Batteries International

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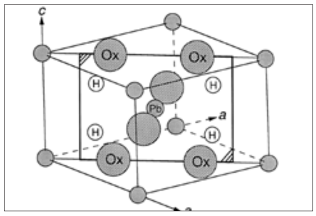

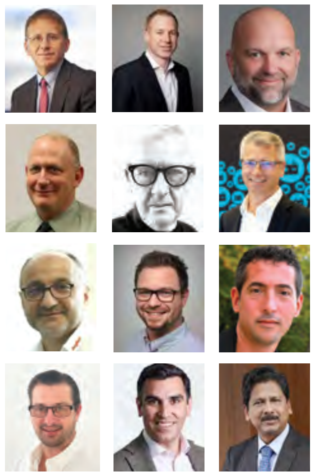

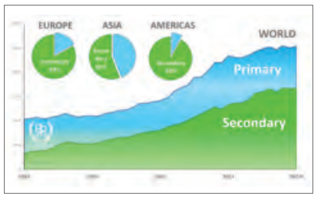

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Politics is the art of the possible. Business the art of the deal. But in Europe the two are intractably intertwined — and contradictory.

The future of Europe's battery industry

Halfway through my career in journalism I was intimately involved with reporting on the formation of what became the European Central Bank.

It was a hugely unreported scandal. It still is. But oddly enough — now an entire generation later — it highlights the coming crisis in Europe's battery industry

Basically, it's the inside story of dodgy dealings at the most senior level in Europe. It's a story about a lack of scruples, of riding rough-shod over everyone else and bending the rules.

The story starts well before the scandal. Jacques Delors, a French politician who became president of the European Commission, campaigned throughout the 1980s for the creation of a new currency that would be used throughout Europe — the euro.

This was agreed in the Maastricht Treaty in 1992.

And that's when the double-dealing began.

Two economic super-hitters of the European Union — Germany and France — had long envied London as the financial centre of Europe.

Almost a trillion dollars a year of business flowed through the City as the hub for European and international finance. It brought in billions of dollars in revenue to the UK.

Most importantly the UK didn't want to belong to the euro currency bloc. That would have meant its economic and currency policy would be set outside the country.

Every currency has to have a central bank that regulates the amount of money issued, the interest rate set and much more, so then the question for the French and the Germans was where the central bank be located.

The Germans said the natural place had to be Frankfurt, they long had had aspirations to make it the financial centre for Europe.

The French disagreed. The financial hub at La Defense in Paris was a more international destination. A capital too — not much of a comparison with Germany's fifth largest city.

It was an impasse. But an impasse that had to be resolved.

The solution was a subtle and, by all accounts, a French one.

Germany could have the financial centre, but the head of the central bank — arguably the most important person in setting monetary policy for the whole of Europe — would have to be French.

But once the European Central Bank was agreed in principle it had to be put into practice.

The trouble was in the run-up to creating the European Central Bank which came into formal existence in 1998.

The difficulty was that the candidate the French wanted, Jean-Claude Trichet, was unavailable.

Trichet had a formidable reputation behind him, as a former governor of the Banque de France, but he was implicated (and later cleared) in a scandal over the near collapse of French international bank Crédit Lyonnais.

The French and the Germans couldn't agree a suitable alternative but finally opted for Dutch central banker Wim Duisenberg. Duisenberg was regarded as an amenable and mostly respected man with a liking for a beer or two and reckoned to be pliable.

But in the fourth year of his eight-year tenure, Trichet was cleared of any wrong-doing and Duisenberg was ordered to stand-down for political reasons. He did so in an orderly manner now that Trichet had become free to take over.

The point of this narrative — apologies if I've been long-winded about this but this is an inside story to the wheels of power — is that Europe's politicians are neither idealistic and, when it matters they are certainly not naïve. Perhaps not so surprising really!

For this very reason, June's European Parliament elections are set to be decisive for the battery and energy storage industry.

In the last two years Europe's politics has verged increasingly to the right — and a nationalistic right at that.

In France, the far right led by Marine Le Pen is now a huge force in the country's politics; in Germany's recent local elections there was a renewed surge of the neo-Nazi Alternative for Germany; and in Italy Giorgia Meloni has led a hard-right government since 2022.

Even the more liberal countries of northern Europe are swinging away from the centre-ground. Geert Wilders, is leading a huge anti-Islam populist surge in the Netherlands, Sweden has now a right-leaning government in place. Finland too. A similar picture is in place across other European countries and some such as Slovakia and Hungary are extreme.

So when the parliamentary elections are over, a different agenda will be in play. Although only a few groups are so extreme as to want to dismantle the union that they label the EUSSR, there is a mounting dissatisfaction with the way Europe is run.

And why not? What sound of mind voter would subscribe to the EU Farm-to-Fork program to make 25% of all European agriculture organic by 2030?

So, in the June tussle for power, Europe as a bloc will lurch to the right.

In practice we shall see four clear trends emerging after the summer — mostly relating to delays to all-encompassing EU Green Deal agenda.

The first is that in the scramble for scarce battery resources — China had the foresight to lock most of these in for its lithium battery pioneers perhaps a decade ago — national priorities will trump EU policy. Rules will be disregarded at a national level.

Second, tied to this is the growing confusion over EU legislation on black mass (shredded, unsorted lithium battery matter that can be recycled) is inevitably going to create a softening of the rules. Legislation is about to be put in place where black mass cannot be stored longer than six months and can't be moved on — while European lithium recycling is expensive, little available and still in its infancy.

Luckily, perhaps since the EU Battery Directive leaves so many decisions over dates and priorities left hanging until 2030, EU policy can be allowed to drift.

Third, inevitably the pace of EU battery regulation will slow; the timetable will be fudged. This will be good news for the lead battery business. The protracted REACH regulations — which *inter alia* threatened to ban vital lead chemicals in battery production and cripple Europe's battery sector — have already been delayed (see news section). We can expect more of this.

Last, attempts to protect European battery manufacturers from outside competition will struggle and probably ultimately fail.

The European Commission has already set the environmental bar too high, or probably so — the cost of conforming to EU standards makes European batteries and their carmakers at a crippling disadvantage.

China's huge overcapacity in battery manufacturing will find its way into Europe one way or another, whatever Brussels says.

German carmakers, for example, are too deeply intertwined with Chinese firms to let the ideological wing of the EU impose its vision of European manufacturing sovereignty.

Mostly this is all good news for Europe's battery makers — for some reason the arrival of nationalism has given a renewed sense of commercial logic to law-making.

One thing stands out clearly, bureaucratic and idealistic, incompetence at the heart of the EU has left its battery and automotive industries at a huge commercial disadvantage. Although the European Commission crows about the energy sector's bright future, everyone in the business knows that Europe is 10 years behind that of China.

Right wing nationalism or not, the question is whether Europe will ever catch up — perhaps the final de-industrialization of the continent is already upon us.

Mike Halls, Editor-in-Chief

It is with sadness that *Batteries International* has to report the death of Lee Koenig, the driving force in creating the modern Crown Battery — he led the firm from 1955-1998 — on January 4 aged 94.

Crown Battery's former head Lee Koenig: 1929-2024

Hal Hawk, president of Crown Battery, said: "It is with heavy hearts that the Crown Battery family shares the passing of our patriarch, CEO-emeritus, and former owner, Lee Koenig.

"The son of our founder and our leader for nearly half a century, Lee was instrumental in transitioning Crown from a small local business into the globally recognized corporation it is today, and he deeply touched the lives of everyone in our Fremont and worldwide communities.

"Rest peacefully, dear friend — your legacy lives on in us all."

Lee's story starts with that of his father, William, a German emigrant and machinist who set up a radiator repair shop in Fremont, Ohio, in 1926. William, a gifted engineer, found that sometimes the battery also needed to be repaired and that year he changed the company name to Fremont Battery. Later this was to become Crown Battery — the family name Koenig means king in German.

The firm prospered for a while but 1929 — the year Lee was born — was the year of the Wall Street Crash and the start of the Great Depression. With car sales slumping and widespread economic collapse across large swathes of the US, the Koenig family struggled to stay afloat.

With the slow pick-up in the 1930s, his father looked to support his entire family. "My father and mother, started out with nothing but built the company that I later ran," Lee recalled. "My mother and sisters all worked at Crown Battery. We all worked there. It was really a family operation."

His three sisters helped with battery assembly and, aged eight, Lee started helping out at the firm. By his seventh grade he ran a pedal-operated press that trimmed the batteries. He cleaned up about 500 batteries daily.

By his ninth grade, Lee had graduated to the assembly department, excited to be making 25 cents an hour placing wood separators by hand between the positive and negative plates in the batteries.

During this time at school and later at university he earned a reputation as being an outstanding athlete and swimmer (though he later joked that he always stayed on at school to go swimming as his father used to make him work after supper).

He went on to a win a sports scholarship at Ohio's Bowling Green State University. He eventually set two varsity records in swimming and was voted most popular man on campus by his fraternity, Phi Kappa Psi.

Physical fitness was a passion of his and in retirement he continued to be a devoted swimmer before stopping a few months before his death.

Andrea Saalman, administrative manager at Crown who worked for him when Lee was in his 50s and 60s, said he would rise every day at 4am, swim five miles and eat his raisin bran before going to work!

"It was part of his work ethic," she says. "The best thing I learned from him was that hard work pays off."

After university he enlisted in the US Navy, ending up as a lieutenant. During his R&R from the navy he would help his father after the Crown Battery business struggled. Lee's situation was all the harder in that he married Marion McCullagh in 1951 and they lived in Akron — almost a two-hour drive to Fremont.

He eventually retired from active duty and moved to Fremont and started full time with Crown. This was a difficult period for the firm. "We almost went out of business in the early 1950s," he later recalled. The family firm, which had employed more than 20 employees dropped to just his father, himself and a part-time salesperson.

But with typical gumption he bought a panel-up truck and started to generate more business through deliveries, marketing and sales. Business started to pick up and in 1954 he bought Crown from his father, though the two would continue to work together until his father's retirement.

Over the next 40 years he grew Crown from a small regional manufacturer with just four employees to becoming a leading US firm with over 270 staff with sales across the US and 16 other countries.

"In 1954, we sold 2,000 batteries, by 1998 when I quit, we were making about a half million," he later recalled.

In the next 20 years the Crown Battery plant at North Fifth Street in Fremont expanded seven times, and in the 1960s distribution centers were added

In the next 20 years the Crown Battery plant at North Fifth Street in Fremont expanded seven times, and in the 1960s distribution centers were added across the US mid-West from Chicago to Buffalo.

across the US mid-West from Chicago to Buffalo. The successful auto and truck battery business was expanded to include marine batteries and industrial batteries.

Lee — like his battery giant counterparts Delight Brieidegam, who founded East Penn, and Roger Winslow at Voltmaster — realised the importance of the battery industry working together and he valued being able to share common problems and solutions.

In 1958 Crown Battery became affiliated with the Independent Battery Manufacturers Association. Lee would eventually become its president and later he also became president of Battery Council International.

Membership of a trade association, he would recall later, proved vital in dealing, in particular, with a host of new regulations and operation limitations introduced in 1976. These threatened the livelihood of Crown Battery — and indeed put many battery companies out of business. In response, Lee moved his manufacturing operations to its present home in Majestic Drive, Fremont.

In 1998, he sold Crown to a group of employees and Hal Hawk took over as head.

In a visit to the Majestic plant last summer, as CEO emeritus, he said he was proud of the "outstanding job" the new owners had done. The workforce at Crown Batteries has subsequently grown to about 500 and sales have increased five times over on the back of international expansion.

Lee had a powerful work ethic, Andrea Saalman recalls. "The word 'strength' comes to mind when I think of Lee. He knew what he wanted, and he got it done. While many thought he was strict he had a big heart for his employees."

Michael Fraley, vice-president of manufacturing operations, who began his career as a young professional working for Lee, said what he learned from him was that "hard work and protecting the company reputation were paramount expectations.

"Lee cared deeply for our community and made impactful donations without the need for recognition. He cared about the well-being of our community and the role that Crown Battery and his family have played in that community."

Even when Lee was in his 50s and 60s, he would rise every day at 4am, swim five miles and eat his raisin bran before going to work. It was part of his work ethic, He was a devoted and regular swimmer into his 90s.

Daughter Amy, Lee and Hal Hawk at visit to Crown Battery last summer

Robert Michael, director of plant engineering, and who knew and worked for Lee for a large portion of his life, said: "He was so successful in his life and career but never felt he was better than others. Lee was a great person who I always held in the highest esteem. I was truly blessed to have had the opportunity to work with and get to know him. Always so kind and encouraging. He made me want to do my best.

"Many people never appreciated the concern Lee had for his employees and their families. He bore the weight of knowing that his every action on how he ran Crown Battery could impact each and every one of them. He did not take that lightly."

Lee himself said he attributed this to a two-way loyalty: "If I had one talent it was the success in the people that I hired. They were loyal; they were hard workers."

After retirement, Lee enjoyed boating and fishing on Lake Erie and spending time at his cottage there on North Bass Island. He was a member of Grace Lutheran Church in Fremont.

He was buried with military honours in a private ceremony held at Oakwood Cemetery, Fremont on January 11.

He leaves behind his children, Susan, Brian and Amy, step-children Mike, Rande and Christy, his grandchildren, great grandchildren and one great-great granddaughter.

He is predeceased by his sisters Louisa, Leonarda and Ann and also by his daughter, Lois Koenig-DeRan. ■

Lee had a very real concern for his employees and their families. He bore the weight of knowing that his every action on how he ran Crown Battery could impact each and every one of them. He did not take that lightly."

CBI confirms Battcon takeover, Vertiv to be platinum sponsor for 2024 event

The Consortium for Battery Innovation has confirmed in December it had acquired the annual US stationary battery conference, Battcon — as revealed exclusively by *Batteries International* in October — with Vertiv set to be a platinum sponsor for next year's event.

CBI said on December 11 it had been appointed to run this long-standing industry event but the global research body — which is supported by the International Lead Association — did not disclose further details of the acquisition.

It is not known why Battcon, set up by the then established battery testing pioneer Glenn Alber, in 1998 and run up until now by technology company Vertiv, should seek such a deal.

A Vertiv spokesperson told *Batteries International*: "After more than 25 years of hosting Battcon, Vertiv is stepping aside as organizer of the popular event.

"The ILA and its subsidiary CBI will be hosting upcoming events and will be providing knowledge about battery trends, safety information and regulations that are important to stationary battery users in our industry.

"Vertiv looks forward to joining the upcoming event as a platinum sponsor."

However, Curtis Ashton, chair of Battcon's 11-member technical committee, said: "Battcon is a popular, user-focused conference and as a technical committee we were keen that an organization committed to battery energy storage should take on its management and future development.

"The committee felt CBI would be the best option. Its expertise and enthusiasm means that we can look to the event's continued growth and focus on the rapidly evolving stationary battery industry."

Battcon's Florida conferences have served as a showcase for all battery chemistry developments for more than 25 years.

The event regularly attracts more than 400 delegates plus exhibitors. CBI said it is also a professional development and networking event for the design, selection, and application of stationary, utility and energy storage battery systems.

CBI has already issued a call for papers inviting speakers to submit abstracts on potential topics demonstrating new technical enhancements for all battery chemistries for Battcon 2024, which will be held in Miami, May 14-17.

Alistair Davidson, CBI director, said: "Given the exciting opportunities for stationary storage across many applications this conference will remain at the forefront of the green energy transition."

Battcon 2024 will be held at the Hyatt Regency Miami, with pre-conference workshops starting on Tuesday May 14 followed by the full conference and trade show. ■

Douwenga quits as Metair CEO, cites health reasons

The CEO of batteries and automotive group Metair Investments, Sjoerd Douwenga, is resigning for undisclosed health reasons.

Metair said on December 6 that Douwenga had taken the difficult decision to resign effective January 31, 2024. The group said it had already begun a search for a successor, although Douwenga would remain available until the end of March to help ensure an orderly handover.

Metair said the board understood Douwenga's reasons for leaving and wished him the best.

Douwenga, a former CFO of the group, was announced as interim CEO last March following the resignation of Riaz Haffejee. Douwenga was permanently appointed to the post in May.

After qualifying as a chartered accountant in 2003 he spent eight years in the company's deals division. He started working with Metair in 2011 during the Rombat acquisition and was appointed business development director at First National Battery in 2013 and later CFO in 2014, which year he joined the board.

In the interim before his successor's appointment, the group said it would continue to be run by a "stable, experienced and skilled" leadership team.

Metair's energy storage division includes Turkey's Mutlu Akü lead battery business, Romanian lead and lithium company Rombat and South Africa's First National Battery. ■

BCI extends Power Mart for centennial event

Battery Council International's annual Power Mart Expo will be expanded to two days for its 2024 convention — which will mark the trade association's 100th anniversary.

The specially-extended Expo, on April 22 and 23, will showcase battery industry trends and innovations from what should be a record-breaking number of exhibitors and attendees for the centennial BCI Convention + Power Mart Expo, being held in Fort Lauderdale, Florida from April 21 to 24. ■

New 'Technical Excellence Council' bid to guide the future of secondary lead

Proposals to launch a tentatively-named 'Technical Excellence Council' dedicated to supporting the secondary lead industry have taken a major step forward with the circulation of a draft discussion paper, a copy of which has been seen by *Batteries International*.

The initiative has its roots in a message by secondary lead industry veteran Mark Stevenson during the 8th International Secondary Lead & Battery Recycling Conference, held in Cambodia in September.

At the conference, Stevenson urged all sectors of the industry to work together — through a forum initially dubbed the 'slag council' — to outline and define the terminology and nomenclature to be used in discussions and test work.

The conference was told the secondary lead industry needed to get to grips with a myriad of issues, not least in defining slag and saying how it is produced and how it can be dealt with.

In the draft TEC paper, which has been widely circulated to key figures across the batteries and secondary lead industry, aims to pave the way to establishing a worldwide industry network to enhance "coordination and communication" to solve technical issues.

In addition, the proposed TEC could be a conduit for exchanging technical communications and act as an inter-industry data sharing platform to help solve issues that operations face daily, the paper says.

But it is proposed that the TEC should not be limited to waste streams and should also embrace discussions of other areas of operations, including improvements in occupational health and safety standards and new recovery technologies.

There are an estimated 250 secondary lead smelting operations across the globe, not including informal or illegal plants, according to the paper.

"Nearly every smelter has slag issues, and every issue is different to that of another smelter," the paper says.

"Building the foundations for the industry will help us better understand the problems and, hopefully, lead to proper, sustained solutions." ■

Distinguished service awards for captains of India's lead industry

Two captains of industry in India's lead battery manufacturing and recycling sectors have received distinguished service awards.

Rakesh Malhotra, founder chairman of Luminous Power Technologies and Rajat Agrawal, MD of Gravita India, received the awards during the India Lead Zinc Development Association's (ILZDA) International Conference on Lead & Lead Batteries annual conference, held on December 7 and 8 in New Delhi.

ILZDA executive director L Pugazhenthy, best known throughout the industry as Pug, told *Batteries International* the awards, which recognized highly successful entrepreneurs, also served to encourage the industry's next generation of leaders and to motivate battery-related start-up companies.

About 200 delegates took part in this year's conference. There were more than 30 technical presentations. ■

From left: ILZDA executive director Pug, Mark Stevenson, Rakesh Malhotra and ILA managing director Andy Bush.

Umicore's Stassin to take-over as BEPA secretary general

Umicore's director of government affairs for electromobility projects, Fabrice Stassin, has been named as the incoming secretary general of the Batteries European Partnership Association (BEPA).

Stassin was appointed at BEPA's 7th general assembly on November 16 and will start his term of office in 2024.

He will succeed Philippe Jacques, who launched BEPA in December 2020 and will step down by the end of this year.

BEPA signed a memorandum of understanding with the European Commission in 2021 to launch a €925 million ($1.1 billion) programme to develop a competitive and sustainable industrial battery value chain.

The program, BATT4EU, is run under Horizon Europe, the European Union's research and innovation framework, which provides funding that will go towards research and innovation to develop a variety of technologies. ■

TBS Mexico names Sonia Martinez Diaz as GM

TBS Engineering has announced the appointment of Sonia Martinez Diaz as general manager of TBS Mexico starting November 1.

UK-based TBS said Martinez Diaz's experience includes more than 17 years across procurement, logistics and business transformation fields within the battery industry.

She is also a former director of procurement for Mexico and Latin America for lead battery giant Clarios.

At TBS, Martinez Diaz reports to aftermarket division group director Francois Serfontein. She will help to strengthen the firm's parts and service presence in Mexico while increasing the wider South American customer base. ■

Kim joins ENTEK as VP of product tech

Heejae Kim has joined ENTEK as VP of product technology and lithium business development, the company announced on January 4.

Kim is a former director of the North America supply chain for LG Energy Solution and global marketing director for the Cabot Corporation.

ENTEK said Kim will work with the company's technical staff, leadership and customers on development of lithium separator production at its new Terre Haute plant in Indiana.

CTO Richard Pekala said Kim's experience in R&D, strategic planning, global marketing and the battery supply chain will help ENTEK expand its separator business more efficiently with lithium ion cell manufacturers in North America.

ENTEK said last September that it had broken ground at the site of its $1.5 billion Terre Haute plant, which is set to produce up to 1.4 billion m2 of battery separators annually — enough to supply material for about 1.4 million EVs every year.

