	0.017	0.007

* Before discharge, more charging steps were applied to ensure no acid stratification. Specific gravities (top & bottom) were measured before discharge.

** Recharge profile: 115% of discharge energy + 15 Ah (boost charge step)

*** Specific gravity (SG) was measured by digital hydrometer in two cells. The results reported are the averaged value.

The combination of lead and lithium in a hybrid system is a commercial avenue players in both battery sectors need to explore.

The hybrid solution for the PESO project

The logic behind a hybrid battery combining lead and lithium is unassailable. It's potentially a great mix between price and performance. The lead battery is cheaper than the lithium one and can do the heavy lifting in terms of longer term energy requirements but the more expensive lithium does the more sophisticated power requirements such as fast charging in PSOC.

The dual-chemistry Gemini battery system for MSE International's PESO project is designed and supplied by GS Yuasa, a well known Japanese company specializing in the development and production of lead acid and lithium-ion batteries.

Invented by senior technical coordinator Peter Stevenson, the prototype 100kW battery uses lithium-ion for fast response and lead acid for longer duration discharge. While other multi-chemistry batteries need different AC-DC converters for each cell type, the Gemini system uses just one converter for both.

The system is already being used to charge electric vehicles at Portsmouth International Port and is part of an integrated energy network supporting the transition to net-zero carbon emissions.

Launched in 2020, MSE's Port Energy Systems Optimisation (PESO) pilot project aims to enable ports to use smart grid technologies and management software to reduce atmospheric emissions and improve air quality.

Energy consumption in ports is changing rapidly and there is an increase in demand for port-side vessel recharging. PESO is designed to eliminate the need for expensive grid upgrades while addressing the growing on-shore power demands and the requirements of ships using shore power and electric propulsion.

Now a third of the way through its two-year pilot at Portsmouth International Port, MSE is working to optimize energy utilization across the port estate, showing how renewable generating capacity, local energy storage and advanced energy management can minimise loading on the grid and maximise the return on investment by the port.

Overview of Portsmouth International Port

"The port already uses electric lift trucks and is keen to increase the general use of EVs within the port area," says a spokesperson for Portsmouth International Port. "This will help to combat ICE emission pollution that is already high from ships and through traffic.

"The lead-acid battery provides the bulk of the energy storage capacity for cost-effective harvesting of renewable energy, and the lithium-ion battery provides high power discharge capability for EV fast charging.

"The lithium-ion also supports the operating condition of the lead-acid battery to extend life and energy conversion efficiency."

UK-based MSE International specializes in private and publicly funded projects in key areas of so-called 'Blue Growth', such as maritime logistics and surveillance, marine energy and the management of ocean resources.

UK energy consultancy Swanbarton is aiding the PESO project with a control system that uses machine learning and AI. Swanbarton's technology can reduce the peaks in the port's energy consumption and exploits the on-site solar PV generation to reduce energy costs.

The control system selects from millions of possible charge-discharge patterns and forecasts the port's balance of energy consumption and generation over several days. A cloud server analyses the data from the control system and uses machine learning to create, review and forecast the best action plan for the battery.

MSE International is hoping the pilot project's success will mean this technology can be rolled out across UK ports as rapidly as possible to support the transition to more efficient and environmentally friendly energy usage. ■

The dual-chemistry Gemini battery system for MSE International's PESO project is designed and supplied by GS Yuasa, a well known Japanese company specializing in the development and production of lead acid and lithium-ion batteries

2019 — RSR Technologies

Doubling the cycle life of lead batteries

RSR Technologies convincingly won the 2019 innovation award after developing a ground-breaking lead alloy that potentially doubles the cycle life of lead batteries.

The new product, branded and patented — unfortunately all in capital letters — SUPERSOFT-HYCYCLE, contains an engineered suite of micro-alloying additions, which enhance the cycling and charge acceptance of the active material in a lead acid battery.

Known as 009, it is a grid alloy engineered for higher use temperatures, developed by RSR Technologies, a subsidiary of the engineering unit of Eco-Bat Group, following a long history of development.

SUPERSOFT-HYCYCLE was initially launched in the South African market, where it went into commercial production at the South African lead battery firm Auto-X, the maker of the Willard brand of batteries.

Tests showed it doubled the cycle life of lead batteries and greatly reduced water loss,

Tim Ellis, president of R&D at RSR Technologies until moving into semi-retirement this June, said the improvement in performance that this product delivers has the potential to help lead acid batteries level the playing field with its main competitor, lithium-ion batteries.

"The fact is that lead acid batteries now have a real competitor in the form of lithium and this can help it compete on performance," Ellis said. "For such a dominant and widely used technology, lead acid batteries were pretty poorly understood. What we have done is apply science to better understand how they work and, as a result, move their performance closer to what it should be.

"Lead batteries have many other advantanges over lithium, especially the success with which they are recycled, and the availability of the raw material compared with lithium.

"Lithium has always had great cycling and great energy but higher cost and nowhere near the recyclability of lead," said Ellis. "Lead is less expensive and more recyclable but didn't have the energy or the cycling. Now it can maintain its low cost and improve its cycling and energy as well.

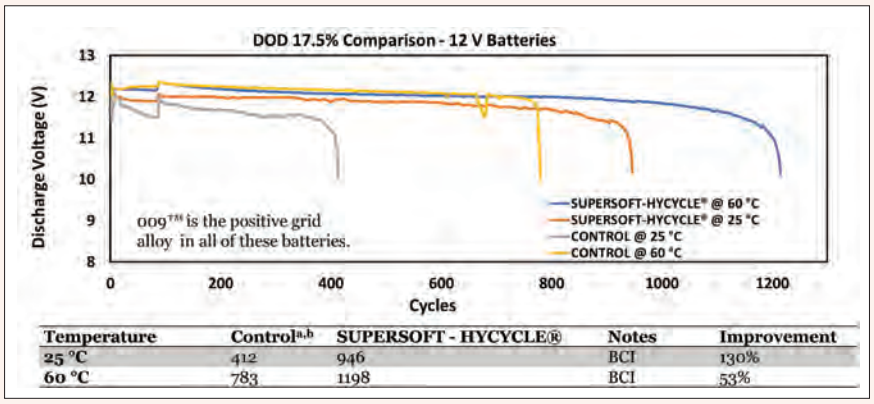
"If we can improve the performance of lead, without having to reinvent the product, this represents a boost to the entire industry. We are very excited about the potential of what we have achieved here."

The foundations of the work that resulted in the development of SUPERSOFT-HYCYCLE began with David Prengaman, the president of RSR Technologies until eight years ago, when he retired and Ellis took the reins.

In his earlier years with RSR, Prengaman completed extensive work to remove and analyze impurities in lead. This gradually moved to focus on the effect of adding selected alloys or 'dopants' to lead, and assessing the effect on the performance of the batteries in which they are used. Over the years, Ellis estimates that the company tested more than 100 combinations of different alloys in this way.

The tests would focus on the capacity of batteries, their dynamic charge acceptance and their cycle life.

"We tested these things extensively to see what would improve the performance of batteries and we realized



Temperature	Control[a,b]	SUPERSOFT - HYCYCLE®	Notes	Improvement
25 °C	412	946	BCI	130%
60 °C	783	1198	BCI	53%

Above: DOD 17.5% testing of Willard Batteries with and without SUPERSOFT-HYCYCLE show the improvement offered by crystal modifying leady oxide.
Below: Performance summary of SUPERSOFT-HYCYCLE performance in 2V test cells.

Product	One hour capacity (mA-Hrs/mg)	MHT cycle life (cycles)	Dynamic charge acceptance (A/A*hr)	DoD 17.5% cycles	DoD 50% cycles	DoD 100% cycles
Control	74	8,000	0.21	3,000	810	765
SUPERSOFT-HYCYCLE Patent 20170317351	84	42,000	0.49	4170	1140	990
Test method	BCI	EN 50342:2015	EN 50342:2015	BCI	BCI	BCI
Improvement	**13.5%**	**x5**	**x2**	**39.0%**	**40.7%**	**40.1%**

that certain combinations would make a big difference to the electrical performance," Ellis said.

The level of the dopants being added is tiny. But he said that in some instances cycle life was improved by some 40%, dynamic charge acceptance by a factor of two and capacity by 10%.

The big breakthrough, however, came when the company secured access to an Advanced Photon Source synchrotron, which is housed at the Argonne National Laboratory and is used in a huge range of scientific disciplines. This allowed it to accurately assess the effect of the proportions of the micro-alloying additions on the micro-structure of the active material. Although the technology had previously been applied to lithium, RSR was the first to apply it to lead.

In essence, it allowed them to watch the performance and evolution of the active material micro-structure in the batteries as they cycled in real time by using the APS synchrotron, allowing far more accurate analysis of the dynamics of crystallization phenomena occurring in the battery during charge/discharge cycling.

"How and why crystals do, or do not, dissolve is key to improving performance in applications," Ellis said. "Prior to using this, we knew there was an improvement in performance, but we did not know why. This allowed us to see exactly what was going on and the effect it was having on the battery.

"We were able to do this x-ray analysis of the battery plate as it went through the charge and discharge cycle, so we could understand exactly what was going on in the lead. That allowed us to understand how to better engineer the metals to make them more efficient."

Ellis said the ANL welcomed the idea of looking at lead. In the laboratory experiments that followed, when the SUPERSOFT-HYCYCLE alloy was placed against a control lead element typical of standard lead batteries, the careful selection of micro-alloying additions and removal of specific contaminants were found to directly aid in changing the $PbSO_4$ to a more easily dissoluble crystal form — thus prolonging battery life.

The cyclability test was based on a specification of a 17.5% depth-of-discharge; normally the cycle rate would be between 800 and 900, Ellis said. Using the RSR alloy it did up to 1,600 cycles.

"This is real; it is not a promise or something that may or may not work. It is real now," Ellis said. ■

2018 — Gridtential Energy

New bipolar lead battery architecture

Three years ago **Gridtential Energy** won the innovation award for its silicon joule technology. This combines the traditional benefits of lead acid batteries, such as low cost, recyclability and safety, with a novel bipolar battery architecture.

This stacked-cell architecture dramatically reduces the weight of the battery and provides it with the power density associated with lithium technology.

John Barton, chief executive of Gridtential Energy, said that by integrating high-volume and low-cost solar manufacturing into the existing lead battery infrastructure, the company has devised an approach that is scalable and should be commercialized, whereas other technologies require novel processing techniques and custom manufacturing equipment.

The commercialization process has proved trickier to execute than previously thought, and it wasn't until the end of April that Gridtential was ready to launch a series of AGM reference batteries produced on East Penn Manufacturing's prototype line.

"These are not just samplers but also batteries that are ready to be sold to the market," said Barton.

The first commercial product is a single-block 24V lead battery optimized for deep-cycle applications. A 12V power version will follow late spring, with 48V versions of each appearing in the second half of the year.

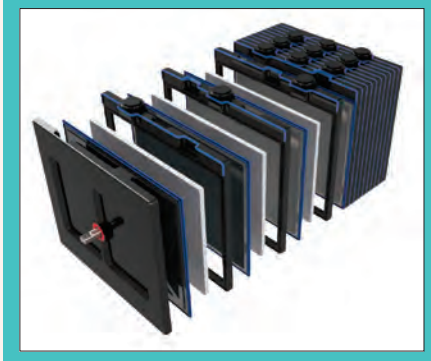
"Silicon Joule technology can also improve the performance of existing SLI and auxiliary batteries by delivering more cranking power over a wider operating range," Barton said. "The improved power performance is also extremely important in backup applications, such as telecom and UPS, where the batteries are called upon to deliver large currents in sub-second time frames.

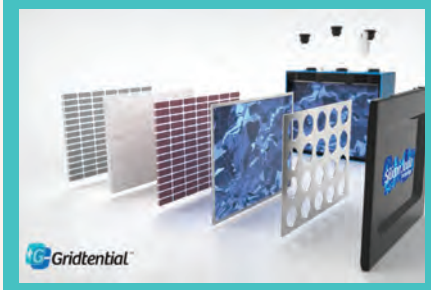
"Overall, as demand in high-power applications increases across industries, the Silicon Joule technology's flexible voltage scalability, thermal management system, recyclability, manufacturability and simplistic design deliver the high dynamic charge acceptance required to meet these evolving performance needs."

Founded in 2011, Gridtential's material discovery — the use of treated silicon wafers inside the battery — led to the development of Silicon Joule technology. Gridtential has subsequently attracted the world's largest battery suppliers, and is eyeing new storage markets across the globe as demand for 48V batteries increases for electric-hybrid vehicles.

Barton said this innovation is important for the lead battery industry, which faces a unique set of challenges brought on by competition from lithium-ion and the reputation of lead commodities.

"Silicon Joule battery technology leverages existing lead recycling infrastructures. But also the amount of lead used in the battery is reduced by up to 40%, significantly decreasing the overall weight of the battery.