Operations are set to start in 2025-2027. ■

Gridtential chairman Kubis to advise UnitX

Lead battery veteran and Gridtential Energy chairman Ray Kubis has become a business adviser to AI technology development company UnitX.

Kubis told *Batteries International* on December 27 that he will continue as chairman of Silicon Joule bipolar tech developer Gridtential — a post he has held since October 2016.

UnitX announced last September it had secured a $5 million investment from SE Ventures, a Silicon Valley-based venture fund backed by Schneider Electric.

The company's inspection and defect detection technology is used in various manufacturing sectors including lithium ion batteries and electric vehicles. ■

Akerson resigns from Novonix board

Daniel Akerson has resigned from the board of battery tech and materials firm Novonix effective December 20. Akerson, a former chairman and CEO of General Motors, joined the board of Canada-based Novonix in October 2022.

He cited personal reasons for his departure — which was announced on December 19.

Novonix chairman Robert Natter said Akerson had played a key role including guiding the company through scaling of its anode materials operation.

Novonix was created from work by Jeff Dahn's research group at Dalhousie University focused on lithium ion battery research and working with Tesla.

Last September, Novonix announced that its Battery Technology Solutions division in Nova Scotia would receive up to C$3 million ($2.2 million) in research and development funding and advisory services from the National Research Council of Canada Industrial Research Assistance Program. ■

Bentner becomes Leclanché chairman

Lex Bentner (pictured below left) was elected to the board of Leclanché on January 12 and also confirmed as chairman of the Swiss energy storage group.

The board room shake-up, which was decided at an extraordinary general meeting of shareholders, follows the resignation of chairman Alexander Rhea on December 31, although Rhea remains as a director.

Bentner is currently head of public transport for the City of Luxembourg.

Abdallah Chatila (below right) , was also elected as a new director of the board, following the December 31 resignation of Bernard Pons as a director.

Chatila is a Swiss-Lebanese entrepreneur and investor and president and founder of the Geneva-based m3 Groupe. ■

Nobel sustainability honour for CATL's Robin Zeng

China's Contemporary Amperex Technology said on November 9 its chairman and general manager, Robin Zeng, has been honoured by the Nobel Sustainability Trust Foundation (NST).

Zeng has been awarded this year's outstanding contribution in sustainability award for his work in support of "global transportation electrification and the energy revolution", CATL said.

Zeng said he regarded the award as a recognition of CATL's activities in the development of battery technologies.

NST said the body's objective is to inspire individuals and organizations to develop sustainable technologies in areas such as energy.

The trustees of the NST, formerly known as the Nobel Charitable Trust, include members of the Nobel family.

In July, CATL's chief scientist and co-president Wu Kai and his team were honoured for contributions to lithium ion battery safety by the European Patent Office. ■

Stryten awards highlight battery tech communications

Stryten Energy has welcomed presentations of two awards for its campaigns to spotlight the firm's battery expertise in powering the energy storage sector.

Melissa Floyd, Stryten's VP for communications and digital marketing, Erica England (Arketi Group) and Jennifer Stancil (Stryten)

Stryten announced on December 12 that, with public relations partner Arketi Group, it had received the excellence award in the B2B media relations category during the 2023 PRSA Phoenix Awards ceremony — and the platinum award in the public relations program category from the 2023 MarCom Awards committee.

Melissa Floyd, Stryten's VP of communications and digital marketing, said the awards were testament to the success of the firm's efforts to share its battery technology expertise in tackling challenges and grasping opportunities in the evolving ESS market.

In addition to promoting coverage about its battery technologies in a wide range of publications, Stryten said the awards also reflected the success of its online newsletter, The Stryten Energy Insider, which has an average 40% email open rate and 5% click-through rate.

The Phoenix Awards competition is held annually by the Georgia Chapter of the Public Relations Society of America (PRSA) to recognize projects and programs that demonstrate excellence from the state's public relations practitioners.

PRSA Georgia is the national organization's second-largest chapter.

The MarCom Awards, administered by the Association of Marketing and Communications Professionals, honor creative brilliance, superior strategy and powerful implementation by marketing communications professionals. ■

Sustainability award honours for Clarios, Schneider

Lead and lithium batteries giant Clarios won the circular economy category of the World Sustainability Awards on October 19.

Clarios was one of 15 companies shortlisted for the award, which honours firms that "go above and beyond" to continuously reuse, recycle and retain materials and products.

The company's VP for sustainability and corporate affairs EMEA, Christian Rosenkranz, received the award on behalf of Clarios at a ceremony in Amsterdam.

The battery group said that by using recycled materials it uses 90% less energy and generates 90% less greenhouse gas emissions than those made with virgin materials.

Meanwhile, French multinational Schneider Electric was announced as the winner of the sustainable supply chain award. Schneider, whose group includes Indian backup power and solar tech firm Luminous Power Technologies, was recognized for efforts to decarbonize its supply chain through its Zero Carbon Project.

The company said it has helped more than 950 suppliers to report their emissions over the past 12 months and as a result has achieved an overall reduction in carbon output from those suppliers of 14%. ■

Christian Rosenkranz

Machines for the produc

Grid Caster
for special applications

Type GB-4

HADI Offermann Maschinenbau GmbH
Gevelsberg, Germany
hadi-germany@hadi.com

tion of lead accumulators

This Grid Caster is a special casting unit for negative oversized grids.

A typical application is casting of grids for „Load Levelling Batteries".

Automatic
One worker
Hydraulic oprated
Max. grid size:
wide 1000mm, height 375mm
Capacity: approx. 30 grids per hour

Complete with lead furnace H-36
Leadbar feeding device
Lead pump
Grid removal unit
Deadhead punch
Grid stacking unit
Cooling water temperature control unit

Mold support for HADI molds.
The mold opens parallel.
It can open very wide
for treatment with cork spray solution.

HADI Maschinenbau Ges.m.b.H.
Amstetten, Austria
office@hadi.at

Uplinger succeeds O'Connell at EnerSys

Chad Uplinger has been appointed president of motive power global at EnerSys, the lead and lithium batteries giant announced on November 8.

Uplinger takes over from Shawn O'Connell, who has been appointed president of energy systems global at EnerSys, succeeding Andrew Zogby.

Zogby's retirement was reported by *Batteries International* in September.

Uplinger started his career with the company in 1999 and he was most recently VP of motive power Americas, a post he had held since 2017.

Before that he was general manager of motive power specialty markets and led the team that launched the company's TPPL, thin plate pure lead maintenance-free batteries into the material handling market.

In August 2022, EnerSys announced the formal opening of its expanded Richmond, Kentucky distribution center in support of its motive power portfolio.

Products shipped from the expanded site include the company's range of traditional flooded lead acid and TPPL batteries and modular chargers. ■

Freyr shakes up leadership in gigafactory drive

Freyr Battery announced changes to its leadership structure on November 27 as the firm pushes ahead with its gigafactory development plans in Norway and the US.

Under the reorganization Andreas Bentzen has been promoted to the role of CTO. Bentzen, formerly EVP of technology, will now lead the development of Freyr's technology strategy and product innovation.

From left: Mike Brose, Andreas Bentzen, Ryuta Kawaguchi

Former CTO Ryuta Kawaguchi becomes chief strategy officer and technical fellow with responsibility for expanding the company's team of battery experts to support technology and product development.

Amy Jaick, formerly senior VP of US communication, has been promoted to head of global communications.

Jan Dahm-Simonsen, senior VP of human resources in Norway, will now head up human resources for Freyr globally.

Meanwhile, Mike Brose, who has been Freyr's senior VP of operations in the US, will lead all of the firm's activities in Mo i Rana, Norway, including the customer qualification plant (CQP), Giga Arctic project, and coordination of teams working with vendors, suppliers, and customers.

He will also oversee final commissioning and lead the start of automated production and scale up at the CQP of battery cells based on 24M's semi-solid lithium ion technology.

Brose will report directly to CEO Birger Steen.

Steen said the changes would strengthen the firm's technology focus including product development and digitalization. Additionally, they will help establish the US as Freyr's primary strategic production hub as it moves toward launching its 'Giga America' battery plant in Georgia and maximizing benefits of potential federal loans and tax credits under 2022's Inflation Reduction Act. ■

Former Jaguar chief Bolloré joins About:Energy board

Former Jaguar Land Rover and Group Renault CEO Thierry Bolloré has joined the board of London-based battery software developer About:Energy, the company announced on November 28.

About:Energy said Bolloré, who is also a former VP of automotive supplier Faurecia, will be responsible for developing its automotive and partnership strategies.

Founded in 2021, About:Energy is a spinout from Imperial College London and the University of Birmingham.

The company's software platform, 'The Voltt', can be used by customers developing their own battery programmes to cut development costs and use the modelling software to reduce time to market for their own products.

About:Energy co-founder and CEO Gavin White said: "Thierry's experience, credibility and industry knowledge will prove invaluable as we continue to scale and support a growing number of customers." ■

Skeleton appoints Huppe as COO Froböse named CTO

Skeleton Technologies, the supercap firm, has appointed Tobias Hüppe as COO, the ultra capacitors company announced on November 23.

Hüppe, former senior director of manufacturing for Swedish battery developer Northvolt, will steer the firm's own expansion of manufacturing, the company said.

He succeeds Linus Froböse, who has been appointed Skeleton's CTO.

Froböse will also be responsible for expanding production of Skeleton's proprietary curved graphene carbon material in Germany.

Curved graphene enhances electrode performance using locally sourced materials which are widely accessible and abundant in Europe, Froböse said. "Our focus now is on expanding production to broaden the material's availability and harness its potential." ■

Tobias Hüppe (left) and Linus Froböse

AM Batteries recruits Celgard's Shi as CEO

AM Batteries said on October 19 it had recruited former Celgard president Lie Shi as its new CEO. The lithium ion dry-electrode tech company said it had also appointed former Tesla director Hieu Duong (right) to the newly-created post of chief manufacturing officer.

An AMB spokesperson told *Batteries International* Shi succeeds Yan Wang, a co-founder of the company who becomes president.

AMB praised Wang's fund-raising abilities in helping the company gain commercial traction and said he would continue to assist AMB while also teaching.

Duong led development of the dry battery electrode process for Maxwell Technologies before the company's acquisition by Tesla in 2019. ■

Sheorey succeeds Tozier as Albemarle's CEO

US-based speciality chemicals producer Albemarle has appointed Neal Sheorey as executive VP and CFO with effect from November 6. Sheorey, who joins the company from materials science group Dow, succeeds Scott Tozier.

Tozier joined Albemarle in 2011 as senior VP and CFO and has now been appointed as a strategic adviser to CEO Kent Masters, the company said on October 26.

Sheorey was most recently VP of Dow's coatings and performance monomers business unit. He is also a former senior director of corporate development and global finance director for Dow's chemicals business. ■

Hammond picks up innovation award for additive product

The Hammond Group was among various companies honoured for product innovation by a leading regional university in the US.

Hammond was recognized for its Treated SureCure product, a battery additive the company says facilitates the controlled growth of uniform tetrabasic lead sulfate crystals in the positive plates of lead acid batteries.

The additive eliminates the need for steam curing, which saves manufacturing time and money, Hammond says. Battery performance is also enhanced with increased charge efficiency and better cycle life.

Contributing members of the team being honoured include Thomas Wojcinski, Gordon Beckley, Richard Botts, Gary Dean Botts, Enqin Gao, Perry Hedge, Perry Dewayne Hedge, Daniel Loosemore, Terry Murphy, Pete Nikoloski, Andrew Reynolds, and James Shearouse.

The Society of Innovators bestows the honour in in recognition of new products with measurable benefits for society. ■

Jeckell joins Alkemy, Tees Valley lithium boards

Battery materials supply chain specialist Vikki Jeckell has been appointed as a non-executive director of Alkemy Capital Investments, the company said on November 20.

Jeckell will also be a non-executive director of Alkemy's Tees Valley Lithium (TVL) subsidiary.

Alkemy said Jeckell's expertise would support its plans to expand in the battery materials sector. The company is working to launch lithium hydroxide production.Jeckell was head of battery materials supply chain strategy at Johnson Matthey for five years and more recently co-founded supply chain consultancy Supply Tactics, of which she is a director. ■

Echion CTO Groombridge joins battery industry LCA program

Echion Technologies' CTO Alex Groombridge has been appointed to the advisory board of the European high-quality life cycle assessment sustainability program for the battery industry (HiQ-LCA), the company announced on December 5.

The program, which is co-funded by EIT RawMaterials and the European Union, aims to help companies produce and recycle batteries more effectively by gathering more reliable life cycle assessment data.

Groombridge who has been involved in developing Echion's XNO niobium-based anode material technology, joins the board as a battery anode material expert. ■

Huge global expansion for Gotion as first US battery packs roll off production line

China-based lithium firm Gotion Hi-Tech has produced its first battery packs for ESS systems at its new factory in California's Silicon Valley, the company announced on December 29.

Gotion said the packs started rolling off the production line at its Fremont factory on December 21 — marking the launch of its 'made in USA' initiative.

Fremont has a planned production capacity of 1GWh to support Gotion's aim of marketing portable energy storage and residential BESS products in the Americas.

The Fremont milestone comes as Gotion prepares to start production at a $2 billion EV battery manufacturing plant in Illinois later this year.

Illinois governor Jay Pritzker said in September Gotion had secured a state investment and incentives package to transform a former plant site in Manteno into the gigafactory.

The company has to invest a minimum of $1.9 billion and create 2,600 full-time jobs.

Thailand

Separately, the first LFP battery packs to be produced by Gotion at a business park in Rayong, Thailand formally rolled off the production line on December 7, the company said.

The development follows SAIC Motor's launch of EV batteries and components production at its joint venture plant in the country just weeks earlier.

Gotion's facility has a planned annual production capacity in its first phase of development of 2GWh.

Production capacity could be expanded to 8GWh annually, subject to demand, the company said. Gotion says its LFP batteries have a charging capacity of 38kWh and a range per charge of 400km.

Neta Auto, the EV brand of Chinese carmaker Hozon New Energy Automobile, will be a key customer for Gotion's new facility. Neta Auto started production in Thailand — its first overseas factory — on November 30.

This is part of a larger geographic picture, SVOLT started building a battery modules and packs factory in Thailand's Chon Buri province in July.

Partnering ABB

Gotion said on December 12 it had signed a memorandum of understanding with Swiss tech group ABB that would support construction of large-scale lithium ion battery factories to serve EV markets in Europe and the US.

ABB will supply a design plan combining automation, electrification and digital technologies. The two will also consider potential R&D cooperation to understand how battery cells, modules and packs from Gotion could be supplied to ABB and its affiliates.

Gotion, in which Volkswagen has a 26.5% stake, is also considering a factory in Morocco. ■

US toughens stance on battery tax breaks for Chinese firms

Further guidance to clamp down on the use of China-supplied content in batteries eligible for EV tax credits in the US was unveiled by the Biden administration on December 1.

The move, by the Department of Energy, aims to clarify the definition of 'foreign entities of concern' (FEOC) set out in the Bipartisan Infrastructure Law — designed to curb the dominance of Chinese and other players outside the US and boost domestic manufacturing capabilities.

The guidance, published for public comment, comes as rules on FEOCs are set to take effect in 2024 for completed batteries and 2025 for critical minerals used to produce them.

FEOC rules cover battery materials processing and battery manufacturing and recycling grants — which have a statutory requirement to prioritize projects with non-FEOC-based supply chains. There are also limits to clean vehicle tax credits where firms have battery supply chain links to FEOCs.

A foreign entity, under the Department of Energy's proposed guidance, would mean a government of a foreign country or someone that is not a lawful permanent resident or citizen of the US.

Partnerships, associations, corporations, organizations or other combination of persons organized under the laws of a foreign country, or having their principal place of business in a foreign country, would also be classed as foreign entities.

The US Geological Survey warned in February 2022, the country is heavily dependent on imports for key battery materials including cobalt, lithium, manganese and nickel.

Last May, the Department of Energy reversed its decision to award Microvast a $200 million grant to build a lithium ion battery separator plant, amid claims the company had links to China. However, Microvast founder, chairman and CEO Yang Wu, an American citizen, said neither China's government or the Chinese communist party had any ownership of the firm or influenced operations in any way.

In September, US legislators threatened to haul Ford CEO Jim Farley before Congress if they did not receive documents relating to the firm's partnership with Chinese battery giant CATL. ■

Lead firms urged to grab share of $3.5bn US battery funding

Lead battery developers were being urged before Christmas to apply for US federal funding worth up to $3.5 billion after energy chiefs clarified their eligibility for the cash.

The Department of Energy said in November the funding was for projects in addition to lithium-based tech — and stressed in a December 1 update to its call for proposals that all battery materials processing and manufacturing technologies are eligible.

North American lead battery industry trade body, Battery Council International, said it was an important acknowledgment that the US requires the full breadth of energy storage options for its clean energy transition: "That includes battery technologies ranging from lead to sodium ion to redox flow," said BCI.

The update comes after BCI president Roger Miksad said on October 18 that US government funding for batteries had been improperly tilted in favour of a handful of technologies. ■


A SEPARATOR FOR EVERY BATTERY

Industry commentator calls Ford's EV loss, Tesla warning a 'truth bomb' for auto industry

Auto giant Ford is facing up to the "truth bomb" that motorists don't want to pay a premium for EVs after posting a third-quarter operating loss of $1.3 billion in its EV division, according to industry commentator Robert Bryce.

The figure equates to a loss of more than $62,000 for each of the 20,962 EVs Ford sold during the period, says Bryce.

The third-quarter loss on the EV business, combined with a $1.1 billion second-quarter EV loss and a first-quarter EV loss of $722 million, means that Ford has already lost about $3.1 billion in total on its EV business this year.

Ford acknowledged in a statement that "many North America customers interested in buying EVs are unwilling to pay premiums for them over gas or hybrid vehicles, sharply compressing EV prices and profitability".

Bryce, who also hosts the Power Hungry Podcast, says: "That's a truth bomb of the first order."

Other auto firms are also reporting heavy losses on EVs or announcing cutbacks in their EV expansion plans, according to Bryce.

On October 18, Tesla CEO Elon Musk said he was concerned about the impact of high interest rates on car buyers and said the firm was hesitating on its plans for a factory in Mexico as it assesses the economic outlook.

You know the EV business is in trouble when Musk makes such comments, Bryce says.

"These moves show that the universe of likely EV buyers is far smaller than the automakers expected. That miscalculation will cost the companies, their shareholders — and taxpayers — tens of billions of dollars in wasted capital."

Bryce's analysis is online: robertbryce.substack.com. He was a keynote speaker at the last BCI conference held in Louisville last Spring. ■

Ford's Q3 figure equates to a loss of more than $62,000 for each of the 20,962 EVs it sold

Innovation driving investment in next gen battery tech, says patents report

Interest in the development of battery technologies continues to grow year on year, according to latest data from intellectual property law firm Appleyard Lees.

Partner and patent attorney David Walsh said on December 8 the firm's Inside Green Innovation: Progress Report 2023 shows that making existing technology work better and driving next generation electrical storage is central to the latest battery industry innovations.

Among the five polymers most popular for production of polymer electrolytes in modern battery cells, innovation is most prolific in polyacrylonitrile, the report said.

In addition, the complex copolymers, poly (vinylidene fluoride-hexafluoropropylene) — or PVDF-HFP — have also emerged strongly.

Countries including South Korea, Japan and the US are spearheading the most innovation through companies including LG, Samsung, Toyota, Panasonic and Zeon, the report said.

The latest innovations designed to improve upon lithium ion batteries are focused on alternative metals, according to the report.

Patent applications have spiked for sodium and zinc-related battery technology, based on claims of faster charging, longer lifecycle and reduced cost, while Japanese companies are at the "epicentre" of this innovation area.

Meanwhile, after reaching an all-time high in in 2018, patent filings in 2021 for redox flow battery technology fell by 30% against the 2018 peak.

While redox flow batteries have the capacity to scale easily, making them relevant to storage for large energy sources such as solar and wind, the technology remains relatively embryonic, the report says.

However, innovation such as improving carbon electrodes to decrease cell resistance in flow batteries is prominent in the latest patent filings. ■

Administrators step in to ready AMTE Power sale

An accelerated sales process is underway to seek potential buyers of lithium and sodium ion batteries developer AMTE Power.

The announcement came after the firm said on December 19 it intended to appoint administrators and suspend trading of shares when a planned deal with Pinnacle International Capital fell through.

A conditional subscription agreement between AMTE and Pinnacle, first announced last July, sought to raise £2.5 million ($3.2m). A conditional placing agreement to raise a further £400,000 and a £200,000 convertible loan facility with Pinnacle was also proposed.

However, AMTE said on December 19 Pinnacle had extended the long stop date for completion of the subscription agreement from December 20, 2023 until January 12, 2024, as a result of a delay in receipt of its advisers' due diligence report and the holiday period.

AMTE said it had served a drawdown notice but Pinnacle declined to advance funds under the convertible loan.

The board had no other options to secure finance in the time available and concluded AMTE had insufficient funds to continue trading and intended to appoint FRP Advisory as administrator of the company.

AMTE's temporary suspension of trading on the Alternative Investment Market, a sub-section of the London Stock Exchange, was announced on December 19. In the interim, FRP Advisory will manage an accelerated sale process to seek potential buyers of the business and assets of the company. ■

Transformers bottleneck hits BESS supply chain, says report

A limited supply of transformers has become a major bottleneck in the global energy storage supply chain, according to analysis published on October 30.

Industry is struggling with price spikes and short supplies of transformers, with a minimum lead time of more than a year for transformers of all sizes, the Wood Mackenzie study says.

Kevin Shang, senior research analyst at Wood Mackenzie, said this has a direct impact on system integrators as transformers are integral for grid connections.

Meanwhile, the global BESS integrator market has grown increasingly competitive in 2022, with the top five global system integrators accounting for 62% of overall BESS shipments in terms of megawatt hours, Shang said.

Sungrow dominated the market with 16% of global market share rankings by MWh shipment, jointly followed by Fluence (14%) and Tesla (14%), Huawei (9%), and BYD (9%).

"While global battery supply eased in 2023, after experiencing supply tightness the previous year, the limited supply of transformers has become the new bottleneck of the energy storage supply chain," Shang said.

According to the study, China led the Asia Pacific BESS integrator sector in 2022 with an 86% market share.

However, a price war has started among system integrators in China, with an increasing number of players "willing to sacrifice profits in exchange for market share, dragging down the profitability of the whole industry", Shang said.

Intensifying market competition will make it difficult for companies with low profitability and no clear competitiveness to survive over the coming years, according to the study.

Competition in the US BESS integrator market is set to ramp up too. Shang said the country's Inflation Reduction Act and clean energy policies of state governments will drive growth in the storage market.

Globally, as major policy developments propel the battery energy storage systems market, the BESS integrator industry is becoming increasingly competitive, he said.

"While existing system integrators are striving to increase market share, the fast-growing energy storage market has also attracted many new entrants to this space."

The American Clean Power Association said in December 2022 that more than $40 billion of grid-scale clean energy investments, including several new battery storage plants, were announced in the US in the three months up to November 30. ■

US BESS capacity set to nearly double in 2024

US battery storage capacity is forecast to nearly double to more than 30GW by the end of 2024 according to latest analysis by the US Energy Information Administration.

Planned and operational US utility-scale battery capacity amounted to a total of around 16GW at the end of 2023, the EIA said in its latest Preliminary Monthly Electric Generator Inventory report released on January 9.

Developers plan to add another 15GW in 2024 and around 9GW in 2025.

US battery storage has been growing since 2021 and could increase by 89% by the end of 2024 if developers bring all of the energy storage systems they have planned on line by their intended commercial operation dates, the EIA said.

The forecast expansion of battery storage capacity to more than 30GW by the end of this year would exceed that produced by petroleum liquids, geothermal, wood and wood waste, or landfill gas.

California has the largest installed battery storage capacity of any state (7.3GW) followed by Texas (3.2GW), both largely driven by the rapid growth of variable solar and wind power generating facilities.

The remaining states have a total of around of 3.5GW of installed battery storage capacity.

In a separate report into the energy market of the UK, also released on January 9, LCP Delta said modelling shows the deployment of 20GW of long duration energy storage could save the country's power system up to £24 billion ($30 billion) from 2030 to 2050. ■

Lead metal chemicals listing bid slips further out of REACH

A decision on controversial proposals for lead metal to be added to an expanded European chemicals authorization register is set to be shelved until late 2024 at the earliest, *Batteries International* has learned.

Battery industry leaders have been in talks with European Commission officials since the European Chemicals Agency (ECHA) revealed its proposals in April.

ECHA has suggested adding lead and seven other substances to its REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) list — indicating that the substance would eventually be substituted and could only be used in the meantime with specific permission from the Commission.

Informed sources said on the sidelines of the ILA's Pb 2023 conference in Athens in June that, privately, Commission chiefs had indicated there was "no appetite" for the move — for the time being — not least because it would trigger a huge administrative burden as thousands of applications would flood in and risk clogging up the regulatory process.

EU insiders told *Batteries International* in November the revisions are highly unlikely to be considered before next June's European Parliament elections — or before the subsequent formation of a new Commission.

The composition of the next European Parliament is likely to reflect the general drift to the right in European politics over the past couple of years. Typically, right-wing politicians are less concerned about environmental issues than those on the other side of the political spectrum.

Senior Commission figures have failed to mention the issue when outlining legislative proposals to be dealt with before the current Commission's term of office expires next October, according to global law firm Squire Patton Boggs. ■

Hammond's global supply chain to rescue in testing times for lead battery sector

Two main free trade arteries are now disrupting supply chains with drought reducing transport through the Panama Canal and ships avoiding the Red Sea-Suez Canal route because of attacks arising out of Middle East conflict.

Prices are rising and schedules are being extended but Hammond's global footprint — with facilities in North America, Asia and Europe — means the firm is an invaluable and reliable supplier to the lead battery industry.

Shipments through the Panama Canal, a vital link to Asian lead battery firms from North America, are being severely disrupted by drought. The Panama Canal Authority says 2023 was the second driest year in recorded history, compounded by a late rainy season.

As of early January 2024, some vessels queuing to use the canal had to wait more than 11 days — and the International Maritime Organization has forecast the drought's impact could hamper trade for months to come.

Now Hammond, a key supplier to global lead battery markets, is highlighting how its strategically-located plant in Malaysia can mitigate supply chain risks for Asian battery manufacturers, while other US producers of material for the lead battery sector remain reliant on the canal.

Some US companies are scrambling to use rail links to reach US west coast ports for onward shipping to Asia, but are already experiencing congestion and seeing transportation costs ramp up, while also increasing carbon footprints.

Hammond's Kuala Lumpur plant manufactures expanders and its SureCure TTBLS products, serving an extensive Asia Pacific customer base, with the capacity to supply new customers, including the burgeoning South Korea market, while offering production lead times of just 10-14 days.

Asian companies sourcing Hammond's Malaysia operation also

In normal conditions shipments through the Panama Canal are a vital link to Asian lead battery firms from North America avoid the imposition of inter-country regional tariffs.

Meanwhile, as geopolitical conflicts force shipping to avoid the Red Sea-Suez Canal route, Hammond's UK manufacturing base provides an additional strong link for the battery supply chains into the Middle East and Europe.

The reliability of Hammond's supply chain arguably faced its toughest test during the Coronavirus pandemic.

Brad Bisaillon, VP of sales and quality assurance, says customers later told Hammond it was among the few that never let them down during the global health crisis.

Major companies that it had not supplied for some years returned to Hammond because of the firm's reliability during pandemic restrictions, Bisaillon says.

"As we did then, we continue to demonstrate our expertise, ability and flexibility to respond to the needs of the lead battery industry globally, whatever issues arise." ■

Drought restrictions impacting the Panama Canal were imposed to maintain water supplies for human consumption, amid insufficient rainfall at the Gatún Lake, which feeds the canal.

Maritime traffic was down by around 15 million tonnes as of the end of 2023.

Some 35 vessels would normally use the canal daily, but this is expected to be down to 18 to 24 vessels from February if conditions improve.

Transit slots under normal conditions cost around $100,000 per vessel, but shippers are now reportedly paying close to $1 million per vessel.

European Commission gives green light for €4bn state-aid projects in France, Germany

The European Commission said on January 8 it had given the go-ahead to state aid plans worth a total of nearly €4 billion ($4.4 billion) for batteries, raw materials and renewables projects in France and Germany.

The announcement came after industry leaders warned proposals by EU leaders to slash research and innovation funding by billions of euros risked making "a catastrophic decision" to battery and raw material investment plans (see separate NEWS FOCUS article in this issue).

Commission executive VP in charge of competition policy, Margrethe Vestager, said a German government state aid package worth €902 million had been approved for Sweden's Northvolt to build a battery cells gigafactory in Germany.

Vestager said the aid was approved under the EU's temporary crisis and transition framework (TCTF), introduced to support investment in power and other industry sectors in the wake of rising energy prices following Russia's invasion of Ukraine.

The aid would ensure Northvolt produced battery cells for EVs in Europe instead of being tempted to locate to the US by lucrative tax and other incentives, she said.

Northvolt's approval marked the first use of TCTF's "exceptional possibility" category, which allows for the provision of support if a proposed investment is at risk of being lured away from Europe by subsidies offered overseas.

Also approved under TCTF was a €2.9 billion French scheme supporting production of batteries, solar panels, wind turbines and heat-pumps, related key components and critical raw materials. ■

Report lifts lid on cost of Canada's EV battery deals

More transparency is needed surrounding subsidies for EV battery production in Canada — the cost of which could be up to C$6 billion ($4.4 billion) more than government forecasts, according to an independent report released on November 17.

"It's not just the underestimate that bothers me," said one independent commentator, "nor is it the total C$43.5 billion, that'll be given in subsidies — and that's huge — but it's the worldwide picture. Hundreds of billions of dollars are being invested in a lithium technology that we all agree is a half-way house between lead and the next generation of energy storage.

"With a payback time on these subsidies that can be up to 20 years, how much money will be lost when, a new battery chemistry such as sodium ion becomes mainstream? And that may be in as little as five years' time."

Canada's parliamentary budget officer, Yves Giroux, said he estimated the total cost of government support for EV battery manufacturing by Northvolt, Volkswagen and Stellantis-LG Energy Solution to be C$43.6 billion over 2022-23 to 2032-33 — C$5.8 billion more than the C$37.7 billion in announced costs.

Giroux said the C$5.8 billion in non-announced costs — as the country tries to compete with lucrative incentives enticing battery makers to the neighbouring US — represents lost corporate income tax revenues for the federal, Ontario and Quebec governments combined.

He said the report aimed to increase transparency by providing an estimate of the total cost of government support for EV battery manufacturing, including announced and non-announced costs, because announcements to date have "largely been made in isolation and an estimate of the total cost of government support has not been publicly provided".

Giroux's report also provides estimates of the break-even timelines for announced production subsidies.

Of the C$43.6 billion in total costs, the report estimates that $26.9 billion (62%) will be incurred by the federal government and C$16.7 billion (38%) will fall on the provincial governments of Ontario and Quebec.

The estimate of the total cost is conditional on the US Advanced Manufacturing Production Credit (AMPC) remaining in place until the end of 2032 and on the EV battery production schedules provided by Northvolt, Volkswagen and Stellantis-LGES being realized. The AMPC is among US federal incentives included in the Inflation Reduction Act.

In its break-even analysis, Giroux's report notes that the federal government used his office's methodology to estimate a break-even timeline of nine years for Northvolt's production subsidy, based on full production in every year.

"Based on Northvolt's projected annual production schedule, we estimate a break-even timeline of 11 years for the C$4.6 billion production subsidy," Giroux says.

"We estimate a break-even timeline of 15 years for the C$13.2 billion production subsidy announced for Volkswagen, and 23 years for the C$15 billion in production subsidies announced for Stellantis-LGES — consistent with our previous estimate of 20 years based on their combined production schedules."

In July, Ontario premier Doug Ford said the Stellantis-LGES incentives were a direct response to those offered by the US government — but warned they could be reduced or cancelled if the US should drop its support for battery makers. ■

Battery industry warns over 'flawed' EU net zero laws

For the record, proposed EU laws to boost investment in clean energy technologies including batteries and renewables need revising to remove serious flaws, industry leaders told *Batteries International* in October.

Flow Batteries Europe (FBE) said the Net-Zero Industry Act (NZIA), set to come into force in 2024, would fail to stop investors being lured away from Europe by lucrative incentives such as those offered under the US Inflation Reduction Act.

In a policy paper published on October 11, the FBE called on the European Commission to allocate specific funds to "strategic net-zero technologies such as flow batteries". The paper says NZIA lacks a concrete objective for the battery sector and gives only a general 40% EU manufacturing target by 2030 for all listed technologies. ■

Lithium-sulfur chemistry returns to favour with Gelion £4.2m acquisition of OXLiD

Gelion said it has agreed to acquire UK lithium sulfur firm OXLiD in a deal worth up to around £4.2 million ($5.2 million) — and put Li-S back on the roadmap as a next-generation battery chemistry contender in sectors such as energy storage and EVs.

Gelion said the acquisition will pave the way to establish an R&D hub in the UK that can work with potential European partners and expand links with universities and research institutions focused on Li-S.

Anglo-Australian firm Gelion has also announced a proposed two-tranche equity fund-raising of up to £4.5 million, before expenses, to help fund the acquisition, boost working capital and fund a new zinc cathode feasibility assessment.

In a related move, Gelion also announced a retail offer for shareholders in the UK and qualifying shareholders in Australia to raise up to an additional maximum £450,000 through the issue of up to 1,875,000 retail shares. The offer closes later this month.

OXLiD is dedicated to the commercialization of Li-S batteries for electrified transportation and sustainable energy storage in the aerospace, maritime and EV markets.

The takeover of OXLiD will include an IP portfolio that Gelion said will increase the group's ability to build on intellectual property with Johnson Matthey and Oxis Energy — speeding up eventual product validation and commercialization in the rapidly emerging Li-S market.

OXLiD has filed five patent families in the past 24 months to protect tech advancements to date.

OXLiD has an option for a licence agreement with the University of Nottingham for the use of catalysts to increase charge/discharge rates. It also has an exclusive development licence with the University of Oxford to research into increasing cycle life in lithium metal batteries.

OXLiD has already secured over £1.4 million in grant funding through the Faraday Battery Challenge and other programs.

Gelion said areas of technology that OXLiD has been developing complements its own work in establishing electrolytes that can support multiple anode chemistries and additives to control polysulphide shuttle (the main failure mechanism in traditional Li-S batteries), with lithium anode technology, catalysts, and improved cell designs that will evolve from the acquisition.

OXLiD's existing partnership with a European cell manufacturer should continue to demonstrate the technology in "commercially relevant pouch cell formats" throughout the coming year, Gelion said.

Gelion agreement with Ionblox

Gelion said on November 21 it has signed a joint development agreement with silicon-sulfur battery tech company Ionblox. The partners said they aim to produce high-energy density, lower cost lithium silicon sulfur (LiSiS) cells for the global EV, electrical vertical-takeoff-and-landing (eVTOL) and drone markets — and then moving on to the stationary BESS sector.

LiSiS cells have the potential to nearly double the gravimetric energy density to around 400 Wh/Kg, enabling increased range between charges in EVs, the firms said.

Silicon-sulfur batteries will draw on Australian and US supply chains to manufacture a battery that does not rely heavily on nickel, cobalt or graphite.

According to the partners, their batteries will be 25%-50% lighter than current offerings for the sectors and cost up to 35% less on a materials basis, while also cutting the risk of thermal runaway.

Ionblox is a California-based silicon oxide anode developer whose investors include Lilium, Applied Ventures, Temasek and Catalus Capital.

Gelion CEO John Wood said his Anglo-Australian firm is already developing sulfur cathode materials and quasi-solid state systems utilizing proprietary technology. "Our cathode platform approach now allows us to support multiple lithium anode technologies." ■

EnerSys set for US tax credits boost to earnings

EnerSys said it is set to receive an unexpected earnings boost after the US government unveiled proposed new guidance on battery components and materials qualifying for tax credits.

The US Treasury and Internal Revenue Service released the proposed guidance on December 14 of section 45X of the Advanced Manufacturing Production Credit (AMPC) program — part of the Inflation Reduction Act.

EnerSys said the guidance indicates it could now expect annual tax credits recorded as a reduction to the cost of goods sold and not subject to taxation to be in the range of around $120 million to $160 million up to 2032.

This would represent an annual increase to its anticipated tax credits of around $35 million to $45 million, on top of the previously announced annual range of some $80 million to $120 million.

EnerSys said it will continue to evaluate the guidance and issue an update during its scheduled third-quarter 2024 earnings results conference call next month.

However, president and CEO David Shaffer said 45X credits underlined the critical role EnerSys batteries play in supporting the global energy transition.

Section 45X was created as part of the Inflation Reduction Act and signed into law in August 2022.

The section provides AMPCs for battery cells and battery modules produced in the US with an energy density of not less than 100 watt-hours per litre.

Credits are determined based on sales of qualifying products produced in the US from January 1, 2023 until December 31, 2032.

Separately, EnerSys has secured a deal to supply 50 of its proprietary fast charge and storage system units to infrastructure development firm Landmark Dividend for an undisclosed sum.

EnerSys said on November 8 its lithium-ion FC&S, which combines energy storage, backup power and EV fast charging capabilities in compact units, is ideal for installation in retail parking areas for consumers to recharge their vehicles while shopping. ■

Clarios teams with Altris for Na-ion batteries

Clarios is partnering Swedish sodium ion cathode material and cell technology developer Altris to develop batteries for the automotive industry.

The companies said on January 8 they will work on low-voltage battery solutions for vehicles including hybrid electrics and EVs.

Financial details of the agreement have not been disclosed.

Lead and lithium manufacturing giant Clarios said the collaboration aims to develop a sodium ion battery with a potential of up to 60V to support automotive applications in new vehicles and for aftermarket replacements that can also complement a multi-battery low-voltage system configuration.

While lead batteries represent the best example of a circular economy worldwide and lithium-based products continue to evolve, Clarios said its chemistry agnostic and circular approach is of strategic importance.

Federico Morales-Zimmermann, VP and general manager at Clarios for global customers, products and engineering, said the company had extensive experience with low-voltage systems in the auto sector and would play a leading role in defining and optimizing sodium ion cells.

The company said sodium ion batteries are inherently sustainable and easy to recycle, made from salt, wood, iron, and air.

In 2022, Clarios announced it was teaming up with Natron Energy to manufacture what they said would be the world's first mass-produced sodium ion batteries.

Last November, Altris and Swedish battery developer Northvolt unveiled a sodium ion battery design toward the commercialization of Prussian White-based batteries. ■

US military BESS from CATL shut down in national security row

Energy storage system batteries supplied by China's Contemporary Amperex Technology (CATL) for use at a US military base were shut down on December 1 amid allegations they posed a potential threat to national security.

Legislators from the US Senate and House of Representatives had written to defense secretary Lloyd Austin on November 30 calling for the removal of the ESS from the Camp Lejeune base in North Carolina — and urging checks into whether CATL batteries had been installed at other US military bases.

Utility Duke Energy disconnected the system on December 1, North Carolina Republican congressman Greg Murphy confirmed on December 4.

Murphy said he would "not stand for the infiltration of our military by the Chinese Communist Party. "It is no secret that China is working diligently to undermine the US every single day," he claimed.

CATL said accusations about its batteries posing a potential security threat were false and misleading. Meanwhile CATL is to set up a major R&D hub in Hong Kong as part of plans to invest HK$1.2 billion ($154 million) to promote technology innovation. ■

Energy Vault confirms deal for five new China gravity-based ESS

Energy Vault Holdings is to deploy five additional gravity energy storage systems in China, the company confirmed on November 6.

Energy Vault broke ground for its first such 'EVx' project in 2022 in partnership with Atlas Renewable and China Tianying (CNTY).

That first 100MWh EVx, next to a wind farm in Rudong, was commissioned in June and was prepared for connection to the grid in September, the company revealed.

The new projects, also in partnership with Atlas, and CNTY, bring total existing and planned EVx deployments in China to seven — with a combined 3.26GWh capacity, Energy Vault said.

US-based Atlas supports companies in project dealings with Chinese institutions and regulatory authorities while CNTY is a Chinese environmental services firm.

CNTY chairman Yan Shengjun said EVx systems will help China's clean energy transition by enabling electricity generating by intermittent wind and solar power to be used to reduce fossil fuel-based generation.

Energy Vault uses a block tower system to store and release renewable energy from wind and solar operations. It uses surplus renewable energy to store power by constructing the tower with a crane.

When demand rises, the crane unstacks the tower, producing kinetic energy by dropping the blocks so that they can turn generators and create electricity.

The 25-tonne blocks are made from local soil, avoiding carbon intensive concrete, but can also be constructed with various waste materials like coal ash, concrete debris, mining tailings and other waste sludge materials otherwise destined for landfills.

China's energy policies require renewable energy plants to integrate storage of 20% of their nameplate generation capacity, with a duration of at least 2-4 hours, Energy Vault said.

Most recently, this has been satisfied with lithium-ion battery technology to complement the significant installed base of pumped hydroelectric storage in the country. ■

Monbat CEO says investment partner crucial for expansion

Monbat Group CEO Viktor Spiriev said in a December 19 interview posted on Monbat's website that finding a strategic investment partner "will be crucial for scaling up our current operations", but said it was too early to give details.

He also teased that a separate announcement about Monbat's involvement in a new lead battery project was imminent.

He said the Bulgaria-based firm enjoys close international cooperation with companies through the Consortium for Battery Innovation and he would soon "announce a successful project".

Meanwhile, Spiriev said the company's next five years will see it intensify development of a new range of lead and lithium BESS units Monbat intends to launch on the market for homes, micro- and small businesses. ■

AM Batteries raises $30m in new investment round

Lithium-ion dry-electrode tech company AM Batteries said on December 4 it had raised $30 million in a series 'B' funding round led by Toyota Ventures.

AMB said the oversubscribed round, which takes the total it has raised to date to more than $60 million, will speed up commercialization of its dry powder coating technology and equipment for Li battery manufacturing.

Porsche Ventures and Asahi Kasei are providing what AMB said was strategic corporate support, alongside new financial investment from RA Capital Management Planetary Health, Wilson Sonsini and Industry Ventures. Other participants included existing investors such as TDK Ventures.

AMB claims its process uses a powder-to-electrode method that reduces the number of steps that are needed to make a battery electrode by removing the need for electrode drying and solvent recovery.

This reduces cost, time, and energy while eliminating the need for harmful solvents, the firm says.