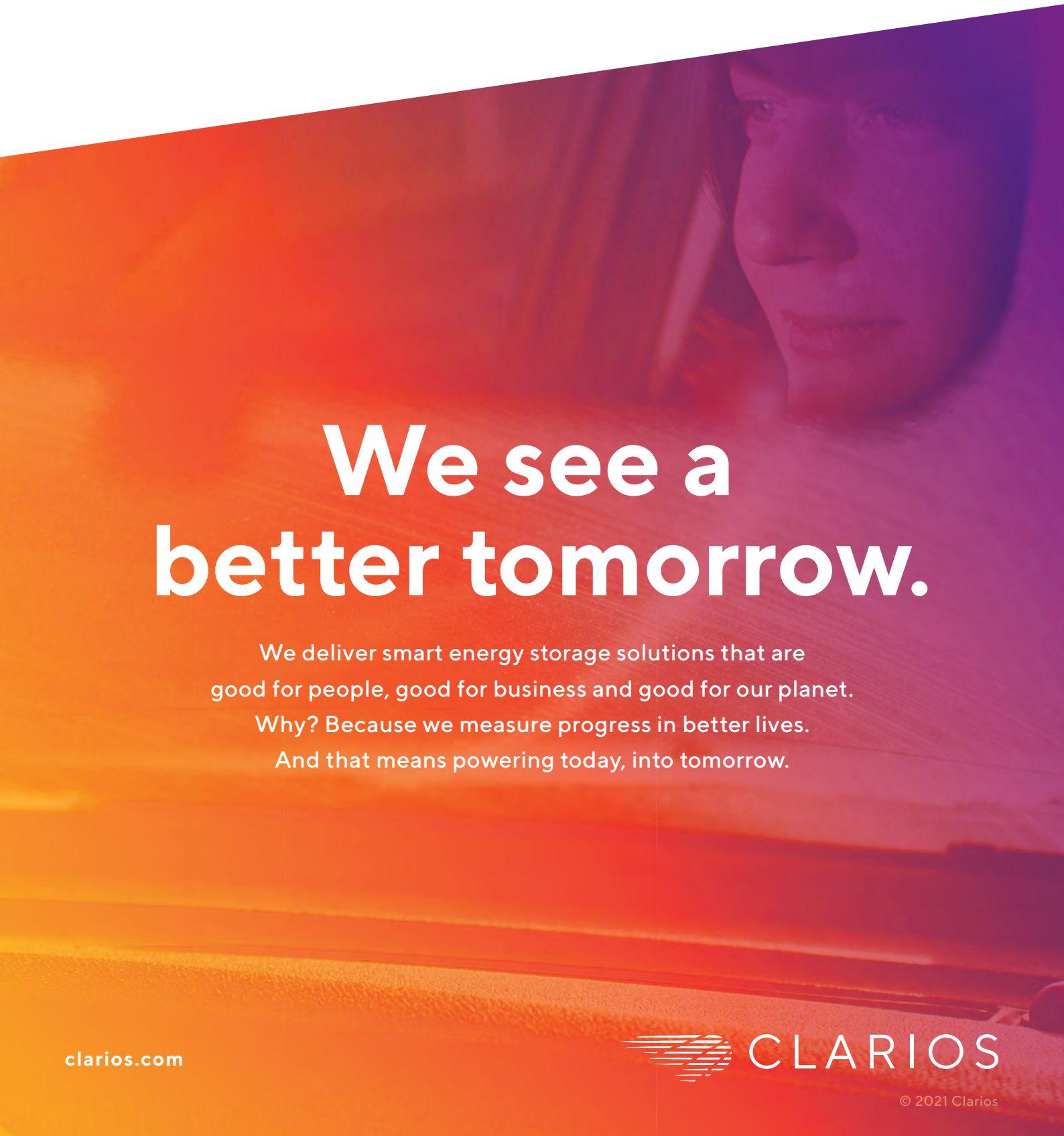




How the bipolar batteries stack up

Continued on page 38

The world sees
a better battery.



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Gridtential: Continued from page 36

"Compared to traditional monoblocs, the Silicon Joule battery is lighter and has higher power densities. Gridtential's approach to battery architecture is built upon a capital-light licensing model that partners with, rather than competes with, battery manufacturers. This allows them to compete against new and emerging technology threats without giga-scale capital investments.

"Lithium alone cannot satisfy the global demand for storage," he said. "As the global EV market heats up and major car manufacturers scramble to secure supply, lithium sourcing challenges loom on the horizon. The same applies to cobalt, which is often used in lithium-ion batteries."

Additionally, as the multi-billion dollar market for 48V battery systems swells to keep pace with newly increased voltage standards in hybrid-electric vehicles, Gridtential's Silicon Joule technology will provide its global battery manufacturing partners with an economic, scalable and reliable platform.

Gridtential's immediate focus is on 12V-48V mild hybrid automotive systems. However, it aims to offer power to a diverse range of technologies across an array of sectors, including material handling equipment, grid storage systems, mobile telephony, back-up power devices for cloud computing, and more.

The first commercial product produced in 2021 is a single-block 24V lead battery optimized for deep-cycle applications. A 12V power version will follow late spring, with 48V versions of each appearing in the second half of the year.

Barton encourages lead acid battery manufacturers to embrace this opportunity — and go big.

"While Tesla was aiming for five gigafactories by 2020, existing lead acid battery manufacturers could license Gridtential's Silicon Joule technology and convert their existing lines to compete with the evolving needs of the battery industry.

"That way, there could be roughly 70 lead acid gigafactories worldwide, with over 500GwH," he said. ■

2017 — NorthStar

Checking battery health from the cloud's vantage

A ground-breaking development in remote monitoring came from **NorthStar** — now part of EnerSys — on the basis of what its then CEO Hans Lidén called its most ground-breaking innovation: NorthStar ACE (Advanced Connected Energy).

This is an IoT service where it connects batteries to a cloud portal.

This means that the battery users can review the battery health and status at any time from anywhere. Furthermore, the embedded battery sensor communicates with both the site technician and the power system, to ensure correct installation and settings. The device has been primarily launched for the telecom sector, but can be expanded to new segments.

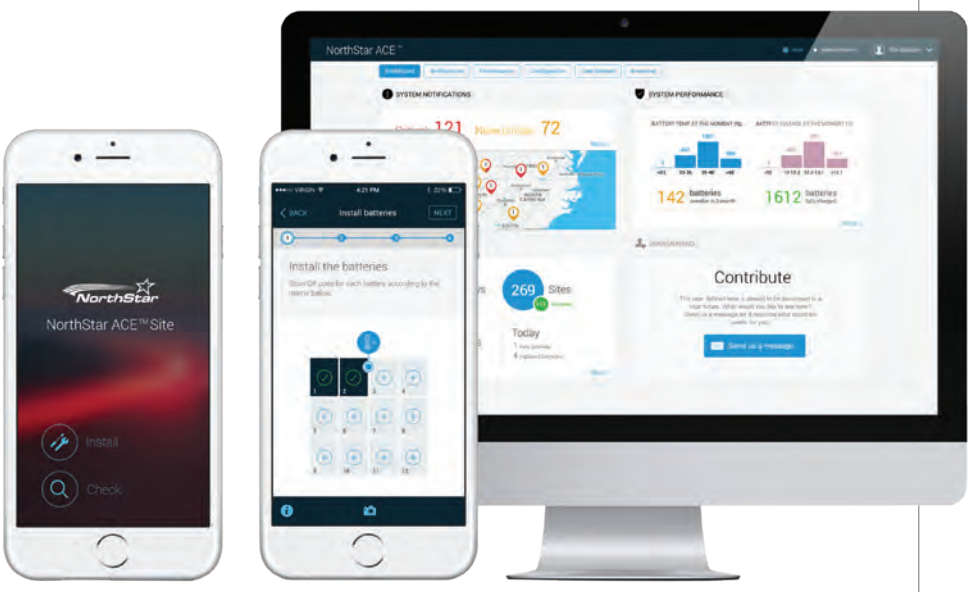
"It started in 2015 with a technology assessment to find a good solution for embedded sensors, and when this succeeded, we started developing the sensor communication system, including the cloud portal and mobile app," Lidén said.

"The work was initiated as part of a broader development strategy, where we analyzed and identified the future growth regions for telecom back-up power and concluded that the growth in remote regions, with challenging conditions, was significant.

"This was a clear driver for developing a remote monitoring solution. In addition, our strategy is to continuously improve both performance and sustainability of our products and we wanted to provide a solution which makes battery usage more efficient and prolongs battery life."

In addition, a sales and marketing team have in parallel been developing the business proposal for NorthStar ACE.

In terms of how this innovation could potentially change or benefit the battery



NorthStar's ACE (Advanced Connected Energy), uses an IoT service where it connects batteries to a cloud portal — and from there to any internet connected device, here a smart phone.

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industry, Lidén said that the biggest direct impact will be longer battery life, but also reduced operational costs for site owner.

"The battery life will be prolonged as installation and settings are done correctly from the start, and the continuous monitoring enables corrective actions when needed and only when needed," he said.

"Added benefits are better warehouse control, less scrapping and the like, which of course lowers operational costs. An unmeasurable indirect consequence of better control of the reserve power is less site down time, which in turn means that lost revenue due to outages is reduced."

In terms of the wider world, remote monitoring of reserve power will have an impact on a number of areas. It can, for example, be used in professional transport, where truck drivers more and more depend on power in their cabins when the engine is off.

Data centres are another critical area that depend on reliable reserve power.

"With a better controlled back-up power source, these applications will improve the situation for the users. Enabling remote monitoring also enables better use of renewable power instead of fossil fuels, as the variation of the main power source is compensated with better control of the backup power," he said.

Looking at a broader scope, increased battery life and improved battery utilization means that fewer batteries are needed, which improves sustainability even if the batteries already today have a high recycling rate, Lidén said.

"Furthermore, remote control eliminates a high portion of unnecessary transport to site, which again benefits the environment.

"NorthStar ACE is an advanced solution in a simple package. The batteries look exactly the same on the outside as our traditional batteries, but with advanced features. As the world is talking about the Internet of Things, this may be the first example of connected energy." ■

2016 — Hammond Group

A two-pronged success: LAB², next gen expanders

Hammond Group, best known in the battery business for its range of expanders, hit the ground running in 2016. It advanced the cause of better lead batteries in two ways — a revolutionary expander formulation and the provision of an open-collaboration research laboratory, known as E=LAB².

Its latest, customizable expanders provide lead acid batteries with dramatically improved dynamic charge acceptance while the LAB2 is dedicated to industry technical development. Its goal is to enable lead acid batteries to achieve 80% of lithium-ion's technical performance, but at just 20% of its cost.

Dynamic charge acceptance — the way batteries can accept and rapidly store large influxes of energy — is the next big thing for the lead acid business. It opens up two worlds — that of microhybrids in the automotive sector and the huge new areas of business with grid-scale storage.

In laboratory testing and now in production batteries, Hammond has achieved an order-of-magnitude increase in dynamic charge acceptance while simultaneously increasing cycle life.

Figure 1 shows relative comparisons to Hammond's control samples.

The innovation does not require a change in other battery paste ingredients, grids, or plates. No change in any other material component or process. No new tooling, production technique, distribution, use, scrap characterization, or recycling. This represents a new expander family, with no safety concerns or known adverse effects.

Moreover, this is customizable according to the needs of the batteries being made and their in-service operating conditions.

Hammond has a long tradition in producing lead chemicals for a variety of glass, ceramics, colour and plastic applications.

"We've always pioneered technical substitutes and advancements in answer to an ever changing market," CEO Terry Murphy told *Batteries International*. "We've been very successful adapting to industry's shifting demand for lead-based chemicals."

The nub of the problem between lead and lithium is mostly a question of price and recyclability. For advanced energy storage — power generation or hybrid vehicles — lithium-ion batteries meet most of the technical requirements, but are too expensive and not recycled. By contrast lead acid batteries are inexpensive and 100% recyclable, but don't have the necessary cycle life.

"On a personal note," said Murphy, "a major influence on Hammond's decision to invest in our LAB² came from Sally [Miksiewicz], who understood these emerging lead acid battery markets better than anyone, which is why East Penn invested in the Ultra Battery.

"My first meeting with Sally was scheduled for a quick 30-minute introduction, but ended up lasting several hours, with another follow-up shortly thereafter. We were immediately on the same page — both recognized the need and importance of research to lead the industry forward."

Hammond has amassed an impressive assembly of state-of-the-art equipment in LAB² — these range from multi-position testing equipment from Maccor and Bitrode, which can test up from mini-cells to SLI batteries to micro-hybrid and stationary testing. There are also general laboratory instruments such as units providing X-ray diffraction,

Continued on page 42

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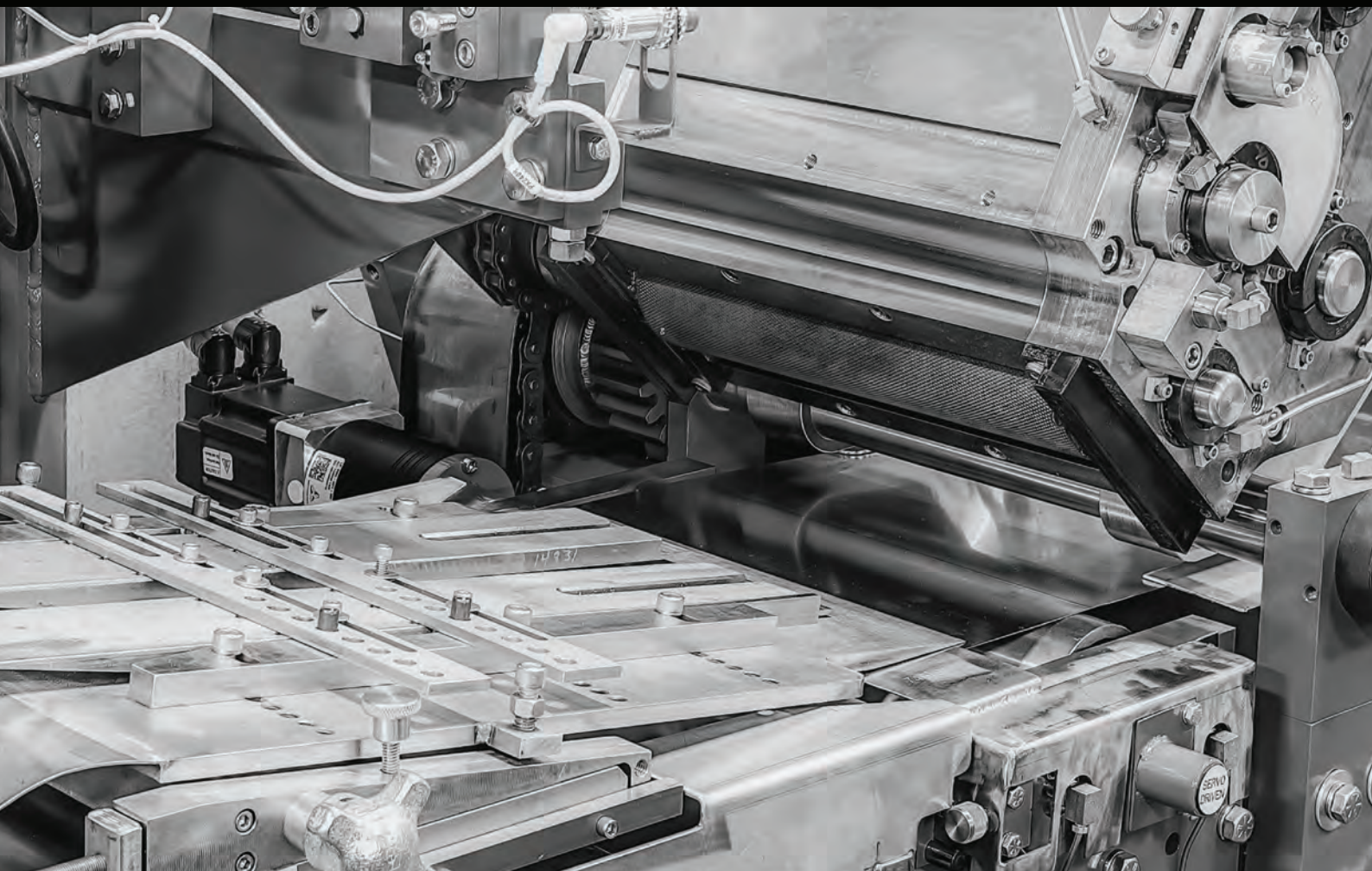


Hammond: continued from page 40

BET Surface Area, UV/Vis spectroscopy.

Gordon Beckley, chief technology officer, said: "With the equipment we have on offer, the huge number of algorithms that can be input to detail the types of usage batteries undergo — and why — that can form the starting point for what performance can be.

"One huge advantage that we can bring to bear is a rapid material and electrode screening process — typically we can make valid performance predictions within a couple of weeks.

"This is unheard of in an industry where typically it takes several months for a clear picture to emerge from research."

Hammond's investment in technology is effectively an attempt at a company level to compete against the US government-subsidized advanced battery research, which has focused on lithium-ion.

The traditional lead acid battery suffers a critical, but certainly not unsolvable, technical deficiency. When subject to high-amp, irregular re-charging intervals — such as energy re-capture from braking, battery life may be seriously shortened, said Murphy.

This helped form the background for Hammond's thinking in looking at ways to see how a better hybrid vehicle battery could be made to accommodate rapid and intermittent charging and discharging. Similarly, an energy grid storage battery must handle the inherent gaps between intermittent wind and solar energy generation and its consumption.

"These applications require a battery to perform well in high-rate partial state-of-charge (HRPSoC) operations, accepting a wide range of charging amps at various states of overall charge, and maintain this quality over a normal cycle life," said Murphy.

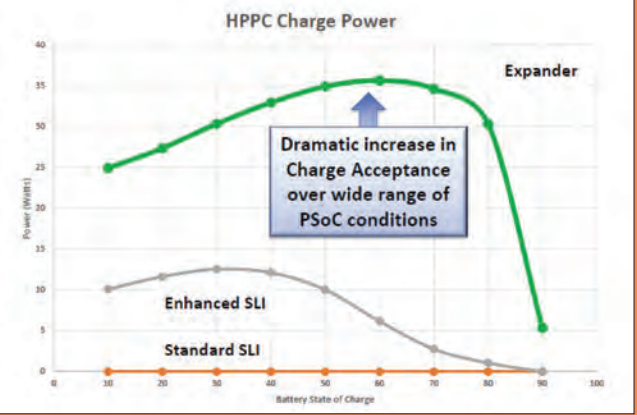
"As a speciality chemical business, I felt that Hammond had an enormous potential to address this deficiency, so we made the investment and the strategic commitment to address the PSoC requirement."

Hammond investigated the lead acid battery principle failure mode in HRPSoC applications through a materials interaction study, testing traditional and advanced expander materials.

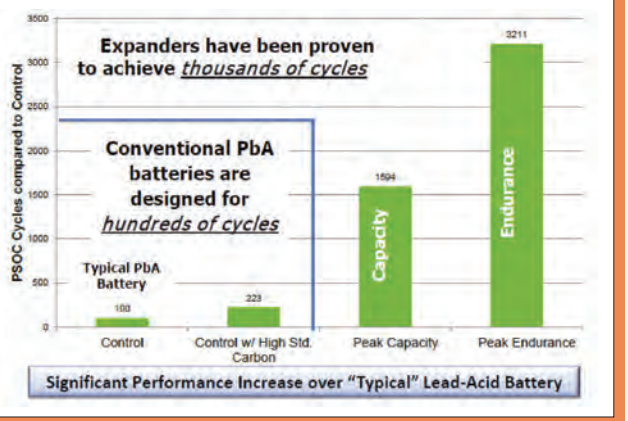
"Exploiting insights on material selection, material interaction and duty-specific formulations, Hammond's work culminated in its family of negative plate expanders, available for a wide range of HRPSoC applications.

"We've discovered a whole new class of materials, but it wasn't just our new material, or a particular carbon, it was the interaction and exact dosing of these new compounds that was central to this technical breakthrough." ■

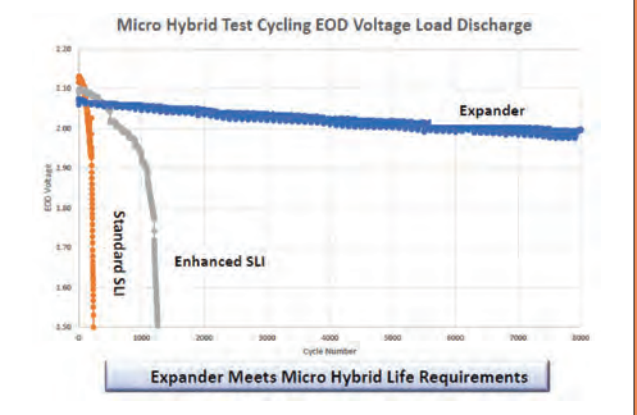
Charge acceptance improvement



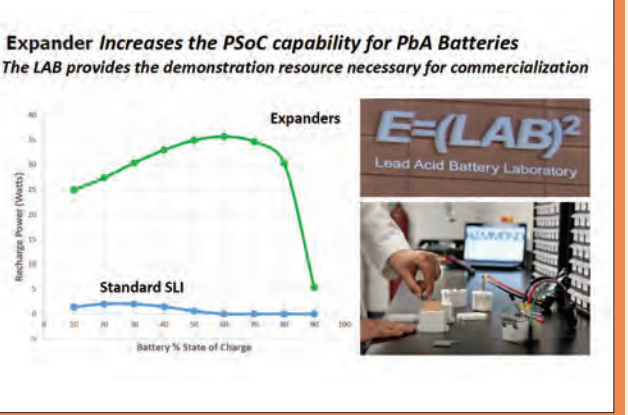
Simulated energy storage application



PSoC cycling improvement



2016's winning entry: expander and E=MC² laboratory



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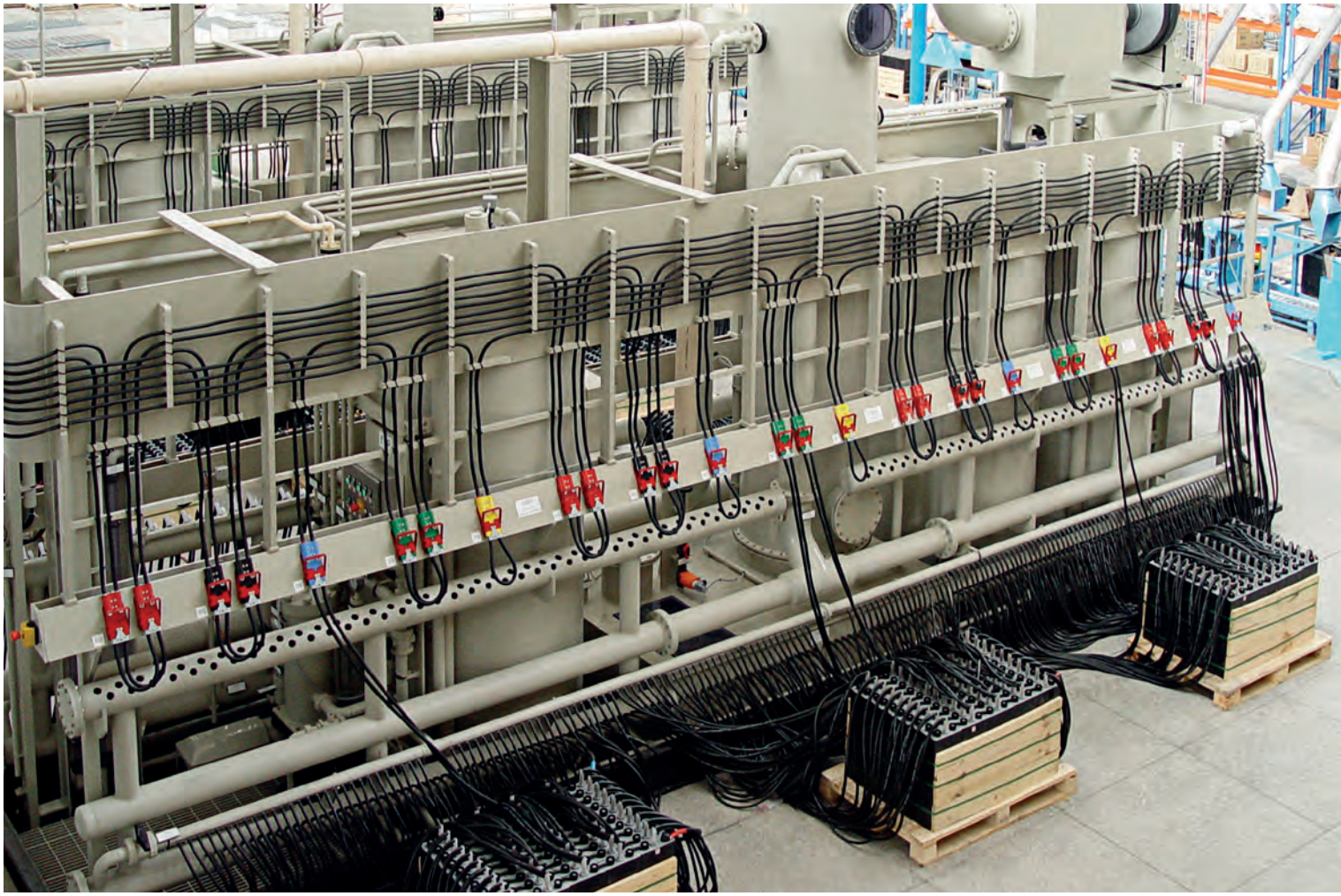

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Abertax

Ever inventive, ever attentive to detail

In 2018 the firm applied for the BCI Innovation Award on the basis of the one-valve battery lid for VRLA batteries

Abertax has been nominated three times in the awards for a wide variety of submissions.

In 2019 the company patented an innovation aiming to give the optimal charging regime, involving Abertax Battery Management Systems (e2BMS).