In April, the company said it was teaming up with Amperex Technology to develop solvent-free electrode manufacturing technology for lithium-ion cell production.

The partnership is further developing AMB's dry-electrode fabrication technology with the lithium battery manufacturing expertise of Amperex, from which Chinese battery giant CATL was spun off in 2012.

Amperex is now owned by Japan's TDK Corporation.

In October, AMB announced it had recruited former Celgard president Lie Shi as its new CEO, with former Tesla director Hieu Duong appointed to the newly-created post of chief manufacturing officer. ■

GS Yuasa in $320m shares sale plan with Honda to boost battery business

Lead and lithium battery giant GS Yuasa said on November 20 it planned to raise up to ¥47.2 billion ($320 million) in a sale of new shares and third-party allotment to Honda Motor.

Yuasa said the cash raise would fund capital expenditure planned across its battery manufacturing including a new EV lithium batteries plant.

According to Honda, its stake in Yuasa will increase to nearly 5% following the transaction.

The companies signed a 50-50 joint venture agreement in May to form a lithium battery R&D business.

That deal came just weeks after Japan's government backed plans by the partners to invest ¥444 billion ($3.3 billion) in a battery manufacturing plant for EVs and residential energy storage systems.

Batteries International reported in August that Yuasa was selling controlling stakes in two of its China-based lead battery firms to Leoch in a deal worth up to Rmb280 million ($39 million).

Leoch signed an agreement to acquire a 70% stake in Tianjin GS Battery and Yuasa Battery Shunde. ■

TagEnergy hails innovative £70m finance deal for UK

For the record, TagEnergy unveiled on October 17 a non-recourse debt package of up to £70 million ($85 million) for a 100MW/200MWh BESS project in the UK.

The package by lenders Santander, Rabobank, and Triple Point will finance the construction and operation of TagEnergy's Lakeside project in North Yorkshire.

The deal includes an uncommitted accordion facility — potentially allowing TagEnergy to increase its borrowing.

Tesla, Habitat Energy and RES will be the project partners, with Tesla supplying its Megapack lithium-ion battery tech.

TagEnergy acquired its 100% stake in the battery storage facility from RES in December 2021.

Construction started in August and the facility is scheduled to start operating by the middle of next year.

TagEnergy CEO Franck Woitiez said: "Securing a single non-recourse debt package without a revenue floor is testament to the value our innovative approach to financing offers the market." ■

French grant of €659m for Verkor gets go-ahead

For the record, a €659 million ($703 million) French state aid grant plan for lithium-ion batteries developer Verkor has been cleared by the European Commission.

The Commission said on October 30 the positive aspects of the proposal — to support R&D into battery cells and modules for the large-scale deployment of EVs — would outweigh any potential distortion of competition and trade in the EU.

The aid will be in the form of a direct grant to cover the R&D project until the end of 2026.

Automization of electrode production and battery formation and a pilot production line will form part of the project. ■

Allkem, Livent merge to form Arcadium Lithium

Allkem and Livent said on January 4 they had finalized their merger to become Arcadium Lithium. Combined total revenue of the firms in 2022 was around $1.9 billion with a total workforce of more than 2,600.

The companies' shareholders voted in December in favour of the merger to form the lithium chemicals production group.

Livent has been a key player in lithium extraction and purification technology.

Allkem's portfolio — now part of Arcadium — includes its majority-owned flagship brine-based lithium facility, based in Northern Argentina, which supplies high-quality lithium chemicals worldwide.

Arcadium CEO Paul Graves, previously CEO of Livent, said the merged company is trading on the New York Stock Exchange and is a leader in every major lithium extraction process, from hard rock mining to conventional pond and direct lithium extraction-based brine processing. ■

Komatsu to take over American Battery Solutions

American Battery Solutions said on November 20 it is to be acquired by construction and industrial equipment company Komatsu. The deal, for an undisclosed sum, is subject to completion of various regulatory and other procedures.

The companies say they plan to develop advanced energy storage systems specifically designed to support next generation electrified equipment being produced by Komatsu.

ABS founder and CEO Subhash Dhar, a long-time entrepreneur and developer of energy storage systems, said the move will enable the lithium ion battery firm become a leading partner for electrification of industrial equipment and commercial vehicles.

Dhar thanked initial ABS investors, the KCK Group, for supporting the development of the firm over the past four years.

The acquisition follows ABS's launch of a new transit bus battery pack for New Flyer Industries.

Komatsu CTO and president of the firm's development division, Taisuke Kusaba said: "After more than a year of evaluating potential battery partners, ABS stood out because of the depth of the team and their strong technical skill base, breadth of business and battery systems know-how, and battery manufacturing expertise for heavy duty markets."

ABS, which has nearly 200 employees across its headquarters and engineering development site in Michigan and a manufacturing plant in Ohio, will continue to operate as an independent entity and under its existing management team. ■

Graphenix secures €20m EU bank boost for silicon anode tech

The European Investment Bank said on January 10 it had signed a €20 million ($22 million) loan for Graphenix Development to develop its silicon anode battery technology in Europe.

The EU-owned bank said the equity-type venture debt facility for New York-headquartered GDI, which has an R&D center and pilot production facility in the Netherlands, aims to boost the use of silicon battery tech for EVs and reduce dependency on graphite.

The agreement is supported by the InvestEU programme, which the bank said aims to trigger more than €372 billion in additional investment in new technologies up to 2027.

GDI plans to produce its silicon anode at industrial scale in Germany — and has selected an industrial site with a glass-coating production facility owned by AGC Glass Europe, a leading tier one supplier to European auto OEMs.

The AGC factory in Lower Saxony will provide coating expertise, advanced manufacturing equipment, and knowhow.

European copper foil company Schlenk SE will supply the facility.

GDI said its technology has the potential to produce silicon anodes that increase lithium ion cell energy density by over 30% compared with today's graphite anodes — boosting the range of EV batteries.

The company claims its technology can also reduce battery charging time by two thirds. ■

California solar-storage project secures $191m financing

Renewables firm Arevon Energy said on November 8 it had secured a financing deal including $191 million in US tax credits for a solar-BESS project in California.

Financing for the Vikings solar+storage project used a combination of debt financing and tax credit transfer. An additional debt facility of $338 million was financed by financial institutions including MUFG, BNP Paribas, Sumitomo Mitsui Banking Corporation, First Citizens Bank and National Bank of Canada.

The Vikings project features 157MWDC of solar coupled with 150MW/600MWh of battery storage to help support grid stability in San Diego starting in late 2024.

The IRA's transferability tax credit provision allows for the simplified transfer of tax credits from project owners to profitable taxpayers. Smith said: "Vikings has been a landmark project from its inception."

Tesla is supplying the facility's utility-scale batteries, which will power up to 50,000 homes. Commercial operations are to start in Q3 2024. ■

UK pledges battery strategy investment boost

The UK government pledged £2.5 billion ($3 billion) of fresh investments in the auto sector on November 22 including support for EV and battery manufacturing — but industry observers claimed that total included cash already pledged to attract projects such as Tata Sons' planned 40GW battery cell factory in the country.

Business minister Kemi Badenoch acknowledged on November 26 that aid pledged for the new battery strategy, unveiled in the country's autumn financial statement, "builds on recent investment wins" including the Tata deal and Nissan's £2 billion investment in its Sunderland EV battery factory. ■

SAIC Motor starts Thai EV battery production

Chinese auto firm SAIC Motor has started initial EV battery production at its new joint venture plant in Thailand, Chinese state media reported on October 31.

The 120,000ft^2 battery and components plant will have an eventual production capacity of 50,000 batteries annually, Xinhua said.

The plant is operated by SAIC Motor-CP, a joint venture with Thailand's Charoen Pokphand Group.

SAIC started construction of the plant earlier this year and said it was scheduled for full completion by 2025.

Meanwhile another Chinese carmaker, Changan, signed a land purchase agreement during October with Thai industrial parks developer WHA Group to build a new EV production plant in the country.

The facility will have an initial production capacity of 100,000 vehicles annually. ■

Ahlstrom-Munksjö launches fiber-based pasting material for lead batteries

Ahlstrom-Munksjö has launched a fiber-based pasting material in a move aimed at supporting development of advanced lead batteries.

The Finland-headquartered firm said on November 9 its hybrid pasting material is a combination of natural and synthetic fibers that provide adhesion of the active material on the battery plate surface, after the natural fibre content has dissolved in the battery acid.

Ahlstrom claims this specific property stabilizes the active mass on the grid, allowing higher cycling and longer battery life, as well as easing battery recycling.

Recent advancements in lead batteries are focused on higher performance as well as on lowering the overall environmental footprint of the battery lifecycle.

The company has four manufacturing sites in Europe including an AGM line in Italy and a glass fibre tissue line in the US.

Ahlstrom said the Italian line in Turin marked a key step into supplying products in support of expansion in the energy storage market.

In 2021, Ahlstrom signed a marketing licence agreement with Soteria Battery Innovation Group toward production of fiber-based separators for lithium ion batteries. ■

CMBlu, Argonne and Idaho labs team up for organic flow battery research

Organic flow battery firm CMBlu Energy is teaming up with two US national laboratories for a long duration energy storage demonstration project.

CMBlu said on December 4 it would work with the Argonne and Idaho national labs on research aimed at improving microgrids in cold climates and providing fast charging for EVs in underserved communities.

CMBlu said the project will deploy its Organic SolidFlow technology using batteries made from non-metallic and abundant materials.

The project is one of six selected in September by the Department of Energy's Office of Clean Energy Demonstrations.

Researchers will conduct performance tests at the Idaho lab's Battery Test Center. They will also assess how well the Organic SolidFlow batteries perform at different temperatures in diverse environments.

Other partners supporting the project include the Illinois Alliance for Clean Transportation, Electric Power Research Institute and National Grid.

In October, Austrian construction technology group Strabag announced its entry into the energy storage market with a near $107 million investment in CMBlu. *See separate story below.* ■

Strabag enters ESS market with $107m boost for organic flow battery firm CMBlu

For the record, Austrian construction technology group Strabag is entering the energy storage market with a near $107 million investment in CMBlu Energy, an organic flow battery firm, the companies announced on October 25.

CMBlu founder Peter Geigle said the $106.7 equity deal validates the firm's long duration energy storage technology and will enable it to expand production capacity in Europe and set up a manufacturing facility in the US.

CMBlu said it is already working on multiple pilot projects in Europe and the US to demonstrate its technology.

CMBlu is also working on projects in the US including a 5MW 10-hour duration pilot project called Desert Blume in Arizona. CMBlu will build, own, and operate the batteries on behalf of nonprofit utility Salt River Project. ■

Factorial leads charge into solid-state EV batteries

Solid-state battery developer Factorial Energy has opened a $50 million pilot manufacturing plant in the US, the company announced on October 23.

The Massachusetts plant will eventually support domestic production of the firm's battery tech for the EV sector, Factorial said.

CEO Siyu Huang said the plant will have an initial annual production capacity of 200MWh.

Joe Taylor, Factorial executive chairman and former chairman and CEO of the Panasonic Corporation of North America said the plant will make automotive-sized solid-state batteries at pre-production speed and volume, "illuminating a clear path to mass production and reaching economies of scale".

The company says its Factorial Electrolyte System Technology quasi-solid-state batteries are designed for higher energy density and safety compared to lithium ion batteries.

Factorial has joint development agreements with Mercedes-Benz, Stellantis, and Hyundai Motor Company. ■

Northvolt, Altris energize Prussian white R&D for Na ion batteries

Swedish firms Northvolt and research partner Altris unveiled a sodium ion battery design on November 21 — saying it marks the start of a journey toward the commercialization of Prussian White-based batteries.

The technology is based on a hard carbon anode and a Prussian White-based cathode that is free from lithium, nickel, cobalt and graphite.

Prussian White is a derivative of the arguably better known Prussian Blue sodium ion batteries, such as those under development by Clarios and Natron.

Northvolt says its own R&D labs in Västerås have validated the cell for an energy density of more than 160Wh/kg.

This first generation cell is designed primarily for energy storage while future iterations could move into the e-mobility sector, Northvolt said.

Altris says sodium ion batteries comprise salt, wood, iron and air and are inherently sustainable and easy to recycle.

Company CEO and co-founder Peter Carlsson said: "The world has put high hopes on sodium-ion and we've developed a technology that will enable its widespread deployment to accelerate the energy transition."

The low cost and safety at high temperatures make the technology attractive for energy storage solutions in upcoming markets including India, the Middle East and Africa, Carlsson said. ■

Auto firms lagging in European race for battery metals

Auto firms in the European market have secured less than a fifth (16%) of the key battery metals they will need until 2030, according to a new study published on December 4.

Clean transport campaign group Transport & Environment (T&E) said it reviewed publicly disclosed contracts to rank manufacturers in the battery supply chain — based on raw materials secured, cell production and responsible practices.

Only Tesla and China-based BYD are doing enough to guarantee supplies of cobalt, lithium and nickel to meet their 2030 sales goals, while most European manufacturers — with the exception of Volkswagen and Stellantis — are far behind, T&E said.

The campaign group claims Tesla leads the overall ranking on the strength of its raw material and cell production strategies, "but trails several competitors on responsible practices".

By contrast, T&E said Volkswagen performs relatively well in all three categories to finish second, just ahead of BYD, which tops the raw materials score "but falls down on responsible practices because it provides no information about sustainable sourcing".

Analysis shows only six companies — Tesla, BYD, Volkswagen, Ford, Renault and Stellantis — have long-term contracts for each of the three key metals or plan to change battery chemistries to end their dependence on one of the metals, according to T&E.

Mercedes has only one publicly disclosed contract for a key mineral while BMW, which T&E said opposes the EU's phase-out of combustion engines, has not disclosed enough information about how it plans to secure nickel, cobalt or cathode materials.

T&E's senior director for vehicles and e-mobility supply chains Julia Poliscanova said: "There is a clear disconnect between carmakers' EV goals and their critical mineral strategies.

"Tesla and BYD are way ahead of most European players who are only waking up to the challenge of securing battery metals now."

In a separate report published in March, T&E said nearly 70% of Europe's overall planned pipeline of lithium ion battery cells production capacity by 2030 was at risk of being delayed, scaled down or cancelled. ■

Core suspends Australia mine work as lithium prices plummet

Core Lithium has suspended mining at its Finniss project in Australia in the face of what the firm said on January 5 were tough market conditions.

According to Core, the price of spodumene concentrate has fallen more than 85% in the last 12 months, including by 50% since the end of October 2023.

Core CEO Gareth Manderson said the suspension was a difficult decision, but it would continue to generate revenue by processing its existing ore stockpiles of 280,000 tonnes, while the company focuses on managing cash reserves prudently.

Manderson said the firm's Grants open pit at Finniss would be maintained to allow an orderly ramp up when conditions improve.

Australia's Department of Industry, Science and Resources said in a report published in December that the country, which mined about half the world's lithium in 2022, can expect to see the spot price of spodumene fall to A$2,200 ($1,473) per tonne in 2025 from an estimated average of A$3,840 per tonne in 2023. ■

Refined lead metal supply exceeds demand in first 10 months of year

The worldwide supply of refined lead metal exceeded demand by 41 kilo tonnes during the first 10 months of this year, according to latest provisional data released on December 18 by the International Lead and Zinc Study Group.

The Lisbon-based group said total reported stock levels increased by 129kt.

A 2.8% rise in global lead metal production was mainly a result of higher output in Australia, China, Germany, India, Taiwan and the United Arab Emirates, the group said.

However, output fell in Bulgaria, Italy, Japan, South Korea and the UK compared to the same period in 2022.

Global lead metal usage rose by 0.3%, primarily influenced by increases in Europe, China, India, Mexico and Taiwan that were largely offset by falls in South Korea, Turkey and the US.

Meanwhile, Chinese imports of lead contained in lead concentrates increased by 22% to 562kt. Net exports of refined lead metal totalled 153kt, which the group said was an increase of 60kt compared to the first 10 months of 2022.

World lead mine production rose in Bolivia, Kazakhstan, South Africa and Australia, where Galena successfully commissioned its majority-owned 95,000 tonne-per-year Abra mine in January, according to the group.

These increases were partially balanced by reductions in Europe, Mexico and the US, resulting in an overall worldwide rise of 1.5%. ■

Neometals quits Finnish vanadium recovery project

Battery materials recycler Neometals said on October 30 it was pulling out of a proposed vanadium recovery project in Finland.

Neometals had planned to build VRP1 in partnership with Critical Metals. The facility would produce high-purity vanadium pentoxide (V2O5) from high-grade vanadium-bearing steel making by-product (slag).

Neometals has a majority stake in VRP1 through its 72.5% ownership of Recycling Industries Scandinavia (RISAB) — a joint venture entity in which Critical Metals has a 27.5% stake.

The partners said in June that the project was at the financing stage, ahead of taking a decision to go ahead with construction.

However, Australia-listed Neometals is now halting further financing blaming instability in global financial markets, despite acknowledging that projections indicate VRP1 would have low operating costs.

Meanwhile, Neometals intends to revert to a technology licensing business model to commercialize its proprietary vanadium recovery process (VRP Technology). ■

SQM agrees stake with Codelco for Chile lithium mining partnership

Battery-grade lithium producer Sociedad Química y Minera de Chile said on December 27 it had reached a framework deal to give a majority stake in its Chilean brine assets to the country's state-owned copper corporation Codelco.

Under the terms of the memorandum of understanding, if ratified, SQM will be able to extend its operations in Chile for another 30 years from 2025.

The agreement aims to build a public-private partnership to produce high-quality lithium products in Salar de Atacama in a sustainable manner and 'in harmony' with the communities, the companies said. There has been much criticism in recent years for the way lithium extraction in the region has created shortages of water for local farmers and damaged the environment.

A new operating company will be set up to invest in equipment and technologies needed for the partnership and to produce lithium carbonate and lithium hydroxide on properties SQM leases from the Chilean Production Development Company.

The new operating company — of which Codelco will own 50% plus one share to SQM's 50% minus one share — will also look to start other projects and sell lithium worldwide.

The framework agreement follows plans announced last April by Chile's president, Gabriel Boric, to nationalize the country's lithium industry and cash in on the importance of the metal to the burgeoning global EV batteries market.

Ricardo Ramos, CEO of SQM, said: "This is a significant milestone in public-private partnerships in Chile.

"We believe that the successful development of the Salar Futuro Project will make the Salar de Atacama operations the most sustainable lithium operation in the world."

Last September, SQM's Lithium Ventures arm invested nearly $2.6 million in UK battery recycling tech firm Altilium as part of a series 'A' funding round. ■

Report claims human rights abuses fuelling EV battery metals supply chain

For the record, increasing demand for EV battery metals is fuelling forced evictions and human rights abuses in the Democratic Republic of Congo, a new report has claimed.

Multinational companies are failing to safeguard families, according to the 100-page report* — *Powering Change or Business as Usual?* — published by Amnesty International and the DRC-based Initiative for Good Governance and Human Rights (IBGDH).

The report, released in mid-September, calls on DRC authorities to establish an independent commission of inquiry and to strengthen legislation relating to mining and human rights.

All companies involved in the supply chain have a responsibility to investigate all allegations of abuse, "provide effective redress and act to prevent further harm", the report says.

The report focuses on several case studies and interviews Amnesty and IBGDH conducted with residents at mining projects in two separate visits in 2022.

One case study highlights an open-pit copper and cobalt mine operated by Compagnie Minière de Musonoie Global SAS (COMMUS), a joint venture between China's Zijin Mining Group and DRC state mining company Générale des Carrières et des Mines.

Since the reopening of the mine in 2015, "long-established communities have been destroyed in the heart of the city of Kolwezi", the report says.

"People who were evicted said the compensation offered by COMMUS was not enough. Many have suffered a significant fall in their standard of living, including having to move to properties without running water or reliable power on the outskirts of the city."

A Zijin spokesperson told Amnesty the company would work with the organization to promote protection of human rights and the wellbeing of DRC citizens.

COMMUS had not responded to a request for comment from *Batteries International* at the time of going to press.

Amnesty secretary-general Agnès Callamard said: "The people of the DRC experienced significant exploitation and abuse during the colonial and post-colonial era, and their rights are still being sacrificed as the wealth around them is stripped away."

Callamard said the DRC can play a pivotal role in the world's transition from fossil fuels, but the rights of communities "must not be trampled in the rush to mine minerals critical to decarbonizing the global economy".

In February 2023, the Geneva Center for Business and Human Rights and the New York University Stern Center for Business and Human Rights claimed companies in the EV battery manufacturing chain were still not doing enough to ensure the cobalt they use does not involve child labour at unsafe artisanal mines in the DRC. ■

Korea trade warning over batteries 'upheaval' from EU chemicals ban bid

For the record, Korea said on October 4 it had raised concerns with the World Trade Organization over EU proposals to ban a group of chemicals crucial to batteries.

The European Chemicals Agency (ECHA) is recommending the ban on per- and poly-fluoroalkyl substances, or PFAS — a proposal that has already been criticized by flow battery firms and other industry leaders.

Now Korea's Ministry of the Ministry of Trade, Industry and Energy and the Korea Agency for Technology and Standards has written to the ECHA over the issue and has told the World Trade Organization the ban could violate the body's technical barriers to trade rules.

Even a gradual introduction of the ban, to find alternatives to PFAS, risks causing upheaval in the production of batteries and semi-conductors and recycling — which could delay the adoption of EVs, the ministry said.