It was designed to identify wirelessly which battery, from a number of batteries, has been connected to a charger, and also gather relevant battery data allowing it to programme the most efficient and economic charging profile possible as well as extending the battery lifetime.

It was developed in collaboration between the R&D team at Abertax with charger manufacturer Industrie Elektronik Brilon in Germany.

"Having a battery communicating with its charger to provide the required data to charge it at the right charging profile will have a huge impact on the lifetime and battery performance besides saving time and energy," the company said.

In 2018 the firm applied for the BCI Innovation Award on the basis of the one-valve battery lid for VRLA batteries, which it says will mean a more reliable and better performing lead acid battery.

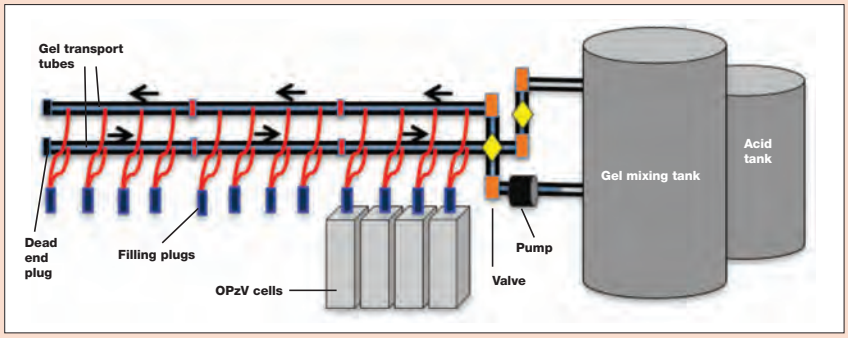
Abertax developed a valve with extreme low opening pressure tolerances of +/-25mbar. (The standard is more than +/-50mbar.) However, different opening pressures result in different gassing rates and water loss and leads to premature failure. This new lid design guarantees the same pressure in each cell.

The firm believes this design will eventually be used in all VRLA batteries. It will also mean cost savings, making it even more appealing to manufacturers.

In 2016 Abertax displayed a new patented gel filling process for use in PzV and OPzV cells, which could make the manufacturing process cleaner, safer and cheaper while improving the quality of the batteries.

One of the reasons for gel batteries having a slightly higher price than AGM has been the cumbersome process associated with their filling, formation and finishing processes, and this alleviates some of the problems. ■

2019: Battery Monitoring System – ABERTAX® e² BMS



In 2016 Abertax displayed a new patented gel filling process

Advanced Battery Concepts

The joys of bipolar batteries

Advanced Battery Concepts is one of two firms pushing the boundaries of bipolar batteries. In 2016 it won an honourable mention from the BCI judges and it returned the following year showing improvements in its GreenSeal technology.

This was a suite of patented technologies and simplified production processes, to enable the construction of reduced lead content, high performance, lower cost lead batteries in existing formats for today's and newly enabled future markets.

Advanced Battery Concepts said at the time it was close to full scale production and a global roll out of its bipolar technology. Seven battery firms have subsequently joined ABC as licensees.

The battery industry has always recognized that if a bi-polar lead acid battery could be manufactured successfully it would have significant advantages for the battery manufacturer and the end user.

"Bi-polar battery designs eliminate grids and top lead and utilize the active chemistry far more efficiently thereby reducing the lead content for the same energy. They would be cheaper to make, smaller and lighter, better for the environment, have a faster recharge rate and greater cycle life," the firm says.

"To be successful a bi-polar battery needs to be commercially scalable, recyclable and robust. We have concentrated our business focus on simplifying materials, product designs and manufacturing processes and are taking bi-polar lead acid batteries to a new level at ABC."

Previous attempts at making a commercially viable bi-polar battery at scale have met with limited success because of a number of problems, including the inability to seal between cells and failure to seal to the external environment,

Continued on page 48

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ABC: Continued from page 46

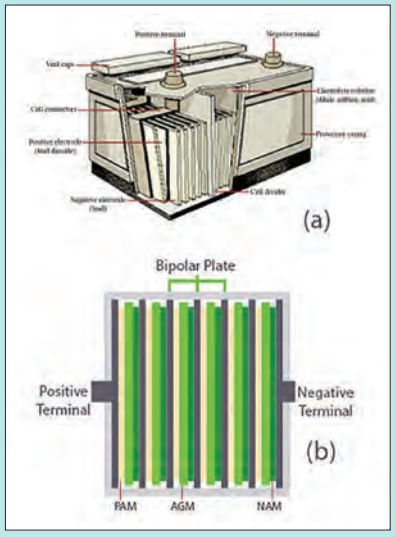
the use of costly exotic materials to overcome corrosion and conductivity issues, the requirement for an external strengthening structure to provide uniform AGM compression and to overcome cycling stresses which ultimately result in poor performance in terms of energy and power density, cycle life and cost.

"ABC's batteries are lighter and cheaper than equivalent batteries in the market today and our partners are really achieving the results we've claimed. We have made things simpler and the performance is better," says the firm.

One of the biggest breakthroughs in the design is that it reduces the lead content in the battery by some 45%.

"That reduction, which is attributable to the bi-polar design, means a significant reduction in the battery manufactured costs," Hobday says.

The company has also achieved a higher energy density (50 Wh/kg with a path to > 60 Wh/kg — this compares with 35Wh/kg for the best in class AGM batteries today. It has also achieved higher power — >1000 W/kg while maintaining high energy (>40 Wh/kg), a faster recharge of 1.4x faster, a cycle life of three to six times the current VRLA battery life with the potential for more than 10 times, and all at a lower cost. ■



In 2016 Abertax it won an honourable mention from the BCI judges

Aqua Metals

Recycling without the smelting

Aqua Metals received an honourable mention in the 2017 awards. Aqua has developed a lead battery recycling process that it calls AquaRefining as an alternative to high temperature smelting of a molten lead.

AquaRefining, the firm says, is a more efficient, less expensive way to build and produce a higher quality product. AquaRefining is a form of electro-winning.

As a liquid-based room temperature process using methyl sulfonic acid it eliminates the processes which produce lead-containing dust, sulfur dioxide and other emissions that are inherent to smelting. This, the firm says, makes environmental compliance simpler and less expensive.

Aqua Metals had intended to bring the technology to market first by building and operating its own facilities to demonstrate how a plant would operate.

However, much of its Reno facility in Nevada burnt down in November 2019 before Aqua Metals had achieved its goal of having 16 AquaRefining modules in place to show its commercial viability.

The company says it has continued to advance the technology of AquaRefining and is seeking a commercial partner to act as a licensee. ■

Modifications to the 2013 prototype (left) resulted in the commercially replicable version.

Battery Rescue Australia

A safer way to collect and recycle

Battery Rescue Australia provides an environmentally friendly, safer and more convenient method for storing and transporting used batteries called the Battery Transport & Storage container that was entered for the award in 2019.

The company was established as a demonstration battery collection business by its sister company Uniseg Products, using a BTS container developed by Uniseg as a safer, more environmentally sustainable and efficient method of storing and transporting used lead acid batteries destined for recycling.

The product was developed by inventor, entrepreneur and managing director Fenton Goddard, who noticed when helping a friend in his recycling business that the transport and storage of used lead acid batteries was neither safe nor

"The containers provide an environmentally superior, safer and more convenient method for storing and transporting their used batteries," says the firm. "The use of battery-powered 4G IoT technology has enabled us to overcome many of the transport challenges to large mine sites in remote areas."

Bush says many mining companies such as BHP are seeking a safer, regulation-compliant solution for the onsite storage and transport of used lead acid batteries, while also reducing their environmental impact.

The product offers benefits including better safety loading and transport; improved environmental outcomes by eliminating acid leaks (containing high lead levels); more convenient and efficient stacking of batteries; regulation compliance and reduced legal risks; and improved battery recycling rates from remote mine sites. ■

Black Diamond Structures

Opening the battery world up to nanotechnology

Black Diamond Structures received an honourable mention in the 2016 category bringing the advantages of the world of nanotechnology to a wider audience.

Black Diamond Structures is the commercialization vehicle for Molecular Rebar, a nanotechnology, based on a patented form of the discrete carbon nanotube, that offers a variety of improvements to the lead acid battery industry.

The first, says the firm, is a dramatically improved cycle life — with increases of over 50% in cycling. Charge acceptance is also improved by around a quarter and there are also benefits of greater performance in cold temperatures as well as strong resistance to physical and thermal abuse.

Molecular Rebar can be easily incorporated into the existing manufacturing process — with no additional capital costs or modifications to production processes.

In recent years, lead acid battery developers have used activated carbon, graphite and hybrid lead carbon electrodes to accommodate higher rates of charge and PSoC operation. These additives show promising results, but frequently require significant alterations to existing production lines and paste-mixing recipes. Determining the optimum carbon composition and implementing the new additions have been challenging.

Furthermore, carbon additives present a host of problems: many contain high concentrations of metallic impurities, which can lead to severe side reactions. Their presence in raw materials destined for use in lead acid batteries is therefore strictly regulated. Carbon additives also alter paste rheology, requiring downstream process changes to accommodate the mix.

The Molecular Rebar technology delivers advanced technological solutions at an industrial scale with a minimum of disruption to production.

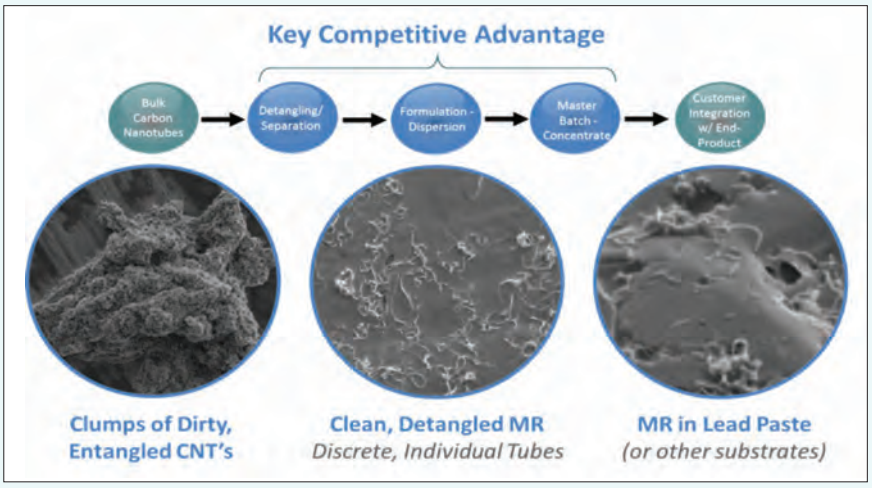
"When we first started thinking about adding Molecular Rebar to batteries, we understood that the processes of mixing, pasting and curing are well established and have been optimized over decades in the industry," says a Molecular Rebar Design and Black Diamond Structures spokesperson.

"We challenged our team to ensure that our product could be incorporated into existing processes without disruption or additional optimization of the manufacturing process."

Black Diamond Structures and Molecular Rebar design, disentangle and functionalize stock carbon nanotubes, making the surface of the tubes compatible with the lead acid battery operating environment, and opening the ends of the tubes.

The process also cleans the carbon nanotubes to reduce the residual catalyst content.

To prepare for use in lead acid battery pastes, the tubes are uniformly dispersed in an aqueous solution. The final product is a pourable liquid which can be introduced directly into the paste mixing process.



Finding competitive advantage in the process change

The addition of this product to the negative active material improves charge acceptance and extends lifetime under lab-based cycling protocols and in real-world field trials. These tubes in the positive plates enhance the durability of plates subjected to charge/discharge cycling still further.

"Black Diamond Structures has collected significant performance data from industrially produced 12V batteries at its own testing facilities, at customer sites and at third-party testing facilities.

"The data show reductions in charge times of 25%-75% under constant-voltage conditions and increased cycle life of 25%-300%, depending upon the protocol. Pasting trials have shown that Molecular Rebar can reduce waste and improve production quality," said one of the principal team members engaged in the project. ■

Daramic

A portfolio of inventiveness

Daramic, the international separator giant, has advanced separate developments in its technology portfolio.

In 2019, the last year of the innovation awards, Daramic and Huff Technologies developed a way of better simulating how batteries perform in the real world by showing how they move around during everyday use.

The Daramic Shuttle Table was designed to mimic real-world scenarios during testing. It was developed because the companies acknowledged that in all types of environments, vehicles and the lead acid batteries they use are constantly moving.

Together, they have developed a proprietary testing method along with innovative new machinery to allow battery manufacturers to test their products in a real-life scenario.

The technology is able to test up to 12 group 31/L3 batteries simultaneously and the user can select a variety of different programmes offering different types of movements and cycles.

Continued on page 50

Daramic: Continued from page 49

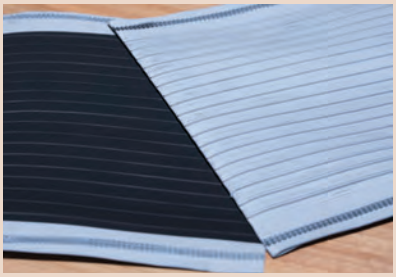
The system allows for a direct comparison between batteries based on different working patterns and battery environments.

Data are collected via an external drive and transferred using USB ports on the machine. A versatile t-slotted rail system allows for quick and adjustable tie down of batteries of multiple configurations and sizes.

The year before, the firm showcased its latest product using carbon coated separator technology. This reduces sulfation crystal growth, delivering a more active surface area on the plates for improved conductance of the electrode. This received an honourable mention.

"Carbon applied directly to the separator, using a proprietary method, while being in contact with the negative active materials shows increased dynamic change acceptance at the cell and battery levels versus standard separators," said Daramic at the time.

"This has been proven to slow the growth of lead sulfate crystals, which otherwise tend to grow more rapidly in batteries continuously operating in partial states of charge.



2018: Carbon Coated Separator Technology

"This is part of the Daramic EFB solution roadmap, to support this new battery working pattern."

In 2017, using advanced computational fluid dynamics, Daramic developed two new separator solutions — Daramic EFS and Daramic RipTide.

Daramic EFS is specifically designed to support start-stop vehicle batteries by reducing the battery's internal resistance and improving voltage drop and CCA.

Daramic RipTide combines the latest innovations of Daramic with novel separator profile designs using advanced computational fluid dynamics computer modelling to enhance EFB durability by reducing acid stratification in a partial state of charge environment, which is more typical in start-stop applications.

Daramic's first entry to the BCI Innovation Awards in 2016 was for a product innovation invented three years ago with research continuing on further refinements.

Called DuraLife, this helps protect and maintain the quality and performance in battery designs that use less lead content — a technique that many battery producers have adopted as a way of reducing the overall cost of their products.

DuraLife is a new, high performance polyethylene battery separator. Its design improves battery performance, improves efficiency and yield during battery assembly and, most importantly, compensates for lack of performance or lifespan in battery designs where manufacturers are looking to reduce the amount of lead. ■

2019: The Daramic Shuttle Table was designed to mimic real world scenarios during testing

Digatron

Battery testing's next leap forward: rethinking switch mode technology

Digatron Power Electronics approached the innovation award in 2016 with a different angle — looking to reinvent the battery testing system from scratch with what it calls the world's first laboratory test system with silicon-carbide technology.

"Points of departure from the norm," said the firm, "were customer demands with regard to energy efficiency, construction size, circuit density, ergonomics, power and dynamic envelope, as well as the latest semiconductor technology derived from military and aeronautics: Silicon Carbide (SiC) MOSFETs."

Digatron introduced battery testers with active frontends and output amplifiers in SiC-technology in their Repoweren UBT (20V) and MCT (6V) lines. These systems provide up to six 1.8kW test circuits in one 4U (178mm) rack module.

This is equivalent to an almost 10-fold increase of power density compared to any previous designs.

"Our Biconditional Energy Supply Tracking (BEST) system ensures optimum energy efficiency under any operating condition," says the firm. "This process automatically balances the energy flows between the six circuits and tracks the energy balance of the DC link accordingly, either to regenerate 100% in the DC realm (and top off from AC as needed), or to feed excess energy back to the three-phase grid."

The Repoweren units can be cascaded in standard 19 inch rack systems. Test circuits can be paralleled up to several kiloamperes. Extra expenses for climatization or acoustic insulation are unnecessary. ■

IS YOUR BATTERY MANUFACTURING

~~DIFFICULT~~ *easy*

~~COMPLEX~~ *simple*

~~EXPENSIVE~~ *affordable* ?

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EnerSys, MAC Engineering

Further bold moves to remove lead from the air

Two of the major themes of the 2015 BCI conference — the need for tighter environmental rules and greater health regulation — were picked up by EnerSys and MAC Engineering in the following year's innovation award nominations.

One BCI conference panel session in particular stood out. It was called "Let's Get the Lead Out: Designing Lead Emission Out of the Manufacturing Process" and was chaired by EnerSys.

The panellists — a mix of battery manufacturers and machine suppliers — consisted of representatives from Johnson Controls, East Penn, MAC Engineering, BM Rosendahl and Sovema. They talked about the challenges faced by manufacturers and the potential problems manufacturers, suppliers and producers would have to overcome if these restrictions become more and more stringent and therefore more and more unmanageable.

Following the BCI meetings there was a flurry of ideas and meetings between EnerSys and MAC. The initial proposal aimed at improving the pasting line — possibly the hardest point to contain lead in the manufacturing process — which immediately looked an early winner.

This involved looking at pasting, flash drying, stacking and the palletizing of plates. If lead and dust could be kept cleaner in this area, both companies believed it would greatly reduce lead in air in the rest of the plant.

Keep the paste where it belongs and nowhere else, was the idea.

"Perhaps the most important underlying idea was that if we could come up with good ideas for taking this forward the knowledge would not belong to us as a machinery manufacturer or EnerSys as a battery maker but it would be open to the whole industry," MAC Engineering said.

Part of the process was a dis-assembling of the existing health and safety precautions such as cages and guards to protect the employee before assembling them again with the changes.

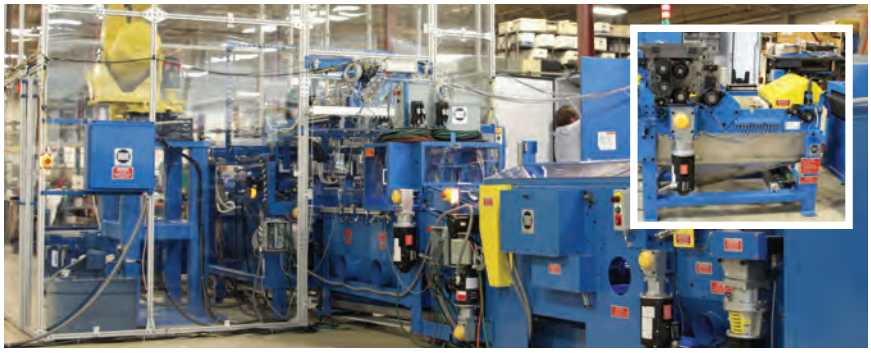
This involved designing modifications, closing off any unnecessary openings, using sealed conveyors to transport flaked off paste to sealed drums, extending guards, eliminating places where lead dust can gather, creating more efficient ventilation ports, and leaving as little space as possible for any lead to collect.

Because manufacturing lines vary from plant to plant, the thinking was that generic solutions needed to be found — approaches that could be transferred across the industry.

EnerSys and MAC said: "We have developed numerous pragmatic and effective measures to reduce lead emissions into the environment, and therefore a genuine hope that the entire battery industry can be a more productive and environmentally safer place in the future."

Mark Thorsby, then executive vice president at BCI, was positive about the move.

"This is a great example of the industry as a whole working together to forge a way ahead," he said. "What's particularly impressive is that it started with a couple of individuals being fired up at BCI and taking it from there — this wasn't about a series of high level meetings to decide to get things done nor was it about making someone richer on the basis of this, It was quite simply working out ways for the industry to get lead out of the air." ■



Glatfelter

How a composite scrim laminate can extend EFB cycle life

The development and use of enhanced flooded batteries in stop-start systems is progressing at rapid pace. One of the key improvements required to make EFB viable is increased cycle life, particularly of the positive plate.

One of the promising routes is to apply a scrim material to the surface of the plate to reduce the degradation rate of the positive active material during cycling.

This makes it possible for one product to play two crucial roles: as pasting paper during the production on the pasting line, and then as a retainer scrim, significantly increasing battery cycle life once in operation.

Glatfelter has developed a unique composite scrim Dynagrid NG328 that performs both these functions. The product is a composite laminate made up of two layers, one layer of cellulose fibres adjacent to a layer of polyester (PET) fibres.

The Glatfelter inclined-wire paper making technology ensures a laminated product with a perfect interface between the two layers of the above mentioned cellulose and PET.

Independent analysis showed, among other things, that the Dynagrid NG328 scrim (PET based) increased the DOD 50% cycle life at 40°C by more than 40%. This increase is comparable with glass scrim: Dynagrid NG328 gave an increase of 43%, glass scrim 44%.

The Dynagrid NG328 scrim reduces the rate of deterioration of electrical properties during discharge-charge cycling.

This results in better C20 capacity retention, improved cold start properties and lower increase of internal resistance during cycling. In all of these properties the effect of Dynagrid NG 328 was moderately superior to glass scrim. ■

GNB Exide

A breakthrough for tough, industrial batteries

GNB Industrial Power, part of what was then known as Exide Technologies, applied for the BCI Innovation Award on the basis of a new battery that came in two forms: TENSOR is a unique high performance battery and TENSOR xGEL an innovative maintenance-free battery.

GNB Industrial Power said the innovative design of this traction battery technology shifts the performance of batteries of this type to a completely new level: "It has more power, is faster at recharging and has a higher efficiency than traditional batteries; meanwhile the gel variant is also maintenance-free."

The TENSOR batteries combine high performance and maximum uptime with long service life and high energy savings. These batteries are designed for all demanding applications in tough industrial environments and allow fast charging, the company says.

The TENSOR battery will fully charge in four hours, is capable of intermediate and opportunity charging, can last up to 50% longer than standard batteries in cold environments and performs well at very low temperatures.

This makes them ideal for heavy-duty trucks, especially those that are operated outdoors throughout the year.

The TENSOR xGEL represents a "fusion between high performance TENSOR technology and maintenance free gel technology".

Research on this project was kick-started by attempts to find solutions to some of the challenges faced by batteries operating in tough industrial environments where charge times could be too short and traditional batteries struggled in extreme temperatures and also required regular maintenance. ■

HighWater Innovations

Tripling power performance through better design

HighWater Innovations applied for the BCI Innovation Award for the second time in 2018 on the basis that it had developed its invention 'the GO Battery'.

This is a low-aspect ratio, spiral wound battery, which is designed for maximum power and life. It is specifically intended for use in hybrid electric vehicles at a fraction of the cost of current battery technologies such as nickel and lithium chemistries.

GO Battery — it stands for Geometrically Optimized — had achieved some 1,000W/kg in power performance by then with a clear development path to more than 1,400W/kg. A conventional lead acid battery delivers some 350W/kg; lithium-ion is now around 1,400W/kg (but more expensive); the GO Battery is already at 1,000W/kg and improving.

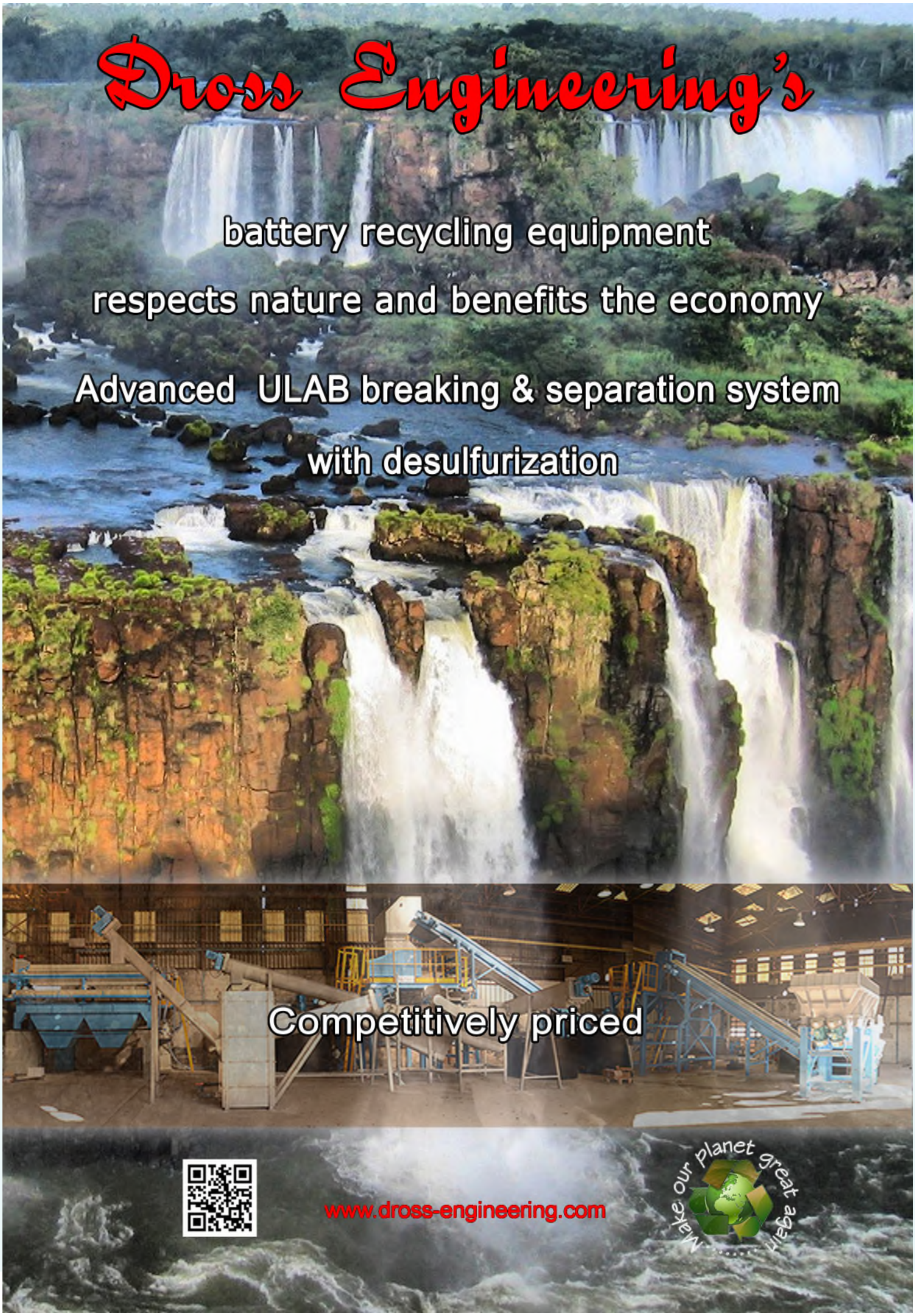
"We are close to achieving three times the power of conventional VRLA batteries," HighWater says. "We are now approaching what is delivered by lithium-ion batteries but at a fraction of the cost. At around $100 per kilowatt hour, we are in a similar price range to any lead acid battery — and that is a tenth of the cost of a lithium-ion product."