Korea is calling on European authorities to first launch a detailed assessment of the potential environment and health effects of PFAS. ■

Narada delivers 100MW BESS for China economic zone

Narada Power said on November 10 it had shipped a 100MW/200MWh BESS to the Hebi Baoshan economic development zone in China's Shandong province.

The lead and lithium battery manufacturer said it won the tender for the BESS, for an undisclosed sum, earlier this year.

The system comprises 60 containers featuring the company's proprietary 'center L' liquid-cooled 280Ah lithium battery tech and will help improve the stability of electricity supply in the area and promote the use of renewables, Narada said.

Center L was unveiled in September 2022. Narada says the system includes enhanced fire suppression measures — together with a "precise early warning system" to identify incidences of thermal runaway.

Earlier in the month Narada Power has signed a Rmb335 million ($46 million) deal with Shanghai Electric Power Design Institute Materials to supply battery tech for a BESS project in Western Australia.

Narada said on November 3 it had signed a purchase contract with Shanghai Electric Power to supply the lithium iron phosphate batteries for the 100MW/200MWh Wagerup Big Battery project near the state capital of Perth.

Shanghai Electric Power and Sunterra have been contracted by Alinta Energy to deliver the BESS at the gas and diesel-fired 380MW Wagerup Power Station.

Alinta chief development officer Ken Woolley said the battery will connect to existing high voltage infrastructure at Wagerup and is to be commissioned in H2 2024. ■

Countries sign up to new BESS consortium in plans for battery storage

More than 10 countries have joined a new BESS Consortium as first mover nations pledging to expand deployment of battery storage systems alongside renewable energy projects.

The Global Leadership Council (GLC) of the Global Energy Alliance for People and Planet said India, Egypt and several African nations were among those that signed up to the GLC's consortium initiative — launched on December 2 at the COP28 climate change conference in the United Arab Emirates.

Partners supporting the consortium and helping countries prepare projects, support dealings with regulators and attract private and public investment, include the African Development Bank, World Bank and clean energy developer Masdar.

The GLC said the consortium is on track to meet its target of securing 5GW of BESS commitments by the end of 2024 and deploying these by the end of 2027.

In March 2022, the African Development Bank confirmed a $20 million equity boost for an Africa-focused fund to promote private investment in battery storage and energy-efficient technologies.The bank said it had made the combined equity investment in the AfricaGoGreen Fund with the bank's Sustainable Energy Fund for Africa. ■

Solvay, Orbia in US battery material JV for EVs

Solvay, the chemical multinational, said on November 2 it will build an EV battery materials plant in Georgia as part of a joint venture project with Orbia.

Construction of Solvay's battery-grade polyvinylidene fluoride (PVDF) facility (for an undisclosed sum), will be supported by a $178 million grant from the US energy department's Office of Manufacturing and Energy Supply Chains.

The grant was awarded as part of the US Infrastructure Investment and Jobs Act to expand domestic manufacturing of batteries for EVs and the electrical grid that promote regional industry and material security.

PVDF is used as a lithium-ion binder and separator coating in EV batteries and the Georgia plant will provide enough for more than 5 million EV batteries a year at full capacity, the partners said.

The finished PVDF product, it is claimed, can extend the range of EVs, increase battery life and improve battery safety.

Solvay and Orbia intend to have two plants in the southeastern US — the Georgia one for finished products and another in Louisiana for raw material conversion.

Both are to be operational in 2026. ■

Canadian Solar's e-Storage to supply 220MWh Australia BESS

Canadian Solar said on January 8 its e-Storage division will supply a 220MWh BESS for the Mannum energy storage project in South Australia.

The BESS will use e-Storage's SolBank lithium iron phosphate battery tech. The container-based BESS comprises battery management and thermal management systems. Construction starts in Q2 this year. Mannum is owned by South Australia-based Epic Energy, which said on January 8 it had acquired the project from Recurrent Energy. The BESS will support operation of an existing 46MWp (megawatt peak) solar farm capacity at the same location, boosting grid stability in the region. ■

Sila, Worley team up to build 150GWh silicon anode plant

Battery materials firm Sila is partnering with American-Australian engineering company Worley to build a commercial-scale nano-composite silicon anode production plant in the US.

The partners said in early December Sila's existing Moses Lake facility in Washington is being expanded to have an annual capacity of up to 150GWh by 2028, with production starting in 2025.

Manufacturing operations at the facility, which will serve the EV market, will use hydroelectric power.

Sila says its patented process can mass manufacture the firm's 'Titan Silicon', which Sila claims could eventually replace traditional graphite anodes within lithium ion batteries and boost battery energy density by 20%.

Major financial investors in the company include the Canada Pension Plan Investment Board, Matrix Partners and Sutter Hill Ventures. ■

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Narada, Shandong to build first BESS in Namibia

Narada Power is one of two Chinese companies that signed an agreement on December 13 with utility NamPower to develop the first BESS for Namibia.

Narada and state-owned Shandong Electrical Engineering & Equipment Group said the 54MW/54MWh Omburu BESS, in the capital of Windhoek, is backed with €20 million ($22 million) in grant funding from Germany's KfW Development Bank.

The lithium-based BESS will help combat power shortages and reduce the impact of intermittent solar power.

Shandong said construction is set to start in February 2024 and could ease Namibia's reliance on imported supplies of electricity.

Neighbouring countries currently supply up to 70% of Namibia's power needs, Shandong said.

NamPower, which will own and operate the BESS, said the facility could also help Namibia boost its participation in electricity trading within the 12 member states of the Southern African Power Pool.

Narada said in August that while it is developing a range of lithium BESS projects, it is also committed to expanding its recycling of lead batteries as part of its corporate social responsibility commitments.

East Penn boosts battery line-up for auto market

Lead batteries major East Penn Manufacturing is powering ahead in the automotive market with a new 12V AGM brand.

The company said on November 13 the new EHP (electric hybrid performance) branding helps consumers make a clear choice in a world where vehicle electrification and its complexities are continually evolving.

EHP is designed to clearly indicate which AGM batteries are best suited for electric, hybrid and start-stop 12V systems, East Penn said.

EHP has been designed using state-of-the-art to be a reliable partner in providing the performance needed for critical auxiliary functions, the company said.

"Safe, reliable power in any location and a high rate of recyclability helps raise the safety and sustainability profile of electric and hybrid vehicles."

East Penn president and CEO Chris Pruitt revealed in July that nearly 80% of the lead the company used in 2022 came from recycled sources.

Pruitt, who presented the battery giant's 2023 Sustainability Report, also said the lead smelter at the company's Lyon Station global HQ recycled 188 million pounds of lead from batteries that were collected from customers, as well as non-conforming material from its battery manufacturing plants.

Brussels proposes UK trade rule delay to avoid tariffs on EVs and batteriies

The European Union has proposed a three-year delay in tightening 'rules of origin' due to come into force in 2024 that would entail import tariffs imposed on batteries and EVs from the UK.

The EU said on December 6 the proposed "one-off extension", until December 31, 2026, follows concerns raised by the European automotive, battery and chemical industries.

If the extension is formally approved by EU member states by the end of this month, it will avoid the imposition of 10% tariffs on the export of European-built battery electric vehicles to the UK

Director general of the European Automobile Manufacturers' Association, Sigrid de Vries, said the move was vital to ensure the well-being of EU BEV manufacturing, but also of the whole European battery value chain.

"Failure to approve the proposal would result in reduced competitiveness of our exports. It would also have a negative knock-on impact on demand for European batteries and battery materials, based on lost BEV market share to third-country competitors."

De Vries said a failure to suspend the tariffs could cost €4.3 billion (over the next three years) for EU vehicle makers, potentially reducing BEV production by some 480,000 units, which he said was equivalent to the output of two average-size auto factories.

Hyperbat ramping up UK battery pack project

An £11.3 million ($14 million) UK project aims to boost the country's battery pack manufacturing and supply chain capability.

Hyperbat's 'H1perChain' in Coventry, which was funded by the UK's Advanced Propulsion Centre, said on November 17 it has successfully developed an automated pilot line for module/pack assembly, cell joining and in-line testing.

Hyperbat project leader Jon Bell said the move marks a step-change in high performance battery costs and scalability and a commercial deal has already been agreed to supply battery packs for a global customer.

Hyperbat is working with consortium partners Unipart Manufacturing, WAE, Coventry University, Direc-Tec and the Welding Institute and has a 50-strong workforce at the production facility.

Thermo fisher opens asia-pacific battery innovation hub in seoul

Thermo Fisher Scientific said on November 13 it was inviting global battery makers to use its new South Korea facility as a clean energy development hub.

The US-headquartered analytical instruments and services group said its battery customer experience center (pictured) in Seoul puts its latest metrology and quality control technologies at the disposal of battery manufacturers.

A company spokesperson told Batteries International the center will, among other services, provide battery electrode coating simulation lines and support the analysis of customer samples under dynamic in-line conditions.

The center is staffed with applications experts and technologies in the field of material characterization, extrusion, rheology, in-line thickness and in-line basis weight metrology and product inspection, the spokesperson said.

In addition to providing applications support, product demonstrations and training, the center will encourage companies to work together on innovations in battery manufacturing and quality processes.

Korea was chosen as the location for the center because of its proximity to the wider Asia-Pacific region and will help Thermo Fisher support battery innovation and production in key end markets, such as China, the spokesperson said.

"Moreover, Korean battery companies are investing heavily in joint ventures and operations in Europe and North America and we wanted to provide close technical support to the development teams in Korea as they choose next-generation technologies for sites globally."

Exide Industries ups investment for battery cells project

Indian lead and lithium batteries producer Exide Industries said mid-October it had boosted investment in its Exide Energy Solutions (EES) subsidiary.

Exide invested Rs1 million crore ($12 million) in EES in a rights issue — its second such investment in as many months — to support construction of its lithium ion battery cells manufacturing plant in Karnataka state.

The 80-acre plant is being built under a collaboration deal with China's SVOLT Energy and the latest investment comes after Exide asked state authorities for an additional 40 acres of land to expand the project.

The first phase of the facility is to be operational by the end of 2024.

SVOLT, in addition to providing the technology for the plant, is providing unspecified support for construction on a turnkey basis.

Exide is also setting up a research and development laboratory and pilot manufacturing line to support new product development for the Indian market.

Exide CEO and MD Subir Chakraborty has stressed that the development and sales of lead batteries continues to be the company's "core business", despite its foray into the lithium ion sector.

ABB backs ZincFive for UPS projects

Swiss tech group ABB has selected nickel-zinc batteries producer ZincFive as an approved tech supplier for UPS systems.

ABB has already deployed ZincFive battery tech for several energy storage projects, the company said on October 9.

ZincFive's tech had been selected for reasons including safety, because there is no thermal runaway, high ambient temperature operation and full life cycle sustainability, ABB said.

The developer says its BC series UPS battery cabinets are the first nickel-zinc battery energy storage solution with backward and forward compatibility with megawatt class UPS inverters.

Sébastien Surply, head of power protection for ABB Electrification said on October 9 that ZincFive's tech had undergone extensive testing to ensure batteries met datacenter safety performance and reliability criteria.

"The adoption of NiZn technology will enable our MegaFlex UPS solutions to provide high levels of power protection and will support customer decarbonization goals," Surply said.

Batteries International reported in December 2022 that ZincFive had raised $54 million in fresh funding.

The series 'D' funding boost was key to supporting moves to expand the firm's presence in markets such as datacenter UPS systems and power systems.

The facility includes incoming cell OCV (open circuit voltage) testing, adhesive robot stations, laser welding, potting machines, and robotic assembly.

Bell said: "Our brief was to find a way of reducing costs while increasing performance and meeting lead times, something we believe we are well on the way to achieving with the pilot line successfully assembling packs and a digital twin in play to scale up production into the tens of thousands.

"If the UK is going to compete in the electrification race, it is critical that we have a domestic battery making capability and a supportive supply chain in place."

LG Energy Solution in $3bn Michigan investment boost for Toyota Batteries deal

LG Energy Solution is investing around $3 billion to expand battery production at its Michigan plant to support a new landmark supply deal for Toyota electric vehicles.

The firms said on October 5 that LGES is to provide 20GWh annually of its high-nickel NCMA long cell pouch-type batteries starting in 2025.

LGES will build new production lines for battery cells and modules at the Holland, Michigan facility exclusively for Toyota — following what the South Korea-based battery maker said is its largest single supply agreement outside of joint venture deals.

An LGES spokesperson told Batteries International on October 10 the new financial commitment is in addition to the $1.7 billion already pledged for the expansion of the battery plant in Holland, Michigan.

In May, LGES held a topping out ceremony (pictured) marking the completion of the structural steel framework for the expanded section of the plant.

LGES's current annual production capacity at the site is 5GWh and will increase to 25GWh when the expansion is finished next year and mass production starts in 2025, the spokesperson said.

LGES has a total of eight battery manufacturing facilities either operating or under construction in North America.

Toyota Motor North America president and CEO Tetsuo Ogawa said securing supplies at scale of lithium battery tech was key to the auto giant's expansion of its electric vehicles production and sales across the region.

Batteries International reported in September that LGES had raised $1bn through its first global green bond issue, to be invested in its global battery production facilities.

UL certifies green credentials of East Penn lead batteries

Batteries produced by lead acid major East Penn Manufacturing have been endorsed with a top recycling accreditation by global testing and certification firm Underwriters Laboratories (UL).

East Penn said on December 4 its full line of transportation batteries had secured UL's validation for comprising 98% of recycled material.

The company said the accolade represented the highest UL recycled content validation for batteries worldwide.

The batteries were evaluated under UL's '2809 environmental claim validation procedure', which determines the amount of recycled content in products.

UL says its environmental claim validation mark gives companies a distinct advantage in an ambiguous, green marketplace.

Recycled content speaks to the efficiency and integrity of a firm's supply chain and represents the commitment companies have made to product circularity and environmental stewardship, UL says.

The certification body says it uses "rigorous processes and robust scientific analysis" to confirm that claims made by manufacturers about their products are factual.

East Penn welcomed the endorsement, which it said gives consumers confidence they are using products that help power their vehicles and form part of a circular economy and a closed-loop recycling system.

The company announced in July that nearly 80% of the lead it used in 2022 came from recycled sources.

East Penn said in its 2023 Sustainability Report the lead smelter at its Lyon Station global HQ recycled 188 million pounds of lead from batteries that were collected from customers, as well as non-conforming material from its battery manufacturing plants.

Fluence eyes tax credits with new US-content BESS pack

Fluence Energy unveiled the latest iteration of its Gridstack BESS on October 12, which can use one of the firm's new US-only content battery packs — eligible for federal investment tax credits.

The Gridstack Pro offers enhanced performance and lower operating costs and is available in two- and four-hour system configurations, Fluence said.

A Fluence spokesperson told Batteries International on October 24 that in the US, Gridstack Pro can use a battery pack version featuring domestically-manufactured cells and modules.

This makes the BESS eligible for the 10% Investment Tax Credit domestic content bonus under the US Inflation Reduction Act, the spokesperson said.

The launch comes amid increasing pressure from US political leaders to avoid battery tech and component of non-US origin, although the spokesperson declined to comment.

The spokesperson said Fluence's existing Gridstack battery tech and the new 'non-US' pack version uses cells from suppliers in many countries.

Fluence has a supply agreement with Japan-based AESC for US-manufactured battery cells. AESC has production plants in the US and several other countries.

In third-quarter results released in August, Fluence also revealed it had an NMC batteries supply agreement in place with European manufacturer Northvolt.

Fluence announced in December 2022 that it would develop its own battery packs, with production set to start in the US in early 2024.

CBI welcomes results of Spanish lead battery research program

The Consortium for Battery Innovation has released the results of a new pre-competitive research study focused on neutron diffraction and lead batteries.

The study — Operando analysis of the positive active mass of lead batteries by neutron diffraction — was supported by CBI's technical program and conducted by Spanish research center Instituto de Nanociencia y Materiales de Aragón and the country's Exide Group in Spain.

CBI said on November 30 that researchers' main goal was to track the phase formation and distribution in charge/discharge processes of the electrodes of industrial lead batteries by neutron scattering experiments under operational conditions.

The results bring new insights into PbO2 and PbSO4 evolution in the positive plate and the estimation of charging efficiency.

The full paper is online.

In November, the CBI launched its latest bid to identify new battery research projects for potential future funding — seeking proposals for studies covering either techno-economic analyses of lead BESS systems or material science studies into the failure of lead batteries in such systems.

Exide Industries welcomes end to Chloride trademark legal fight

Exide Industries said on November 17 it welcomed a court ruling ending a longstanding legal battle over its use of the Chloride trademark.

Exide said in a financial filing that the Delhi high court decree of November 10 formally concluded legal action dating back to 2006 between the battery maker, the Vertiv Company Group Limited UK (formerly known as Chloride Group Ltd) and Vertiv Energy Pvt Ltd India (formerly known as DB Power Electronics Pvt).

Exide said the companies involved in the dispute had agreed to withdraw all claims to the Chloride trademark.

The battery manufacturer did not disclose when the agreement was reached but indicated there had been no financial settlement.

Exide said the dispute had not hit its business because it had continued to use the Chloride trademark for its UPS products throughout the litigation period, thanks to an earlier ex-parte injunction granted in its favour by the Delhi high court.

In August, Exide subsidiary Chloride Metals launched commercial production of its fourth lead battery recycling plant in India.

The plant — built on a greenfield site spanning more than 15 acres on the Supa-Parner Industrial Park in Maharashtra — has an initial 96,000 million tonnes per annum capacity rising to 120,000 mtpa.

Lead batteries set to power stellar lead demand in India, says CRU's Morris

"All bets are on India" to be the primary driver of growth in demand for lead in the next few years, according to the head of research consultancy CRU's base metals division, Simon Morris.

Morris (pictured) told the LME Metals Seminar in London on October 9 India's stellar performance is expected on the back of buoyant economic growth, with increasing numbers of vehicles on the roads in the populous country.

CRU analysis shows demand in India will grow by around 5% annually to account for over half of lead demand growth in Asia excluding China, more than 30% of lead demand in Asia including China and in excess of 20% of global lead demand growth.

India's government is pushing green mobility with EVs, but the reality is that ICE/HEVs will drive most of the vehicle growth through this decade — almost all are using lead batteries for starter/auxiliary functions, according to CRU.

Additional lead battery demand in India is also to continue from backup power energy storage units in middle-to-high income homes and smaller businesses.

Meanwhile, major growth in Chinese secondary lead supply is forecast to continue at pace — with 60% of secondary supply growth over the year ahead coming from China and rest of Asia, Morris said.

In Europe, where energy costs account for around 50% of operating expenses of the region's smelters, Morris said geopolitical instability and oil price volatility could bring further pressure to bear on costs.

"We are seeing a weak demand story in Europe and power is going to be a major question in terms of smelting capacity going into 2024."

The global energy transition will fuel price volatility in battery-related metals but not through zinc or lead, Morris said.

"Lead is not a great story but it's a stable one. Given a lot of the emotion that sits alongside the tumult of the energy transition, I think we'd call lead a bit of a balm to that."

There is downside risk if the EV story gathers pace but, at the moment, lead does not play a major part in terms of EVs, Morris said.

"However, if we can position lead as having a bigger role to play in the fixed energy storage facilities sector then that gives us a bit of upside." ■

Italian battery machine developer has adapted the principles of magnetic induction to develop a more economic melting pot.

From coffee pot to money-saver: magnetic induction comes of age

All new technologies have to start somewhere. And for Italian battery machine manufacturer CAM, it started with an induction ring on the stove in sales manager Francesco Marfisi's new kitchen.

Staring at the Moka pot as Francesco made his breakfast expresso he was impressed by the speed of the induction ring. A thought flashed through his head: "if I can make coffee so fast, why can't we find a way to melt ingots faster"?

The rest is development history as CAM's R&D department spent the following year and more struggling with the twin difficulties of building a machine in scale and also ensuring that the feed stock could be introduced, melted and removed consistently.

The result was Fasmelt. "This is a first for our industry," says Francesco. "Until now, the grid producing process depended on traditional melting pots. What we've done is create a magnetic induction melting pot, with a rapid melting time, extremely low dross production, and perhaps best of all, roughly 60% lower energy costs."

The concept of the oven retains the elements of a classic gas or electrical melting oven. It is equipped with a completely automatic ingot conveyor designed specifically for this application. Fasmelt uses a high frequency generator to heat the melting pot by means of copper coils, which generate a magnetic field that quickly melts the lead ingot.

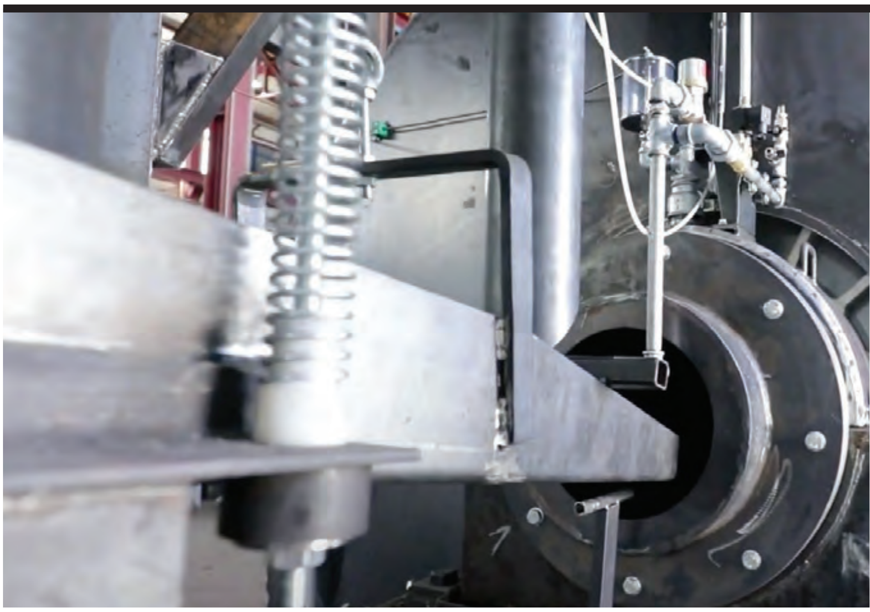
"We achieve the melt temperature of around 400°C in just 20 minutes," says Francesco. The kettle is covered with a special insulation system to guarantee consistency of temperature. The ingot is lowered into the melt when the bath temperature and level settings are reached. It has been designed to isolate residual magnetic fields thanks to an aluminium shield.