The GO cell features a low aspect ratio spiral-wound construction with a stackable pack design. This single cell building block can be used to assemble high voltage batteries of any voltage and offers a wide range of form and fitment to the vehicle designer.

The cells are also designed to stack and interlock to form a compact, air-cooled battery pack. The end cells in the pack will be thermally insulated so that all cells will be thermally matched and will therefore operate at the same temperature.

The HighWater founders say the battery will produce more power and have an extended operating life compared with other VRLA batteries. Their low aspect ratio grids will increase the overall power capabilities in the HEV application. Meanwhile, its open central core is designed for improved thermal management. ■

The GO battery is a series of cylindrical two-volt cells with four instead of two current take-off tabs, and a hole in the centre of the cell, through which air can pass. These two-volt cells can be stacked to form strings of any voltage.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Microporous

Booster mat for increased DCA

Separator product developer Microporous has come up with a dynamic charge acceptance booster for lead batteries that works without changing the negative active material. The firm received an honourable mention in the 2019 innovation awards.

The DCA Booster Mat can be bundled with its SLI or industrial separators and is suitable for the growing enhanced flooded battery market. It allows charge acceptance optimization and is suited to High Rate Partial State of Charge requirements for start-stop applications.

The firm says this separator component offers excellent charge acceptance in industrial markets such as motive power, where opportunity charging is required.

The Booster Mat fits tightly against the negative plate surface to add a powerful three-dimensional buffer layer that shuttles charge to and from the NAM. Initial testing demonstrated a 300% improvement in DCA over the control.

Microporous has for years explored ways in which carbon could improve lead acid battery performance and tried to solve some of the problems previous studies had encountered.

"We put our concept to work in 2018," the firm says. "We saw the need for improved DCA in lead batteries and the imminent threat of Li-ion in start-stop vehicles. Previous studies have shown that mixing carbon into the NAM has its drawbacks and we looked for a better solution.

"The work had four main aims: to improve the DCA in batteries; to do this without negatively affecting cold cranking amps; to do this with minimal impact on water consumption; and to eliminate the need for special NAM formulations.

Improved DCA allows for more efficient opportunity charging, which reduces undercharging and increases cycle life. For EFB battery design, improved DCA removes the phenomenon of battery walk down, which is often seen in automotive batteries used in start-stop operations. ■

Narada

A new approach to grid-level frequency regulation

Narada has partnered energy storage operator Upside Group in an innovative frequency regulation project, which represents the first large-scale application of lead carbon batteries in grid-level frequency regulation energy storage systems. This project was given an honourable mention in the 2019 BCI awards.

The frequency regulation project was for the German power grid and the installation, at Langenreichenbach, has a planned construction capacity of 75MW. The installed capacity of the first phase of the project is 16.4MW, and the peak energy storage capacity can reach 25MWh. This project consists of 18 containers, and the battery consists of 10,584 units of 1200Ah lead carbon valve regulated cells. It is powered by nine inverters, each of which can provide 1.8 MVA.

Narada was one of the pioneers in terms of developing lead carbon battery energy storage systems in energy storage.

It says it elected to do this project in Germany because the utilization of renewable energy in the country is one of the most advanced in the world. Its power grid frequency regulation market is thus a mature power market auxiliary service trading market. The company says its entry to the German energy storage market marks the beginning of Narada's entry to the global market.

The project was driven by the Narada Project Development Team, which was responsible for the finance and development of the entire project. It says it believes that the application of lead carbon batteries in energy storage systems is groundbreaking.

"This project is the first large-scale application of lead carbon batteries in grid-level frequency regulation energy storage systems, and is of exemplary significance worldwide," the company said. "In mitigating the power consumption of the local power grid, it adjusts grid balance, saves energy and reduces carbon dioxide emissions. And it provides electricity for local residents."

The company said the project will help Narada better understand this sector. It now wants to be heavily involved in the storage market of frequency regulation to promote energy storage systems throughout Germany and then Europe. ■

Philadelphia Scientific

Doubling the capacity of battery charging rooms

Philadelphia Scientific has developed a 'charger splitter' capable of doubling the capacity of a typical battery room, offering a much better return on investment in the process.

Philadelphia Scientific's iBOS Charger-Splitter is used in tandem with the iBOS [Intelligent Battery Organizing System] battery room management system, effectively using one charger to charge multiple batteries, and increasing the charging capacity of a battery room.

The Charger-Splitters are installed on conventional battery charging systems and when a battery is charged, a flashing LED alerts operators to disconnect it and plug it in to an uncharged battery. This enables the sequential charging of two batteries with one charger.

One of the biggest investments in a battery room is the cost of the chargers. They are an essential piece of equipment but are only used an average of 22% of the time.

The iBOS Charger-Splitter makes it possible to utilize unused charger capacity and halve the number of chargers needed to charge a battery fleet.

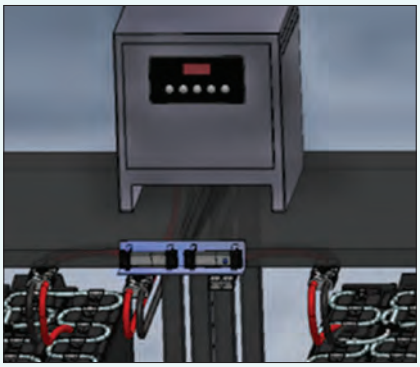
The company estimates that for sites with 20 chargers or more, it will more than pay for the entire iBOS system with money left over.

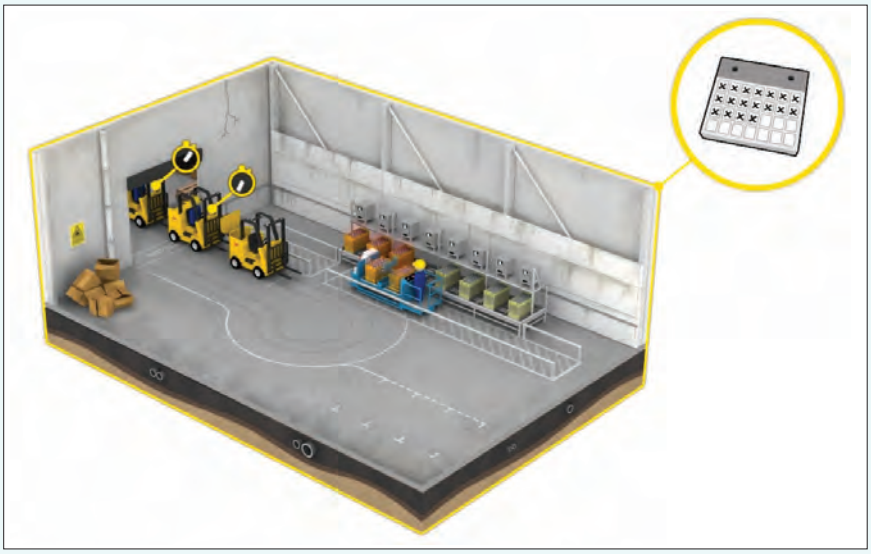
Alerts are displayed on the remote operations display to ensure the switch gets done and reports on the iBOSWorld website track user performance using the system.

In some cases, Charger-Splitters will enable battery room managers to reduce the number of chargers used by a third to a half, the company estimates. For the average battery room, that's an annual saving of tens of thousands of dollars.

It estimates that warehouses and DCs that are planning a new battery room can achieve 50% savings on charger purchases because they will require only one charger for every two batteries, not one charger per battery.

For battery rooms that must increase capacity by purchasing more batteries or trucks, half the number of chargers will be required than if Charger-Splitters are not being used. Charger-Splitters also provide an ideal solution when managers do not want to install costly extra power infrastructure to support additional chargers in a battery changing area. ■





iBOS 2 — Battery Management System (below). Philadelphia Scientific charger-splitter (right)

Power Sonic

The joys of smart grid management

Power Sonic's DRM (demand response module) is an innovative energy storage system suitable for the smart management of medium and high voltage electrical grids. It was nominated for the innovation award in 2019.

The firm said: "Our DRM system enables fast response times to variations in demand and supply, helping maintain grid stability and ensuring reliable, high-quality energy supply response through a range of applications.

"Based on current demand side response markets the DRM would pay for itself after four years. This is down to the speed in which it can respond to demand signals from the grid. With different financial models available including leasing and the ability to generate revenue from day one tied into long-term contracts with the grid, the DRM doesn't just offer an innovative solution for energy storage but also a great investment as a stand-alone asset.

"Power-Sonic is capable of managing the energy to meet all demands according to the requirements set by the utility provider."

The applications supported by the system include emergency backup in the event of a power interruption; with micro grids, a localized grid that can operate independently; renewable energy, the system facilitating seamless integration with renewable power generation sources; and reserve capacity, the DRM system providing power and energy capacity to the power grid as a stand-alone asset.

Other challenges it can address include peak shaving, frequency regulation, load levelling, renewables capacity firming and power quality, resulting in less energy consumption, more grid resilience, better power quality, monetary savings and income generation. The company says it can stabilize the grid to manage the consumption and production of renewable energy. ■

OUR NEW STRIP CASTER TECHNOLOGY RAISES THE BAR ON STRIP QUALITY

The as-cast strip thickness can be varied simply by changing the feed nozzle and adjusting the casting roller positions to produce as-cast thicknesses between about 0.200 inch (5.0mm) and 0.470 inch (12.0mm). Our rolling mills can also make minor adjustments to the final rolled thickness "On the Fly" during operation so the Wirtz strip casting system produces the highest quality strip in the most flexible system.

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INNOVATION. PERFORMANCE. RELIABILITY.

Remy Battery

The return of packaging for dry charged lead acid

Remy Battery applied for the BCI Innovation Award in 2017 on the basis of its FreshStart packaging solution for utility, automotive and commercial dry charged lead acid batteries.

The company says its solution solves a problem for a useful and age old product — how to activate a dry charged battery with the proper amount of electrolyte.

The firm says there is still a market for dry charged lead-acid batteries, which have significantly longer shelf life than traditional wet lead acid or AGM batteries. These dry charged batteries meet a current niche where a battery may not be put into service within the first three to 12 months of the battery's production date.

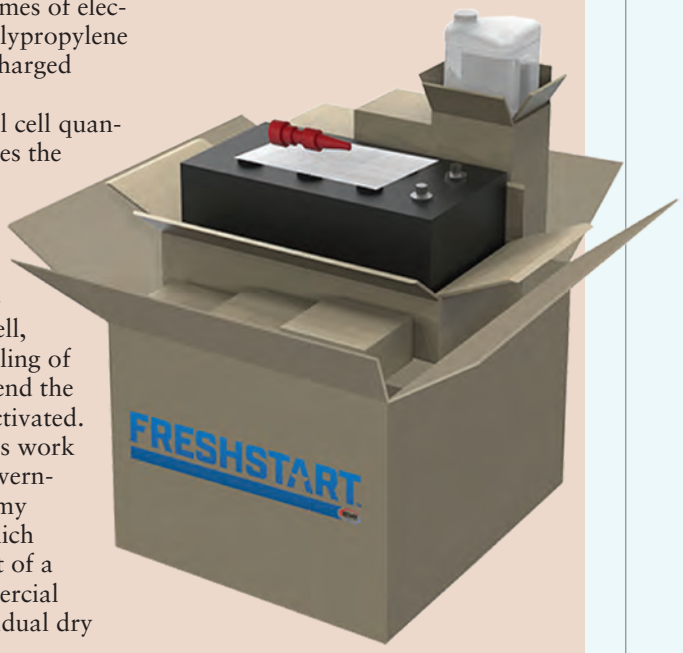
"Increasingly, the challenge for dry charged batteries has been sourcing the battery electrolyte to activate these batteries," the firm says.

"With increased shipping and environmental regulations over the past decade, securing and storing battery electrolyte has become increasingly difficult for the distributor and consumer.

The FreshStart solution solves this problem by packaging individual limited required cell volumes of electrolyte in high density polypropylene containers with the dry charged battery."

By packaging individual cell quantities of electrolyte it solves the problem of the consumer having to search locally for a source for electrolyte and also provides the exact amount of electrolyte needed for each cell, no overfilling or under filling of cells, which will help extend the life of the battery once activated.

The background for this work was the result of a US government contract, which Remy Battery was awarded, which required the development of a larger dry charged commercial battery where each individual dry charged battery had to be shipped with the exact amount of electrolyte in a secure, durable performance shipping container. ■



Terrapure

Solving lithium ion dangers in the recycling process

Terrapure has developed a product to detect and remove lithium-ion batteries from the lead recycling stream, an innovation that has important implications for the sector given the significant safety risks posed by lithium-ion batteries mistakenly ending up in the lead recycling process. It was nominated for the BCI award in 2019 and 2018.

Called the Li-ion detector, or LI Detector, it uses high-frequency radio waves to detect lithium batteries by scanning for their unique charging and protection circuitry. If detected, they can be easily removed by hand or automatically.

More than one million tonnes of lead acid batteries are recycled every year in North America alone. One of the early steps in the process is battery breaking, which involves disintegrating the batteries mechanically so the acid can drain out.

This is normally a reliable and safe process; however, problems can occur when batteries other than LABs accidentally enter the process. The biggest risk is from lithium-ion batteries. Upon entering the breaking process, they can explode in contact with the acid, causing damage to equipment and exposing plant personnel to potential harm.

Terrapure LI detector

Separating LIBs from LABs is a challenging task as they often look identical or very similar. BCI has been at the forefront of campaigning for standard packaging detailing which batteries are which.

"The LAB recycling industry has proposed several ideas to identify LIBs but all require tagging or colour coding LIBs at their point of manufacture. Getting all LIB makers around the world to agree to modify their designs at additional cost will be difficult if not impossible. In addition, none of these solutions applies to the countless LIBs already in use," he says.

Work on the LI Detector started in 2017 with the first commercial tests happening in September 2018. Terrapure has several handheld functioning prototypes.

"This is a huge safety advance for the industry with the capability to protect people as well as equipment from explosions and fires," the firm says. ■

UK Powertech

Improving battery formation through better connectivity

UK PowerTech applied for the BCI Innovation Award in 2018 on the basis of both design and an improvement to the manufacturing process for batteries.

Increasingly, battery makers have been pushing the limits in terms of how quickly they can charge a battery post manufacturing. Formation times have dropped from 24 to six hours for SLI batteries due to advances in formation cooling technology, acid recirculation and switch-mode pulsing rectifiers.

But the resulting fourfold increase in charging currents has exposed an inherent weakness in the connections between the batteries in the formation circuits. This is the high resistance interface between the connector head and the battery terminal.

This resistance has several causes including a barrier layer on the connector head surface resulting from the hostile environment of the formation department; a reduced contact area from poorly fitted connectors due to the difficulty of making and then removing around 3,000 connectors per man in a single shift; heat generated during formation from high resistance joints; and connector damage due to battery terminals being occasionally incorrectly manufactured, plus electrical arcing from damaged or loose connectors.

Since average SLI formation currents have increased from 15 to 60+ amps, the damage to batteries and the likelihood of formation room fires has increased.

UK PowerTech developed a blueprint for changes to working practices to ensure that connectors are fitted correctly and maintained and cleaned better. The firm also developed a new type of connector. The UK Powertech P type connector is designed to alleviate all of the problems with the standard design. The design uses a split spring design head, which will mould around the battery terminal even if placed unevenly.

This design does not provide a resistance fit as typified by standard push fit connectors. It is easily removed by an operator, and there is no incentive to loosely fit connectors. ■

Uniseg Products

Better ULAB transportation for safer, more efficient recycling

UNISEG Products applied for the BCI Innovation Award in 2018 on the basis of its Battery Transport & Storage (BTS) container, which brings many benefits to the recycling process including better safety, increased efficiency, better compliancy and improved data transparency on what has been collected and when.

The technology will reduce the amount of battery acid leaking into the environment, improve public safety, eliminate unnecessary double handling of batteries, protect workers from being exposed to acid burns and lead contamination — and also save money.

The BTS container allows the batteries to be ergonomically loaded into a pallet while the rear, left and right hand panels help keep the batteries in place. When the container is full of batteries it can be closed and secured.

One fundamental difference of the BTS container as a replacement for a conventional wooden pallet is that it entails operating a closed loop container pool. After the containers are emptied at the reprocessing plants, they are collapsed and returned.

An independent costing by Fleetrak Consulting demonstrated that despite the additional costs of washing and returning the BTS containers, on average there is a saving of A$21 ($16) per tonne of batteries transported. ■

The BTS container allows the batteries to be ergonomically loaded into a pallet while the rear, left and right hand panels help keep the batteries in place. When the container is full of batteries it can be closed and secured.

Voltific

Universal battery sizing becomes a software reality

VOLTiFiC Technology applied for the innovation award in 2019, having developed a universal battery sizing software that allows for the faster, more efficient and more accurate sizing of batteries. It can also be accessed through the internet.

The VOLTiFiC cloud platform is designed to allow anyone to size or service industrial batteries regardless of technology, manufacturer, chemistry or application.

A typical battery sizing software from a manufacturer can produce between five and 20 battery system designs within 20% of the requirements," says the firm.

"Compare that to hundreds of solutions that VOLTiFiC can generate within 5% of the requirements. The software adheres to international battery standards and allows for deep analysis of battery performance." ■

Digatron Power Electronics

Booth: 507

Digatron Power Electronics is an international group of companies with engineering, manufacturing and service facilities located in Germany, the United States, China and India.

Digatron develops and manufactures computer-controlled test and formation equipment for all kinds of batteries, ranging from batteries for mobile phones to automotive batteries to huge submarine batteries. But also for other kinds of electrical energy storage devices like fuel cells, supercaps and hybrid systems Digatron supplies high dynamic test and load simulation systems.

The combination of heavy duty power electronics in linear or switch mode technology along with digital controllers, data acquisition and comprehensive management software is what makes Digatron unique in this field.

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Eagle Oxide

Booth: 508

AUTOMATION - OXIDE PRODUCTION - MATERIAL HANDLING - SERVICE

EAGLE, a global leader in the design and manufacture of production and automation equipment. With over 25 years of experience working with battery manufacturers, material handling and oxide production systems, Eagle has the expertise to meet your battery production needs. We are the lead oxide experts!

From barton to ball mill systems, red lead and litharge furnaces, melt pots, ingot conveyors, pneumatic transfer systems, and integrated controls, to automated assembly cells, palletizers, and material handling systems, Eagle is your equipment and service team provider.

Competition in energy storage continues to increase. The ability to produce batteries with higher performance, at lower cost, and with lower environmental impact is a constant challenge. Eagle's knowledge of lead oxides and manufacturing automation makes Eagle the strategic business partner you need in this competitive market!

Web: www.eagleoxide.com
Email: sales@eagleoxide.com

See Us at Booth 508

Farmer Mold & Machine Works

Booth: 208

Family owned and operated since 1938, Farmer Mold & Machine Works specializes in the design and manufacturing of any type of machinery, including battery assembly equipment, parts casting equipment, and plant automation and process engineering.

Further, if you need something that's not already in our current product line, Farmer can work with you to create custom machinery for your specific applications — whether a new technology or refining an existing process.

Our portfolio of machinery not only sets the standard within the industry but is ever-growing. Plus, Farmer provides sales and support for acid dilution systems, plate curing ovens, and semi- and fully automated material handling equipment to several industries worldwide.

Our highly interactive and innovative approach to automated machine, tool and die, and mold design follows precise safety standards and utilizes the best materials to produce top-of-the-line machines and equipment that are built to last in 24/7 environments.

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Hammond Group

Booth: 408

Founded in 1930, Hammond Group, Inc. (HGI) is a battery additives/oxides and specialty chemical company that is advancing hybrid automotive and renewable energy markets through proprietary battery chemistry. HGI supports these emerging markets with two US manufacturing operations in Hammond, IN and another in Pottstown, PA. HGI also has International operations in Gateshead, England; and another in Kuala Lumpur, Malaysia.

Be sure to stop by our booth and talk with our specialists about how HGI can help your company overcome technical challenges. We offer technical assistance programs which allow our customers to utilize our experts to augment their research efforts, reduce capital expenditure and fixed costs, and rapidly develop new products.

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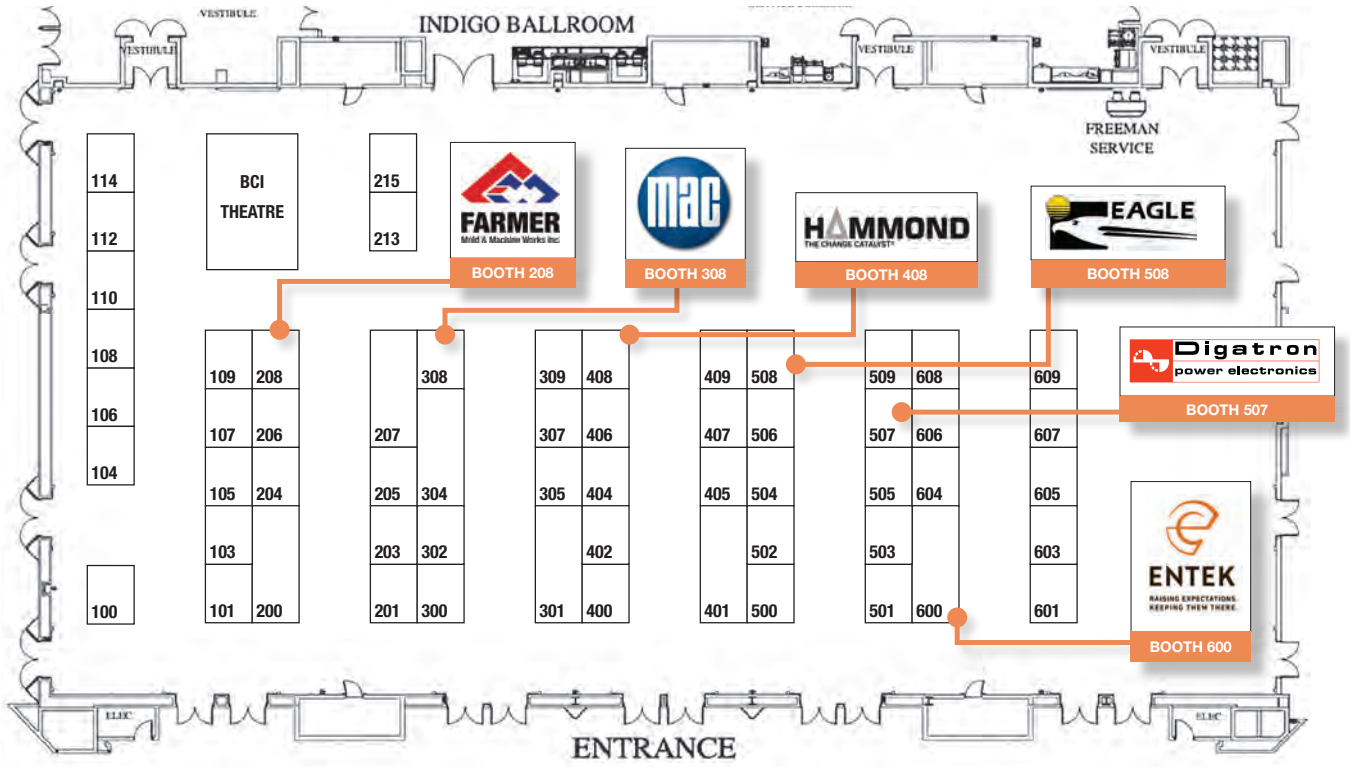

ENTEK

Booth: 600

ENTEK
RAISING EXPECTATIONS. KEEPING THEM THERE.

For more than 30 years, ENTEK has been an innovator and leading global designer and producer of microporous battery separators for lead-acid and lithium batteries. Our separators are used in lead-acid batteries for automobiles, golf carts and industrial applications, lithium-ion rechargeable and disposable lithium batteries.

We are a trusted supplier to leading battery makers in the Asia-Pacific, Europe, and the Americas, and headquartered in Lebanon, Oregon USA, with facilities in the United Kingdom and Asia. ENTEK was founded on the principle of being 'the best supplier to our customers and the best customer to our suppliers' and our focus on customer service has been key to our success.

Our capacity, technical field support, quality systems, logistics teams and local warehousing ensure our customers enjoy on-time and in-full reliability of supply. We continuously invest to grow with our customers and offer the product customization our customers rely on for their success.

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MAC Engineering

Booth: 308

MAC Engineering has supplied the lead acid battery industry with high quality downstream battery making equipment since 1965.

We offer complete systems for feeding, pasting, flash drying and stacking any continuous or gravity cast plate making technology.

From motorcycle and automotive batteries, to industrial and traction, we have equipment to handle any size of battery production.