"We have done exhaustive testing to measure the magnetic field and we had values lower than 10 microT. It's a safe system," he says.

"Our classic CAM pumping system is used to remove the lead from the pot. It is equipped with an extraction pump and a joule effect heated pipe regulated by inverter."

Fasmelt is completely closed, and has a smaller diameter than a classic melting oven. This means the contact of the lead surface with oxygen is reduced, so less dross is produced. This also translates to lower costs for special waste treatment.

Fasmelt is equipped with an automatic dross removal system that channels the dross to a container for easy disposal. ■



"We achieve the melt temperature of around 400°C in just 20 minutes. The kettle is covered with a special insulation system to guarantee consistency of temperature. The ingot is lowered into the melt when the bath temperature and level settings are reached"

China now '10 years ahead' of US, Europe on EV battery recycling

China will become self-sufficient in meeting its needs for key EV battery materials lithium, cobalt and nickel around 10 years before the US and Europe, according to a study published on December 8.

The Asian battery tiger is expected to have the capacity to cater for its domestic demand for lithium from 2059 onwards — but this will not be the case in Europe and the US until after 2070 — says the study by Germany's University of Münster — A battery value chain independent of primary raw materials: Towards circularity in China, Europe and the US.

For cobalt, recycling is expected to ensure that China will be able to meet its needs after 2045 at the earliest. In Europe the study forecasts this will happen from 2052 but not until 2056 in the US.

In terms of nickel, the study says China could "probably" meet demand through recycling in 2046 at the earliest, followed by Europe in 2058 and the US from 2064.

Researchers says they used a so-called dynamic material flow analysis to calculate both future demand and the recyclable raw materials then available.

The basis the team used consisted of data from current research activities and market forecasts of developments in battery production and sales and the associated demand for raw materials.

Research team head Stephan von Delft told *Batteries International* on December 12: "Lithium from primary sources will continue to play an important role, especially in the short-term due to the substantial increase in the demand for EV batteries, but our research suggests that in the long-term it is possible to substitute primary Li sources with secondary sources."

He said there could be opportunities for Europe to make progress, spurred in part by speeding up electrification in the auto industry.

"The reason is that the faster EVs spread throughout the automotive market, the sooner there will be sufficient quantities of batteries available for recycling."

Study researcher Jannis Wesselkämper said the demand for raw materials could also be met much earlier by recycling as a result of a reduction in battery size and by avoiding second life batteries in applications such as stationary energy storage. ■

Gravita forecasts 40% lead recycling boost from unregulated crackdown

Formal lead recycling in India is set to soar by around 40% within the next few years as a result of a crackdown on informal operations, Gravita India forecast at the end of October.

The established lead recycler said in an investor presentation a corresponding fall in recycling in the informal sector is estimated by fiscal 2026, following the introduction of measures in 2022 aimed at forcing unregulated recycling out of the market.

Gravita CEO Yogesh Malhotra said in 2022 the company welcomed the introduction of revised battery waste management rules and extended producer responsibility requirements — making producers responsible for the collection, recycling or refurbishment of waste batteries, and for the use of recovered materials from waste.

The executive director of the India Lead Zinc Development Association L Pugazhenthy, told the International Conference on Lead & Lead Batteries in New Delhi in December 2022 that companies had to remain vigilant in cracking down on the informal, recycling sector.

"We must make sure that backyard recycling disappears from our dictionary," he said. "We are a technologically-advanced country and we don't need it."

Last June, Gravita announced an expansion of lead battery recycling capacity at its Chittoor plant from 26,440 tonnes a year to 64,640 tonnes.

The increase took the group's annual overall recycling capacity to more than 278,000 tonnes — putting Gravita on course to hit its overall target of 425,000 tonnes by fiscal 2026. ■

EU urged to scrap 'cumbersome, costly' lithium recycling rules

EU leaders have been urged to scrap "cumbersome, lengthy and costly" processes holding back lithium battery recycling services and hampering competition.

Eurometaux, which represents non-ferrous metals producers and recyclers in Europe, said in a newly-released open letter, dated November 3, there are too many bottlenecks in trying to ship end-of-life lithium batteries and their black mass within the bloc because EU countries interpret waste regulations differently.

The letter — co-signed by the European Association for Electromobility and Recharge, the European association for advanced rechargeable and lithium batteries — called for harmonized regulations among member states to fast track shipments of waste batteries and black mass.

In a related move, on November 13, the European Parliament and European Council — the body comprising leaders of individual EU nations that sets the bloc's political agenda — reached an informal agreement on the proposed Critical Raw Materials Act (CRMA).

The agreement now needs to be approved by both parliament and council to become law.

The draft CRMA was published in March. Proposed regulations include an updated version of the EU's list of critical raw materials and defines, for the first time, a list of strategic raw materials vital to powering the bloc's green tech agenda, including domestic battery manufacturing for EVs and energy storage systems.

Meanwhile, on November 16, the European Parliament and European Council provisionally agreed on proposed new procedures and controls for shipments involving a range of wastes including batteries. ■

Study sounds alarm over lead contamination at Cameroon plants

Inadequate pollution controls and extensive lead contamination has been discovered at three licensed lead battery recycling plants in Cameroon, according to a study released on November 7.

The CREPD/OK International Study — Investigation of Soil Contamination at Lead Battery Recycling Plants in Douala, Cameroon — says contamination levels in soil ranged up to 7.6% lead inside the plants and up to 15% lead at the facilities' fence line.

Lead levels at the plants averaged 22,952 parts per million (ppm) or greater than 2% lead, the study says, adding that levels above 80 ppm (0.008%) are considered unsafe for children.

CREPD executive director Gilbert Kuepouo said the study found that government regulations and enforcement capacity "are inadequate to protect workers and children from excessive lead exposures".

Testing was also undertaken in surrounding neighbourhoods. Some of the plants are next to agricultural land and others are in dense residential areas, he said.

An earlier study focused on the lead recycling industry in Cameroon and six other African nations, published in 2018, found similar problems with the plants, Kuepouo said.

"Our recent testing showed that even newly-approved battery recycling facilities in Douala lack proper equipment and are causing extensive contamination."

Kuepouo called for lead battery recyclers in the region to be legally obliged to report air emission data annually.

OK International executive director and one of the study's authors, Perry Gottesfeld, said: "Cameroon has been too lax in allowing these companies to set up local operations without first ensuring that measures are in place to control hazardous emissions."

CREPD (Centre de Recherche et d'Education pour le Développement) is a Cameroon-based non-governmental organization focused on health and environmental issues.

Occupational Knowledge International (OK International) is a US-based NGO that supports developing countries in identifying, monitoring and mitigating environmental and occupational exposures to hazardous materials.

Batteries International reported in 2022 that the International Lead Association was joining an international review of battery recycling standards under the Basel Convention.

In May 2022, the ILA welcomed new procedures published by Ghana's government to improve battery recycling operations in the West African nation.

The new standard operating procedures were developed in cooperation with organizations that included the ILA, Battery Council International and EUROBAT. ■

Sunlight spins off lead recycling into new business unit

The Sunlight Group confirmed on November 2 it was spinning off its lead recycling operations into a new subsidiary to guarantee raw material supplies for lead battery production.

The establishment of the wholly-owned 'Sunlight Recycling' was approved at an extraordinary meeting of shareholders on October 27.

Sunlight group CEO Lampros Bisalas said the move would create one of the largest secondary lead producers in the world, help to expand the Greece-based firm's collection of used batteries in Europe and America and make its lead battery production operations more competitive.

The group's existing lead battery recycling plant in Komotini in north-eastern Greece, will in future be part of the new subsidiary.

Bisalas said in May that Sunlight was increasing investment at Komotini, to gradually double lead production capacity from the existing 50,000 tonnes annually.

Komotini's expanded capacity will cover about 50% of the group's future lead supply needs for its battery production plant at Xanthi and allow Sunlight to supply some 23,000 tonnes to third-party European battery makers.

Sunlight is also working on plans to launch a lithium battery recycling plant within the next three years on the back of a €30 million ($32 million) investment by the company, plus a €3.5 million contribution from the European Union.

In June, Bisalas told the Pb2023 conference in Athens that expanding innovation in lead battery technology was key to the industry having a bright future. ■

ACE Green to work with NREL on lithium recycling R&D

For the record, ACE Green Recycling said mid-October it has signed a lithium ion battery recycling R&D agreement with the US National Renewable Energy Laboratory.

The lead and lithium recycling technology developer said the partnership will support its evaluation towards commercialization of its process for recycling LFP batteries and to "upcycle graphite to battery grade".

As part of the agreement, the lab will deploy its expertise in cell production, modelling and analysis at its facility in Colorado.

ACE said the project aims to identify the most effective methods of using its technology to recycle LFP, graphite and other cathode active materials to maximize the performance and lifetime requirements of batteries, as compared to batteries manufactured using virgin materials.

Andrew Colclasure, who leads materials development and modelling research for the lab's electrochemical energy storage group, said: "To encourage a more holistic approach to recycling, we must demonstrate efficient processes that also recycle low-value materials such as graphite and iron-phosphate into commercially viable products."

ACE claims the potential upcycling of graphite obtained using its technology could help ease US dependence on foreign supply chains and current total imports of more than 60,000 tonnes of graphite electrodes annually. ■

Ecobat sells South African lead firms unit Zimco to AutoX

Ecobat has sold its Zimco Group businesses in South Africa including lead manufacturing, recycling and chemicals firms to AutoX.

Under the terms of the deal, which is for an undisclosed sum, AutoX takes over several lead and lead-based product industrial and base minerals firms including recycler Fry's Metals, lead products manufacturer Castle Lead Works and lead chemicals firm Associated Additives.

The move follows the sale, announced in 2022, of Ecobat Resources Stolberg to commodities firm Trafigura. The sale included the Stolberg multi-metals processing plant in Germany.

Companies in the Zimco group are also major producers and suppliers of zinc and aluminium metal and alloys.

Ecobat CEO Marcus Randolph said the Zimco sale would allow the group to focus on its "core business" of battery recycling in North America and Europe.

AutoX produces a range of lead batteries including the Willard brand for all vehicle types and supplies LFP batteries for various applications.

Glenn Geldenhuis, AutoX's CEO, said the acquisition of Fry's would give his company greater control over its supply chain in a volatile market.

Lead recycling by Fry's dates back to 1947 and the company is a longstanding supplier and lead recycling partner to AutoX.

Fry's produces high quality lead alloys and has close ties to Zimco group members Castle Lead Works and Associated Additives. ■

Brill Power in second-life BESS tech tie-up with Pretto

Chemistry agnostic tech developer Brill Power said on November 7 it will supply battery management systems for second-life BESS units produced by Italy's Pretto.

Pretto business unit Dogma Energia manufactures BESS units and EV charging systems using battery cells recovered from end-of-life commercial EVs.

The cells, often underutilised after the vehicles' end-of-life cycle, are given a new lease of life through a process of sorting and requalification, Pretto said.

"Combining the environmentally responsible approach of utilising second life cells with Brill's 'BMS+' technology, the partnership aims to deliver a sustainable, reliable, and economically competitive energy storage solution."

Brill says its technology is scalable to different system sizes and compatible with any battery chemistry.

Separately, Brill said on November 16 it was partnering with UK EV charging firm Pod Point, Chinese battery maker Gotion High-Tech and Slovakian EV battery firm InoBat to develop residential storage systems that can power homes or charge EVs.

Brill CEO and co-founder Christoph Birkl said the energy transition will only happen if all involved in the sector work together to bring future-proof solutions to market.

"Our advanced battery management system delivers an end-to-end solution that extends battery lifetime by up to 60% and will be a key element for Pod Point's entry into the residential BESS market."

In September, Illinois governor Jay Pritzker said Gotion would start production at a $2 billion EV battery manufacturing plant in the state next year. ■

Glencore silent on reported EV pilot away from Italy

Glencore has declined to comment on reports that it is looking to build a pilot EV battery recycling plant outside of Italy.

The move could support the eventual commissioning of a proposed joint lithium-ion battery recycling project at its Portovesme site in Sardinia with Canada's Li-Cycle — which has been held up over a spat with the regional government, Reuters reported on November 23.

Glencore and Li-Cycle are understood to have dropped plans to set up a demonstration plant to produce lithium and other materials from black mass at Portovesme after the island's regional government refused to fast-track an environmental impact assessment for it.

Glencore did not respond to a request for comment about its plans — and continues to avoid questions about the future of its existing lead and zinc processing facility at Portovesme. ■

Work on Gravita Li recycling pilot imminent

Gravita India could start work on a planned pilot lithium battery recycling plant by early 2024, the company's CEO said.

Yogesh Malhotra told a second-quarter conference call the company had applied for relevant regulatory approvals to build the plant at its Mundra lead recycling plant in Gujarat.

Malhotra had hoped the approval would come before the end of 2023 to start the construction process.

Malhotra revealed last January that Gravita was already in talks with potential tech partners to build the pilot facility.

He said India needed "consolidated, complete technology" for sustainable lithium recycling and discussions were underway with potential partners from Europe, Japan and Israel.

Malhotra did not give an update on the technical talks on November 1. However, he said the foray into lithium recycling would be complementary to Gravita's existing lead recycling operations.

Lithium would start to eat into the company's lead battery recycling operations over time, but Malhotra said lead was expected to remain the company's dominant recycling activity for years to come.

Gravita announced in April lead recycling capacity at Mundra had been increased by 40,500 tonnes per annum.

The company said in a regulatory announcement that the expansion took overall recycling capacity at the flagship facility to 60,000 tpa. ■

Gravita starts plastics recycling in Tanzania

Gravita India has started commercial production of recycled polypropylene granules in Tanzania, the company announced on December 7.

PP has a wide range of uses and is one of the most common plastics used in the manufacturing of lead battery cases and the recycling of the material is commonplace.

Gravita said the Tanzania plastics recycling plant, operated by a subsidiary, has an annual production capacity of around 1,800 million tonnes.

The group said it had invested Rs2.25 crore ($280,000) in the procurement and commissioning of the facility, which will source scrap plastic from across the country — then supply its recycled products into manufacturing sectors in Europe and Asia.

Gravita has similar facilities in Ghana, Senegal, Mozambique and India.

Group CEO Yogesh Malhotra said in November 2022 that diversification would lead to at least 25% of its business by 2025-26 coming from recycling commodities other than lead — such as aluminium and plastic — and in future, lithium, copper and paper. ■

Researchers claim e-cigarettes dump huge amounts of lithium batteries into ground-fill

More than 1 million single-use e-cigarettes are discarded every week in the UK alone — amounting to an estimated 10,000kg of lithium from the devices' batteries being dumped annually, according to a study released on December 14.

Extrapolated, worldwide, the figure could be some 18 times higher — 180,000kg — if, using 2021 statistics of vape-smokers, international figures are incorporated.

Research from the University of Oxford and London's UCL, supported by the Faraday Institution, says the disposable e-cigarettes or 'vapes' finish up in landfill sites, where there toxic nickel, cobalt, and organic solvents pose an exponential environmental threat.

The research is in line with figures published by the international Waste Electrical and Electronic Equipment (WEEE) Forum, which revealed in October that the combined total of vapes discarded annually worldwide are estimated to weigh as much as six Eiffel Towers.

According to the latest UK study, e-cigarettes could potentially continue to perform at high capacity for hundreds of cycles — and calls for rechargeable devices to be the "default" product for manufacturers.

Researchers led by Paul Shearing, a professor in the University of Oxford's Department of Engineering Science and UCL Chemical Engineering, harvested batteries from disposable e-cigarettes under controlled conditions, then assessed them using the same tools and techniques used to study batteries in EVs and other devices.

They used X-ray tomography to map their internal structure and understand the constituent materials.

By repeatedly charging and discharging the batteries, the researchers said they determined how well the batteries maintained their electrochemical performance over time.

Shearing said: "The surprise for us were the results that pointed toward just how long these batteries could potentially cycle.

"If you use a low charge and discharge rate, you can see that for over 700 cycles, you still have more than 90% capacity retention. These are just being discarded." The public needs to be aware of the types of batteries in e-cigarettes and the need for safe disposal, he said.

Manufacturers should provide the ecosystem for reuse and recycling of the batteries — and should be moving towards rechargeable devices as the default.

Shearing's team says the use of disposable e-cigarettes have skyrocketed in popularity in the UK since 2021 — citing a separate survey that found an 18-fold increase recorded between January 2021 and April 2022.

Within 15 months, the popularity of e-cigarettes among 18-year-olds rose from 0.4% to 54.8%, the survey said. The Shearing team study, Up in smoke: considerations for lithium-ion batteries in disposable e-cigarettes, has been published online in *Joule*. ■

Extrapolated, worldwide, the figure could be some 18 times higher — 180,000kg — if, using 2021 statistics of vape-smokers, international figures are assumed and incorporated.

Flight of the Phoenix

Australian waste management company, Solo Resource Recovery, said in October that in the previous 18 months there have been 450 fires across Australia caused by lithium batteries — and the prime cause are the tiny batteries used in disposable electronic vapes.

"The used vapes are thrown into the rubbish which is compacted on the garbage truck smashing open the battery and causing a fire. They're a real and present danger to rubbish collection.

"One of our trucks has been set alight four times, we've now nicknamed it The Phoenix." ■

Australia issues national safety alert over home solar-storage batteries

Australia's federal government issued an urgent national fire safety warning notice over home solar storage systems on November 20 — linked to a lithium batteries recall dating back two years.

One home has already been "completely destroyed by a fire linked to an LG Energy Storage (LGES) battery overheating", financial services minister Stephen Jones said.

About 6,000 of a total 8,000 affected LGES batteries in solar storage systems have yet to be tracked down, Jones said.

Affected batteries were supplied nationally through multiple retailers from January 21, 2016.

The government safety notice comes a year after consumer watchdog, the Australian Competition and Consumer Commission (ACCC), revealed the existence of potentially deadly faulty batteries identified in an LGES recall.

The ACCC says, since October 2019, it has received reports of at least nine incidents associated with faulty batteries that have caused property damage and, in one case, a personal injury.

ACCC deputy chair Catriona Lowe said residents should urgently check whether their solar storage battery is subject to the LGES recall.

"This includes non-LG-branded solar storage systems that may also contain a recalled LG battery. If a battery is subject to recall, it should be switched off immediately."

Lowe said LGES will provide a refund, replacement or software update to fix the problem, and has also committed to paying compensation to consumers that incur higher energy bills while their system is switched off.

In response to the government's notice, LGES Australia said on November 22 it was conducting a safety recall* for certain of its ESS home batteries equipped with cells manufactured between March 29, 2017 and September 13, 2018. ■

Australian watchdog makes plea for urgent lithium safety rules

Australia's consumer watchdog is calling for a harmonized electrical safety regulatory framework across all states to help combat fires and other incidents linked to lithium ion battery products.

The Australian Competition and Consumer Commission (ACCC) said in a report published in October 5 there has been one fatality in the country attributed to a lithium battery fire and numerous reports of injuries in Australia.

Consistent state and territory legislation regulating products containing lithium batteries is needed — pooling the expertise of electrical safety regulators throughout Australia.

A national product safety incident database is also needed to support identification and analysis of consumer product safety hazards, the report says.

The exact number of incidents is unknown because many go underreported and the problem is compounded by differences in how data is collected from state to state.

However, the ACCC says there has been a six-fold increase in media reports relating to lithium battery incidents between February 2021 and February 2023 and 23 recalls between January 2017 and December 2022 involving lithium batteries and products containing them.

Those recalls affected an estimated 89,000 products on the market, the report says.

ACCC deputy chair Catriona Lowe said: "We are concerned by increasing reports of lithium ion battery fires resulting in property damage and serious injuries, including burns, chemical exposure and smoke inhalation."

By 2026, most Australian homes will have on average 33 devices powered by lithium ion batteries, the commission says.

The watchdog is calling for a nationwide consumer education campaign on how to safely use lithium battery products and correctly dispose of used batteries.

Meanwhile, the ACCC confirmed that LG Energy Solution Australia is recalling almost 17,000 home solar batteries in Australia because they may overheat and catch fire.

The recall follows a separate warning issued by the ACCC in November 2022 after a recall of "potentially deadly" faulty batteries in residential energy storage systems.

Batteries International reported in October that Genex Power was investigating a fire at an Australian BESS involving a Tesla battery unit design modified following a blaze at a separate facility in the country two years earlier.