New equipment solutions are now available for punched grids. MAC also offers finishing line equipment for automated Cast on Strap, acid filling, leak testing, heat sealing and more.

Contact us today for more information on what we can do for you.

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www.mac-eng.com

Inbatec

Booth: 509

Formation systems with acid recirculation technology

The Inbatec Modules – We form your batteries

Inbatec is the world leader in formation systems with acid recirculation technology with more than 400 systems in operation worldwide. Our formation modules are reliable and proven and are used by many lead-acid battery manufacturers around the world.

Your benefits:

- Closed formation system allows complying with MAC values and environmental regulations
- Precise acid gravity and temperature control results in very uniform cell-to-cell voltage
- Shorter formation time means higher productivity, less space requirement and lower work in progress / inventory
- Self-contained and independent modules – to be supplied only with concentrated acid, demineralised water, compressed air, electrical power
- Whole acid management is done inside the module
- Production capacity grows step-by-step

The Inbatec formation process combines uniform and repeatable quality with high productivity and environmental compatibility. The Inbatec modules – the benchmark for lead acid battery formation.

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Daramic

Booth: 301

Daramic is the world's largest manufacturer and supplier of battery separators for automotive, industrial and specialty lead-acid applications. As the inventor of polyethylene separator, Daramic has led the way in developing innovative technology for the global lead-acid battery industry nearly 90 years

- Innovation: Our scientists and engineers continue to break new ground in the development of advanced separator technology. Our 3 global innovation centers in Owensboro, US; Sélestat, France and Bangalore, India are dedicated to innovation to meet ever-changing industry needs
- Local Supply From A Global Perspective: 10 Manufacturing facilities and 7 Sales offices located in 8 different countries provide local service from a global perspective
- Reliability: State-of-the-art processes and manufacturing equipment deliver consistent, reliable product quality
- Full Automotive Solutions: Leverage the innovation synergy from its sister companies, the world's largest li-ion battery separator makers, that position us to provide full solutions for automotive battery applications from basic SLI to Start-Stop to Hybrid and Electric Vehicles

Contact details
Website: www.daramic.com

Sorfin Yoshimura

Call us for a meeting!

Sorfin Yoshimura is the largest independent trading company serving the worldwide lead acid battery industry.

Sorfin Yoshimura has offices in the USA, Japan, China, France, and Brasil in addition to agency cooperation in several other countries around the world.

We are a global company sourcing the best machinery, materials, and technical services for your battery factories specific needs.

Sorfin Yoshimura offers our customers the benefit of our decades of lead acid battery industry experience. We serve hundreds of customers throughout the world each year and customize our services for each and every factory.

We are constantly combing the world for the latest innovations in both materials and machinery; seeking to add vendors to our already vast network. When you choose Sorfin Yoshimura, you will quickly identify the unique combination of commercial savvy and engineering know-how that has enabled us to become the company that we are today.

We look forward for you to contact Sorfin Yoshimura.

The Source of Power!

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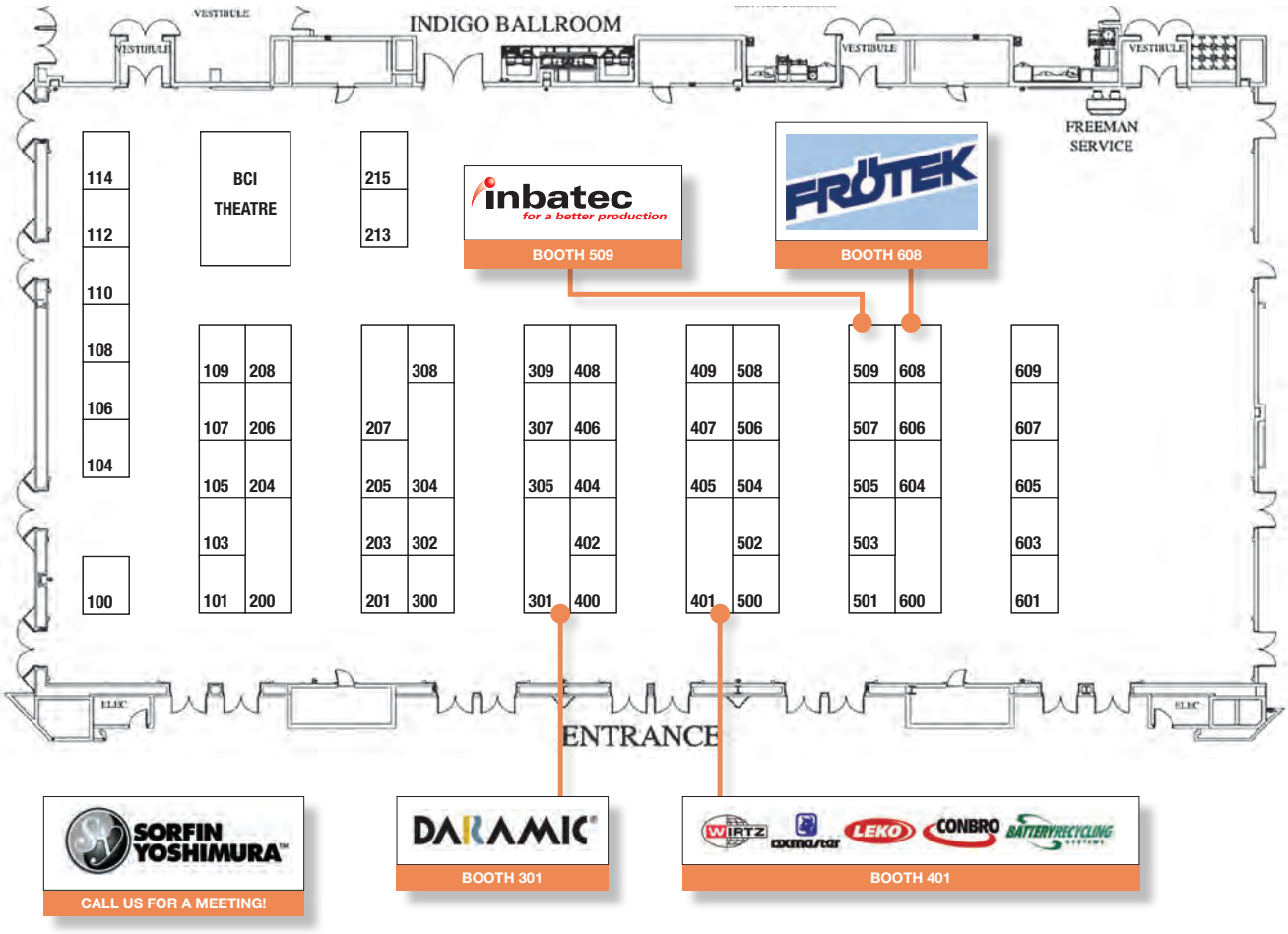

Froetek

Booth: 608

FROETEK Plastic Technology Corporation, a world leader in flexible and rigid intercell battery connectors along with battery accessories is very pleased to announce our newest manufacturing facility centrally located in Winston Salem, NC, USA.

FROETEK USA has been awarded contracts by a major US automobile manufacturer bringing our production to life.

Bolt on connector manufacturing which will kick off in the first quarter of 2022 will enable us to meet the demands of our current and future customers in North and South America. Our team is happy and ready to assist with your injection molding needs.

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E-Mail: info@froetek.de

WIRTZ Manufacturing

Booth: 401

The WIRTZ group of companies provides global solutions to the world-wide battery manufacturing industry.

With state-of-the-art equipment designed and developed by; WIRTZ (gravity-cast, continuously-cast and rolled, punched grid and plate production); OXMASTER (ball-mill and barton oxide production systems, and paste mixing equipment); LEKO (semi-automatic and high speed fully-automatic battery assembly lines); CONBRO (battery filling and formation plants); and BATTERYRECYCLING (turnkey battery breaking lead and plastic recycling systems, including paste desulphurisation).

At BCI, WIRTZ will demonstrate their commitment to automatically control, and continuously improve critical process variables, in order to ensure that their resulting battery products are of the highest QUALITY, DURABILITY and PERFORMANCE.

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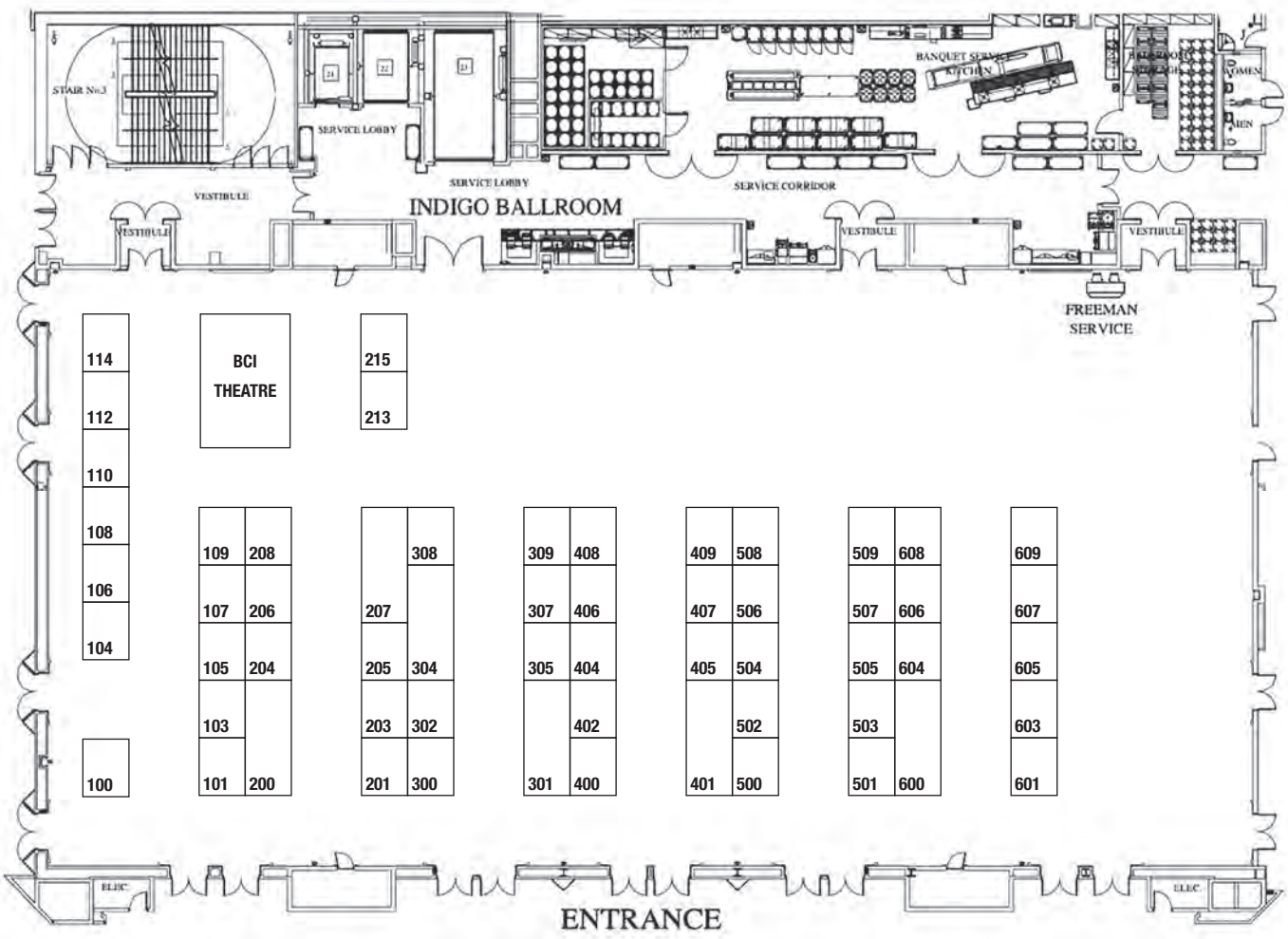
2021 BCI CONVENTION AND POWER MART EXPO – FLOORPLAN



KEY: BY COMPANY NAME

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Bernard Dumas	309	Hammond Group	408	PowerTech Water	110
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KEY: BY STAND NUMBER

101	Flow-Rite Controls	307	Oak Press Solutions	503	VIVET Technology
104	Wegmann Automotive	308	MAC Engineering and Equipment Company	505	Mate Gauge
109	CMWTEC Technologie	309	Bernard Dumas	506	TBS Engineering
110	PowerTech Water	400	Nederman MikroPul	507	Digatron
200	CG Thermal	401	Wirtz Manufacturing	508	Eagle Oxide Services
201	Cobra Wire & Cable	402	Polymer Molding	509	Inbatec
207	Calpine Energy Solutions	404	ITS	600	ENTEK International
208	Farmer Mold & Machine Works	406	www.secondlifelithium.com	601	Tulip-Richardson Manufacturing
213	Water Gremlin	405	Microporous	606	AMER-SIL
300	Sovema Group and Bitrode	408	Hammond Group	607	Pinco
301	Daramic	409	Centrifugal Castings	608	Froetek Plastic Technology
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