Renewables and energy developer Genex said one of the 40 lithium ion Megapack units at the 50MW/100MWh Bouldercombe Battery Project caught fire on the evening of September 26. ■

US PNNL lab offers BESS safety advice for planners

A new report to help planning chiefs prepare for the safe expansion of energy storage systems in the US has been released by the Pacific Northwest National Laboratory (PNNL).

The report, *Energy Storage in Local Zoning Ordinances*, published on November 14, offers "real-world examples" of how communities have dealt with BESS projects to date — including dealing with risks of system failures and fires.

Emergency response plans are needed to deal with what the report says are the "rare event" of fires. For example, whether water will be used, whether containment of run-off will be needed and how to combat potential risks to nearby homes from smoke.

The report says the energy density of lithium batteries is one of the technology's key benefits and also its greatest risk.

PNNL energy adviser and report co-author Jeremy Twitchell said it is unreasonable to expect local planners to become "energy experts" in the short time they are given to consider BESS project applications.

Figures published in December 2022 by the US Energy Information Administration indicated developers and power plant owners plan to expand utility-scale battery storage capacity in the country to 30GW by the end of 2025. ■

Li-powered e-scooter blamed for deaths

Three generations of one family died in New York and 14 others were injured after a fire on a e-scooter on November 12.

The latest blaze comes after the city experienced 219 fires caused by e-bikes, e-scooters and other electric micro mobility devices in 2022, leading to six deaths and 147 injuries.

Two destroyed e-scooters were found by firefighters. New York City fire commissioner Laura Kavanagh said "illegal, uncertified" e-mobility devices continue to be ticking timebombs for NY and other cities and she called for online retailers to ban the sale of lithium battery devices that are not certified by a US national testing laboratory.

In February, Kavanagh urged US consumer safety chiefs to do more to keep substandard lithium ion batteries out of the country and regulate chargers and e-bikes. In July, a new multi-agency safety taskforce was ordered to spearhead inspections of ESS sites across New York State. In October, the ACCC called for a harmonized electrical safety regulatory framework across all states to combat incidents linked to lithium ion battery products. ■

Probe launched into Alaska vessel fire

An investigation has started into the cause of a fire on a cargo ship carrying lithium ion batteries in Alaska, the vessel's owners said on January 2.

Fire was reported onboard the MV Genius Star XI on December 25, according to the Wisdom Marine Group.

A precautionary one-mile safety zone was in place around the vessel, now at anchor in Broad Bay, near Dutch Harbor, until technical experts are satisfied the cargo hold is safe to enter for investigations to continue, the coast guard said on December 30. ■

Battery investments are likely to be a major casualty in a fierce EU budget battle that also embraces financial support for the Ukraine and slowing emigration into the union.

European industry associations denounce proposed budget cuts as 'catastrophic'

Proposals to slash European research and innovation funding by billions of euros risk making "a catastrophic decision" to battery and raw material investment plans, industry leaders have warned.

The flagship Strategic Technologies for Europe Platform (STEP) is set to be cut from €10 billion ($11 billion) to just €1.5 billion. At the same time €2.1 billion is being axed from the €95.5 billion Horizon Europe research programme under budget proposals for the next seven years.

The proposals from the European Council — the heads of state or government of EU members— emerged after crunch talks on December 15 and 16 were blocked.

The talks aimed to revise the multi-annual financial framework and find cash for political priorities including a €50 billion aid package for Ukraine and support border management for migration frontline member states.

However, the proposals were blocked by Hungary, the only one of the EU's 27 member states to do so, with top-level talks aimed at resolving the deadlock expected later this month.

Hungarian prime minister Viktor Orbán said the EU should be working for a ceasefire and peace talks between Ukraine and Russia rather than providing financial support.

Battery czar Maroš Šefcovic told to reconsider cuts

"We understand the financial challenges facing the EU and its member states, but the next two years are crucial to deciding where the world's clean technology manufacturing capacity and supply chains will be built."

Competition

The proposals were part of a mass of budget data released in the run up to the festive holiday period. They stand in stark contrast to a much-trumpeted pre-Christmas pledge by the European Commission to give the bloc's battery sector a €3 billion boost in the face of competition from the US, China and other regions.

Now lithium batteries trade body RECHARGE, European metals association Eurometaux and clean transport lobbying group Transport & Environment are calling on European Commission president Ursula von der Lyen and Commission VP and battery czar Maroš Šefcovic to urgently reconsider the proposed cuts.

In a December 21, the trade bodies warned the cuts "would be a catastrophic decision in Europe's attempt to catch-up in the global cleantech manufacturing race".

The bodies, which represent companies from across the EU raw materials and battery value chain, welcomed the Commission's December 6 announcement that the sectors would share in a €3 billion "stimulus boost" through the EU Innovation Fund.

But the subsequent proposed cuts would mean continued "investment leakage" to other parts of the world, the letter said.

Challenges

According to the trade bodies, building a lithium refinery in Europe is already two to three times more expensive than in Asia and it is 35% more expensive to build a battery plant in the bloc than in the US.

"We understand the financial challenges facing the EU and its member states, but the next two years are crucial to deciding where the world's clean technology manufacturing capacity and supply chains will be built."

Europe cannot sacrifice its chance of establishing long-term climate leadership, the letter said.

Priorities

A key priority of the STEP program, also known as the renewables fund, is to support the rapid development and deployment of clean energy technologies including energy storage systems.

Analysis published by Transport & Environment last March warned that nearly 70% of Europe's overall planned pipeline of lithium ion battery cells production capacity by 2030 was at risk of being delayed, scaled down or cancelled — and EU battery manufacturing was "caught in the crossfire between America and China".

In September, the EU launched an investigation into Chinese subsidies for EVs and batteries, amid fears Beijing could steer Europe's green energy transition off course.

Meanwhile, the US government continues to roll out loans and tax incentives in support of the battery industry, with federal funding worth up to $3.5 billion announced last month alone for battery materials processing and manufacturing technologies. ■

The European Commission has launched an investigation into whether five European battery manufacturers as well as trade association, EUROBAT, have been colluding to fix starter battery prices.

EUROBAT and lead battery giants in price-fixing probe

Some of the world's leading lead battery makers are at the center of a European Commission investigation into alleged price fixing, along with allegations they may have been aided by trade association EUROBAT.

Competition chiefs have accused Clarios, Exide Technologies, Banner, Rombat, Fiamm Energy Technology and its predecessor Elettra of possible collusion to fix starter battery prices.

The EC revealed on November 30 that an investigation had been launched into the alleged breaches of EU antitrust rules — which could potentially see the firms face substantial fines of up to 10% of their annual global turnover if the Commission concludes there is sufficient evidence rules were broken.

The companies now have an opportunity to examine documents in the Commission's investigation file, reply in writing and ask for a hearing with competition chiefs.

There is no legal deadline for the completion of such an investigation, the duration depends on factors including cooperation by companies in the investigation, the Commission said.

The Commission's probe is focused on the period between 2004 up to 2017.

It is alleged the firms published and agreed to use new indices in their price negotiations with car producers, the aim of which was — allegedly — to fix an important element of the final battery prices.

The Commission said it was "concerned EUROBAT and its service provider, Kellen, were aware of the alleged conduct and actively contributed to it by assisting the battery manufacturers in creating and running the so-called EUROBAT premium system".

A spokesperson for the Commission told *Batteries International* on December 11 they could not comment on the origins of the probe, including whether the investigation had been triggered by an industry whistleblower or any kind of complaint.

The spokesperson also refused to rule out an expansion of the investigation to include other automotive battery companies.

A Commission statement said: "If the Commission's preliminary view is confirmed, this conduct would infringe Article 101 of the Treaty on the Functioning of the European Union ('TFEU') and Article 53 of the EEA Agreement, which prohibit cartels and other restrictive business practices.

"This prohibition includes anticompetitive conduct by associations of companies. The sending of a statement of objections does not prejudge the outcome of an investigation."

EU commissioner in charge of competition policy, Didier Reynders, said: "To be effective, competition requires economic operators to act and to determine their prices independently of each other.

"We are concerned that battery suppliers limited price competition, thus harming their customers, in this case car producers, and, ultimately, European consumers."

All of the companies named have been sent a so-called "statement of objections" — a formal step in the Commission's investigations.

EUROBAT told *Batteries International* it will fight allegations suggesting that it may have been involved.

The trade association's spokesperson said on December 8 that its legal counsellor had reviewed the statement of objections and "intends to contest the allegations mentioned".

The spokesperson declined to give details about the so-called EUROBAT premium system.The Clarios director of external global communication and communications for the EMEA region, Christian Riedel, told *Batteries International* the company did not comment on pending investigations and legal proceedings, but said "we don't believe we have any material exposure.

"We are cooperating with authorities in their investigation."

Metair Investments, which owns Rombat, said on December 6 it was considering the statement of objections it had received in detail.

"Rombat, as with all Metair companies, remains committed to conducting its business in full compliance with European law," the group said.

An industry insider told *Batteries International* on condition of anonymity that potential fines of up to 10% of global turnover could be "hefty" — noting that Clarios's turnover alone was around $8 billion in 2020.

This is not the first time the European Commission has investigated suspected breaches of antitrust rules relating to the battery sector.

In February 2017 the Commission fined lead recycling firms Recyclex, Campine and Ecobat Technologies a combined total of €67.6 million (then the equivalent of more than $72 million) for forming a cartel to fix the prices of scrap car batteries.

The collusion was carried out via telephone calls, emails and text messages, and coded language was used to signal different price levels, the Commission said. All of the fines imposed were subsequently reduced. ■

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"To be effective, competition requires economic operators to determine their prices independently of each other. We are concerned that battery suppliers limited price competition, thus harming car producers, and, ultimately, European consumers."

— EU commissioner in charge of competition policy, Didier Reynders

Since launching in 2016 Li-Cycle has made strides in its quest to become a global lithium battery processor, but with a flagship project now stalled, 2024 could be pivotal for the firm

Recycler at the hub of uncertain future

Just two years ago, Canada-based Li-Cycle was being hailed for its progress as an innovator aiming to make its mark on the lithium recycling industry in North America and overseas.

However, the company has since been beset by difficulties and started 2024 battling on several fronts, not least scrambling to keep one of its flagship projects on track— its planned lithium recycling 'hub' in Rochester, New York.

In September 2021, the company announced that Koch Strategic Platforms, a subsidiary of Koch Investments Group, was making a $100 million investment in Li-Cycle through the purchase of a convertible note.

One year later, Li-Cycle celebrated the launch of commercial operations at its Alabama lithium ion battery 'spoke' recycling facility in the US — the company's fourth such plant after New York, Arizona and Ontario.

Then in August 2023 Li-Cycle announced the launch of its first European lithium ion battery recycling plant in Germany.

However, construction work at its Rochester facility was suspended last October after Li-Cycle admitted the estimated cost of the project could double to up to $1 billion.

That prompted one industry commentator to tell *Batteries International* that, with a number of similar recycling projects at various stages of development around the world, the estimated eye-watering costs at Rochester would "unnerve investors and give pause for thought about how to proceed with recycling technologies involving lithium".

Indeed, the outlook for Li-Cycle took another turn for the worse last November, when CEO Ajay Kochhar confirmed the Rochester suspension was being extended for an unspecified period.

At the same time, the company revealed it was "taking steps to conserve cash" in the face of escalating costs.

Several law firms have since announced the filing of class action lawsuits against Li-Cycle, relating to statements made about rising project costs at Rochester.

One of the law firms, Kirby McInerney, said it had filed a suit in the US District Court for the Southern District of New York on behalf of Li-Cycle investors.

Meanwhile key Republican members of the US House of Representatives have called on the Department of Energy's Loan Programs Office (LPO) to give details of a proposed $375 million loan to Li-Cycle — saying they were concerned about the government making possible "reckless investments".

Li-Cycle said in November talks were continuing on how to meet conditions to secure the government loan to help support construction at Rochester.

However, in a December 6 letter to LPO director Jigar Shah, House energy and commerce committee chair Cathy McMorris Rodgers — and the chairs of subcommittees for oversight and investigations and energy, climate and grid security — demanded to see "all internal guidance, memos, criteria, or policies governing each stage of the loan and loan guarantee application review process".

The letter also highlighted concerns by legislators over the filing of the class action lawsuits.

If this were not enough, uncertainty remains over a proposed European lithium ion recycling joint venture between Li-Cycle and mining giant Glencore.

Glencore said in a regulatory filing on December 6 it might convert a $225 million note into Li-Cycle stock, giving Glencore a stake of just over 11%.

Both companies declined to comment further when contacted by *Batteries International*.

However, on the possibility of facing potential lawsuits, a Li-Cycle spokesperson said the company "intends to vigorously defend itself".

Just days before the end of 2023, when Li-Cycle might have been hoping to usher in a happier new year, the company was hit with a notice from the New York Stock Exchange for failing to meet listing standards.

The recycler confirmed on December 29 it had received a written notice after the average closing price of the firm's stock fell below $1 over a consecutive 30-day trading period.

Under NYSE rules, Li-Cycle has a six-month period following receipt of the notice to bring its average closing share price to at least $1 over the prior 30 trading-day period.

The company said it was considering all options to "cure the deficiency", but said the notice had no immediate effect on the listing of its common shares on the NYSE and did not affect business operations. ■

"Estimated eye-watering costs at Rochester will unnerve investors and give pause for thought about how to proceed with recycling technologies involving lithium"

Hub and spoke

The hub and spoke processing system is at the heart of the firm's operations.

Spoke facilities are where all types of lithium ion batteries are transformed from a charged state to what Li-Cycle describes as an inert product.

The resulting black mass is then transferred to a hub, where cathode and anode materials are processed into battery grade end-products for reuse in battery production or other applications.

Li-Cycle says the primary product of its facilities is black mass, which includes lithium, cobalt and nickel, that the company wants to convert into battery-grade materials at Rochester. ■

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The boundaries of our understanding of the role carbon plays in enhancing battery performance have been extended. Sara Verbruggen reviews the landscape.

Hardly black magic at all

Mystery ingredient 'x'! Attend any battery conference 15 years ago and the hottest of hot subjects was this mystery ingredient — also known as carbon (even then).

Carbon seemed to offer both a cure to many of lead's problems such as cycle life but it also offered a path to a promised land of maintenance free lead batteries.

At that time, many of the actual mechanisms of how carbon worked were still unknown — a lot is still unknown — but its conductivity had been known for a couple of generations. The issue then, and to a certain extent now, is fine-tuning the mix for the best results.

Carbon, due to its inherent conductivity in certain forms, or allotropes, is an essential ingredient in many kinds of energy storage devices — both lead and lithium.

In lead acid batteries conductive carbon additives are primarily incorporated within the negative plates, while in lithium ion batteries, these materials are added to both cathode and anode electrodes. Conductive carbon materials also have a critical role in next-generation battery technologies

THE PROSPECTS FOR CARBON ADDITIVES

The market for conductive carbon additives could be worth $7.3 billion by 2028, growing at a compound annual growth rate of nearly 14% in the next five years. EV production will mean the energy storage segment will remain the dominant and the fastest-growing application in the global market until the end of the decade.

The push to commercialize increasingly fuel and energy efficient vehicles continues to be a key factor in efforts to supply superior high purity and more customized carbon black and other conductive carbon additives. But other factors are also shaping the industry, such as ensuring future supplies can be sourced within regional supply chains to reduce reliance on imports and making sure that expanded production capacities are cleaner and emit less CO^2.

In its Battery 2030 report, McKinsey & Company forecasts the entire lithium ion battery value chain, from mining through recycling, could grow by over 30% annually from 2022 to 2030, to reach a value of more than $400 billion and a market size of 4.7 terawatt hours by that year.

"To avoid shortages, battery manufacturers must secure a steady supply of both raw material and equipment. They must also channel their investment to the right areas and execute large-scale industrialization efficiently," highlighted the report.

such as silicon-containing anode, solid state and dry process cells.

Produced in a powder form, conductive carbon additives, describe a range of materials, including, carbon black, acetylene black, graphite, graphene, carbon nanotubes and nanowires.

Typically — along with binders and other additives — these are processed into electrode formulations, some of which may contain blends of more than one, like carbon black and graphite or carbon black and nanotubes, for example, influencing battery characteristics, including charging and discharging times as well as cycle life.

From the 1940s onwards, expanders composed of three key ingredients — barium sulfate, lignosulfonate and carbon black — became an essential component of negative plates of lead acid batteries.

During a battery's charge and discharge cycling, the use of carbon in the expander prevents individual crystals of lead from growing and combining, reducing electrical capacity. (See panel in this feature,)

Companies, such as Borregaard, Hammond and Addenda, are key suppliers of expander products and other additives to the lead acid battery market.

From the late 1980s onwards the benefits of adding more carbon to the negative active mass (NAM), beyond the level required for expanders, were demonstrated by Japanese researchers and academics Nakamura and Shiomi.

Increasing the loadings improved cycle life in high-rate partial state of charge (HRPSoC) operation. This discovery has been critical to the expansion of the microhybrid internal combustion engine vehicle market.

Microhybrids achieve fuel savings of between 5% and 15% by shutting down the engine during temporary stops, such as at traffic lights and, while the engine is off, the vehicle's other systems are kept running through the battery, which is recharged by a combination of energy captured during braking and from the engine.

However, while adding more conductive carbon additives to the negative electrode enhances dynamic charge acceptance the water loss rate is increased, which leads to battery degradation. This has been a key area of research for the Consortium for Battery Innovation, since the organization's inception.

Over the years additive suppliers have addressed these issues by developing and engineering conductive carbon additives with fewer metallic impurities, resulting in extended battery cycle life while minimizing water loss and suppressing the hydrogen evolution reaction, enabling battery makers to use higher loading of additives to achieve higher charge acceptance.

Key suppliers

Cabot Corporation started development of its PBX carbon additives for advanced lead acid batteries in 2010. The range includes products suitable for flooded and valve regulated lead acid batteries, which are used in various microhybrids, including more advanced starting, lighting, ignition applications to improve DCA.

"We quickly realized that creating and selecting the best additives for various lead acid battery applications requires methodical and rigorous application testing to assess how our materials will perform in full size batteries made by commercial manufacturing processes," says Paolina Atanassova, commercial director, Cabot Battery Materials, EMEA.

Over the past 10 years the company has been working to optimize the negative electrode formulations with its PBX product grades, depending on the performance improvement requirements.

In 2014, Cabot built lead acid battery testing capability at its Billerica Technology Center, in Massachusetts, US, which houses paste mixing, cell assembly and testing capability, enabling internal testing through pre-screening different additives and optimizing formulations.

"This allows us to provide more effective support to our customers during the evaluation and adoption of our PBX products. These start with reviewing our cell level data and deciding on two or three formulas (carbon loading, lignosulfonate loading) to test in a large-scale manufacturing trial for further fine-tuning of the best formulation," she says.

The company supplies six out of the seven largest lead acid battery manufacturers, with basic and advanced additives and also many leading regional and medium sized lead acid battery companies either directly or through expander manufacturers.

This is from an extensive portfolio of conductive additives for lead acid battery applications, including some newer formulations consisting of carbon blacks and carbon nanotubes.

Imerys' products for lead acid batteries combine graphite with carbon black. Its Timrex CyPbrid product is the most suitable carbon additive for the negative electrodes of advanced lead acid batteries.

Key features include improved battery performance in terms of DCA and high cycling stability during HPSoC. No additional pre-dispersing unit is required and higher battery production output is possible.

In 2021 Birla Carbon launched a range of conductive carbon additives for the energy storage market. The Conductex e series, for lead acid, comprises several different products. Some are for start-stop/microhybrid EFB or VRLA applications requiring the highest charge acceptance while maintaining a balance of low temperature performance and cycle life.

Another is designed for to enable low water loss and high durability during deep cycle operation in e-bike, stationary storage, telecom, or motive power applications.

Heraeus launched a range of carbon additives for lead acid batteries in 2017, following development and customer trials since 2014. Porocarb Lead increases charge acceptance by up to 120% and endurance cycle life by up to 100%, claims the company.

Orion Engineered Carbons supplies battery manufacturers and expander manufacturers with its

In 1988 Cabot established its first entity in China, Shanghai Cabot Chemical Co with joint venture partner Shanghai Huayi Energy Chemical (formerly Shanghai Coking & Chemical Corporation).

acetylene black products, which are used in SLI EFB and AGM lead acid batteries globally, as well as lead acid batteries for industrial applications and other mobility uses.

The company's acetylene black products are also used in lithium ion batteries. Orion's Printex Kappa family of products is for advanced lead acid batteries, to enable high DCA performance with acceptable water loss, according to Michael Rohde, head of marketing at Orion.

"Our market share in supplying conductive additives for lithium ion batteries and lead acid batteries has grown substantially. The lithium ion battery market is experiencing a significant increase with a CAGR of over 20% and the demand for conductive carbon additives is rising in parallel.

"To meet this growing demand, Orion is expanding its production capacities, ensuring alignment with the rapid growth in this sector while maintaining our strong presence in the lead acid battery market."

Looking ahead he says conductive carbon additives will remain essential for all battery applications. "The industry will likely move toward higher conductivity and purity in carbon black grades. This aligns with the escalating demands for enhanced battery performance.

THE ADDITIVE MIX IN THE EXPANDER

Hammond Group, the international manufacturer and supplier of expanders, has spent many years of research in assessing the role of carbon additives in the expander mix. Expanders are an essential component when mixing the paste for the negative plates of lead acid batteries.

A typical expander consists of three principal ingredients: barium sulfate, lignosulfonates and carbon, most frequently in the form of carbon black.

Each has a different function relating to the crystals that will form on the lead plate.

The barium sulfate act as the nucleation sites of lead sulfate crystals (making discharge easier).

The lignosulfonates increase the surface area and prevents the passivation of negative active material (making the battery more powerful).

The carbon additive has multiple functions in negative active material. One is increasing the conductivity of the battery. The greater the conductivity and dispersibility, the easier it becomes for batteries to recharge more completely. Otherwise, sulfation, the slow build of up lead crystals that do not dissolve in recharging will eventually kill the battery.

"Choosing the right mix and proportions of carbon in the expander is a fine balance between a variety of factors," says Enqin Gao, director of research and development at Hammond. "Too much carbon, for example, and its greater active sites on the surface and impurities from it, leads to gassing and water loss, shortening the life of the battery.

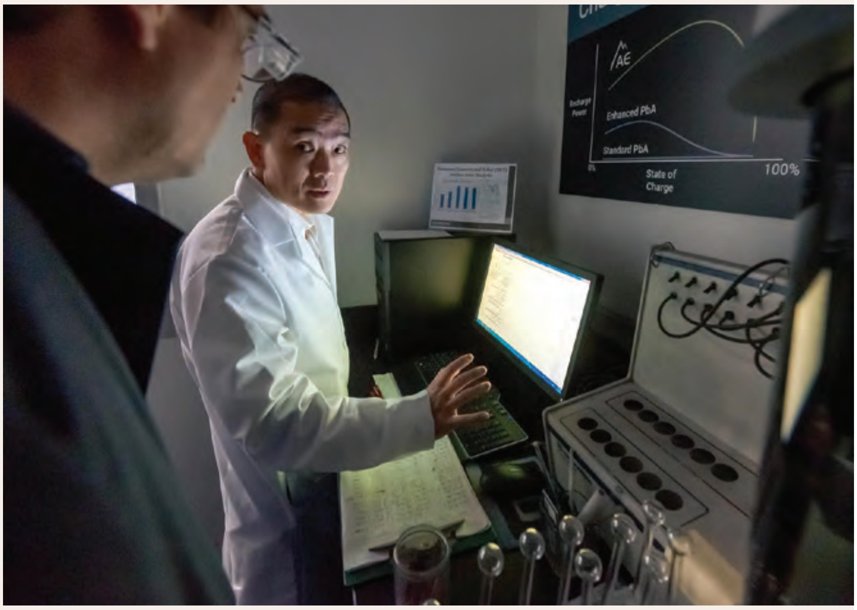
"The choice of which carbon to deploy — typically we mostly use furnace black but we also use acetylene black or graphite — varies with the application that the battery will be used for."

Gao says that Hammond can make up special expander mixes, saying that the firm's R&D department has spent years testing various mixtures (and their interactions with other chemicals such as lignins in the expander) but in general the carbon additives in the expanders are developed for specific applications.

"You need to provide a very different balance of carbon additive in, for example, a deep cycle battery that will operate in high temperatures, to that of, say, a UPS battery."

Gao also says that while acetylene black is slightly more expensive than furnace black, it also has extra capabilities. "There can be specialized functional groups on the surface of carbon black that can also affect factors such as water loss," he says. "Reports show that some acidic functional groups can reduce gassing while some basic functional groups can increase gassing."

"It's all a question of getting the right mix for the right application."



"You need to provide a very different balance of carbon additive in, for example, a deep cycle battery that will operate in high temperatures, to that of, say, a UPS battery. It's all a question of getting the right mix for the right application" — Enqin Gao, Hammond

"Another key factor is sustainability, underscored by low life cycle assessment. This will emerge as critical differentiators in the industry."

From an environmental perspective, Orion's production of acetylene black yields 200kg of CO^2 per tonne of product compared to over 1.6 tonnes of CO^2 per tonne for furnace black, meaning that 90% of the carbon is retained in these conductive additives reducing the carbon footprint compared with highly conductive furnace carbon blacks, according to Rohde.

Carbon nanotubes

With their exceptional conductivity carbon nanotubes have great potential for enhancing both lead acid as well as lithium ion batteries either on their own or as part of a composite.

Cofounded in 2014 as a joint venture between Saudi Arabian chemicals producer Sabic (majority owner since 2019) and Molecular Rebar Design, Black Diamond Structures is targeting the energy storage, automotive, construction and consumer electronics industries with its carbon nanotube materials.

The company is manufacturing products that enhance the performance of lead acid batteries and has worked with over 60 battery makers globally.

Black Diamond Structure's process consists of detangling what it describes as "dirty, raw carbon nanotubes into discrete, individual tubes of uniform size" and then formulating them to they can be used in existing manufacturing processes. "The resulting Molecular Rebar material is cleaner, easier to formulate and easier to apply to a target system," says Black Diamond Structures.

When integrated into lead acid chemistry, Molecular Rebar forms optimal crystal structures that expand application windows, decrease warranty returns by up to 95%, and lowers manufacturing costs 5%–10%. They can be multi-walled or single-walled in nature depending on application or need. They are shipped as solvent or water-based dispersions that can be added to the battery at the point of electrode manufacture.

To commercialize its technology in the automotive lead acid battery industry Black Diamond Structures collaborated with Addenda to incorporate its Molecular Rebar technology into Addenda's proprietary expander composition.

The solution provides AGM-level performance from an EFB design in Volkswagen's Regenerative Ability test, 85% improvement to microcycling durability, heightened cranking performance and improvements to other key OEM-specified parameters while retaining a W4 water loss rating.

A major supplier of acetylene black conductive carbon additives is Japan's Denka, which first began supplying these materials for dry batteries in the late 1940s, then various kinds of primary and secondary batteries, as an alternative to natural black graphite. The company has continued refining its product. Denka Black Li, for lithium ion and next-generation batteries, is made by modifying purification techniques to keep metallic impurities to a minimum. ■

Alex Holland looks at the evolving landscape of graphite anodes in lithium ion batteries.

Changes are on the horizon but graphite dominance set to continue

The next generation of silicon anode materials are inching closer to commercialization with the promise of improved energy density and rate capability. Lithium-metal and anode-free solutions continue to be explored, while options such as niobium oxides have also garnered some interest for fast-charging batteries.

Nevertheless, the good overall performance and low cost of graphite means that it is predicted to maintain its dominance in the Li-ion industry.

Despite developments in new anode materials, graphite, the material used for the past 30 years in Li-ion anodes, is forecast to remain the most widely used anode material in Li-ion batteries through the medium term.

IDTechEx forecasts that the demand for Li-ion graphite anodes will grow considerably and exceed 2 million tonnes by 2029.

Two broad types of graphite are used for Li-ion anode, natural and synthetic (or artificial), each with its own advantages and disadvantages.

Natural graphite is generally a lower-cost option than synthetic. It can also offer a slightly higher initial capacity but also tends to have a lower cycle life, C-rate capability, and initial coulombic efficiency.

By contrast, synthetic graphite is more expensive than natural graphite due to the higher energy requirements for graphitization, as well as being more difficult to mill into spherical particles, but it also tends to offer longer cycle life and marginally higher initial coulombic efficiency.

However, there can be an overlap in the performance and cost of these two types of graphite, and the differences between them have also been closing.

Beyond just the type of graphite, various cell design factors such as cathode choice, electrolyte additives, coatings, particle size and distribution, electrode balance, as well as the specification and quality of the graphite product will have a significant impact on eventual cell performance, cost, and cycle life.

> According to 2021 figures for graphite anode production, China produced 85% of supply, Japan 10%, Korea 4% and the rest of the world just 1%

Both synthetic and natural graphite continue to be used with blends widely utilized. IDTechEx estimates that there is a roughly even split, by kt sales, between synthetic graphite and natural graphite. However, there has been a slight shift toward natural graphite over the past few years due to cost pressures and high energy prices.

As with other raw materials, increasing the output of natural graphite to keep up with the rapidly growing demand for Li-ion batteries has proven challenging.

The US DoE and the European Commission have included natural graphite in their latest critical raw materials/minerals lists due in part to Li-ion batteries' important role in transport electrification and stationary storage applications.

China's dominance of graphite anode production also presents a supply risk, though Li-ion graphite anode production outside of China is starting to develop from firms such as Syrah Resources, Northern Graphite, and Nouveau Monde in North America, or Talga Resources, SGL Carbon and Vianode (synthetic) in Europe, among others.

According to 2021 figures for graphite anode production, China produced 85% of supply, Japan 10%, Korea 4% and the rest of the world just 1%

In addition to diversifying material supply, improved sustainability and ESG metrics will be important factors for new graphite production.

Lower energy consumption and embedded emissions will become an increasingly important metric. This is especially true in Europe, with the European Battery Regulation set to implement carbon footprint labels and declarations for Li-ion batteries above 2 kWh in size.

This may favour natural graphite and its lower energy consumption, though particulate emissions and acid waste streams from the purification process also need to be carefully managed.

Lower cost and low carbon energy from renewable sources could help improve the competitiveness of synthetic graphite in this respect, though it will still be reliant on fossil feedstock.

These points help to further highlight the fine balance between natural and synthetic graphite.

Ultimately, the dynamic Li-ion graphite anode market and high growth rate in Li-ion demand will ensure ongoing demand for both synthetic and natural graphite anode materials. ■

Alexander Holland is research director at IDTechEx. He specializes on energy storage technologies and his activities include technology benchmarking, supply chain analysis and market forecasts. Before joining the firm in 2019, he worked as a product development analyst at a B2B renewable energy supplier.

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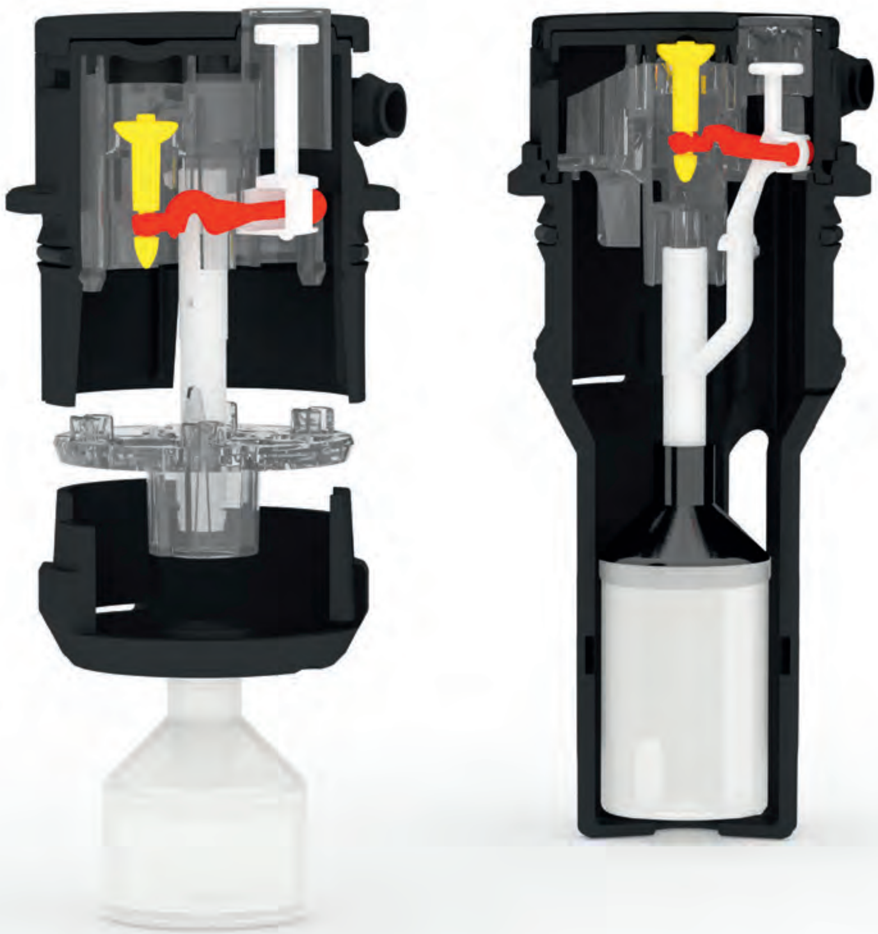

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With demand growing for additives — seemingly on an exponential basis — boosting manufacturing capacity for lithium ion battery demand is as important product innovation, writes Sara Verbruggen

Putting pedal to the metal, ramping up for the boom

Each EV is powered by a lithium ion battery with an average capacity of 60kWh, compared with an SLI lead acid battery that is typically less than 1kWh … that means correspondingly larger quantities of conductive additives are needed

Talk to additive manufacturers and one almost immediately find that once the technical conversation is out of the way, their interests are focused on customer requirements and geography — which, if surprising at first, starts to make sense when one talks about supply chains and support.

Cabot, for example, works with three types of customers in the lithium ion battery industry.

"First, are the leading global battery markers," says Matt Wood, vice president global strategy and marketing, Cabot Battery Materials, EMEA. "We have commercial sales with nine out of the 10 top global producers.

"Second, are leading EV manufacturers, which include automotive OEMs who are leading the way in EVs and are producing or starting to produce their own battery cells — either directly, through subsidiaries, or through joint ventures. Finally, we also collaborate with other regional battery players."

Cabot operates its battery materials business globally, with production, sales support, and technical support in each region — Asia, Europe and the Americas. In each of these regions, there are customers who have representation in the value chain, in either specific technologies, or downstream with secure offtake of their batteries.

Orion supplies cell manufacturers but also EV makers, with full vertical integration and dispersion houses as an intermediate.

Both Cabot and Orion have been investing in expanding their battery operations globally, primarily to capture growing EV demand. The projected growth in demand for lithium ion batteries significantly higher than for lead acid batteries.

Each EV is powered by a lithium ion battery with an average capacity of

Meet the team

Bringing the industry together www.batteriesinternational.com

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"We are developing more sustainable, affordable and high-quality carbon black additives for lithium ion batteries, which will be made in Europe, rather than imported"

— Michael Rohde, Orion

60kWh, compared with an SLI lead acid battery that is typically less than 1kWh. That means correspondingly larger quantities of conductive additives are needed for lithium ion batteries, according to Wood.

Cabot has grown its conductive additives business largely by upgrading capacity at certain, specialized production units to produce battery materials. "As a result, we now have conductive additive capacity in each region across our network: Asia, EMEA and the Americas," says Wood.

"Furthermore, we have expansions in each region, having recently expanded our carbon nanotube and conductive dispersions capacity in Zhuhai, in China, opened a new Technology Centre in Münster, Germany that is dedicated to battery applications. We are also expanding production of our additives for coating cathode active materials in Rheinfelden, Germany.

"We are also adding conductive carbons capacity at our existing facility in Pampa, Texas, US, as well as exploring other options to further expand our manufacturing and technology footprint throughout our network."

Meanwhile, Michael Rohde, head of marketing, says Orion is building the only plant in the US producing acetylene black. The factory in La Porte, Texas will produce approximately 12 kilotonnes per year, quadrupling its effective manufacturing capacity. "Orion has a similar plant in France, and it's the only producer of acetylene-based conductive additives in the EU."

Orion recently opened a Battery Innovation Center in its main innovation hub in Cologne, Germany, which features advanced production, testing and diagnostic equipment.

"The lab will greatly enhance Orion's product and process development as well as create closer collaboration with customers to inspire innovation and address evolving customer needs," says Rohde.

Cabot's innovation in conductive carbon additives is grouped into two focus areas — performance and sustainability.

Battery producers are seeking improved energy density to enhance battery performance, which can be enabled through conductive carbon additives engineered to perform with higher energy density anode and cathode materials. Examples include high-nickel cathodes and silicon-containing anodes.

"Our highly conductive additives, including bespoke blended conductive dispersions, are engineered to provide either higher conductivity performance or the same conductivity performance with a lower additive loading, which enables a higher loading of active materials," Wood says.

He says that Cabot's conductive carbons are specifically engineered to provide the conductivity and mechanical performance needed to enable dry processed electrodes. "We have developed aqueous-based conductive dispersions, which also eliminate the need for undesirable solvents during electrode manufacturing without needing to solve the challenges of dry-processed electrodes.

"Additionally, our fumed alumina additives for cathode active material (CAM) coating enable the use of low-cobalt cathodes," says Wood.

Orion is part of the EU-funded HiQ-CARB consortium project that is developing more sustainable, affordable and high-quality carbon

MAKING THE ELECTRODES

In lithium ion batteries conductive carbon additives are mainly used to increase the electrical conductivity of the electrode materials. The electrodes are made of active materials that store and release lithium ions but these materials often have poor electrical conductivity so the addition of carbon improves conductivity, facilitating a more efficient flow of electrons during charging and discharging.

This efficiency is critical for high power output and energy density, key parameters battery performance, which in turn extends battery life.

Lithium-ion battery electrodes are manufactured by casting a slurry on to a metallic current collector. The slurry comprises the active material, conductive carbon additives as well as a binder in a solvent. When the slurry is dried it creates a dry porous electrode which is used to manufacture the lithium ion battery.

The slurry requires mixing with dispersants to produce it. BASF is a major global supplier of water-based and solvent-based dispersants for carbon based conductive materials which improve dispersibility and conductivity as well as binders.

Customers include battery manufacturers, which produce the slurry themselves as well as some suppliers of conductive materials which pre-disperse their conductive materials and supply the slurry to battery manufacturers.

"Our highly conductive additives, including bespoke blended conductive dispersions, are engineered to provide either higher conductivity performance or the same conductivity performance with a lower additive loading" — Matt Wood, Cabot black additives for lithium ion batteries, which will be made in Europe, rather than imported. In the project acetylene black production, including the "wet-beading" step will be scaled-up, while the production of improved, thinner carbon nanotubes, processed from bio-based materials, developed by Arkema, will also be scaled up. These two conductive additives will be combined in a carbon mix dispersion, for markets such as EV batteries.

Nanotubes too

TrimTabs is a start-up seeking further funding for commercializing a clean process for making carbon nanotubes which can be located within regional battery supply chains. Its founder Orbaek White has spent parts of his academic career working with Andrew Barron, a director at the company, and a leading academic authority on nanotechnology and CNTs.

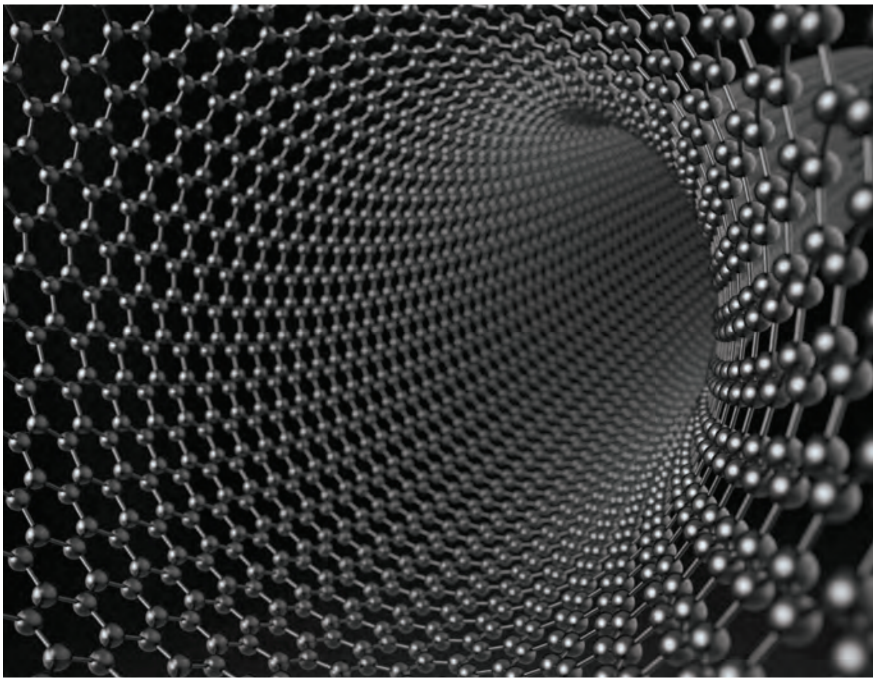
TrimTabs is in the process of setting up a 30m2 prototyping facility at the Brackla Industrial Estate in Bridgend. Both Orbaek White and Barron moved from the US, from MIT and Rice University, respectively to Wales.

At the end of 2023 Orbaek White relocated to Ireland, where he is originally from, to oversee the setting up of TrimTabs' main commercial and production operation in Kildare within a 500m2 facility previously part of a Hewlett Packard clean room and printer manufacturing site.

It will host equipment and processes for scaling up TrimTabs' proprietary technology developed to take a wide variety of waste hydrocarbon feedstocks from plastics, including used binliners and even ostomy bags, as well as solvents, reagents and cleaning products, and turn these into carbon nanotubes, using chemical vapour deposition. The carbon nanotubes can then be made into nanowires.

The company claims it can turn $1 of waste plastic and solvent into $57-worth of carbon nanotubes. It says TrimTabs can produce nanotubes at less than 4% of current retail prices. Conventional manufacturing techniques achieve 1%-2% yield from the carbon input into the process, whereas TrimTabs' technology can achieve 25% yields in the first pass.

TrimTabs' processing technology is modular, with a relatively small footprint allowing for the possibility of producing CNTs at customer sites. "Based on the fact we are using a wider range of feedstocks we predict the ability to make more differentiated CNTs compared to our competitors," Orbaek White says.



TrimTabs claims it can turn $1 of waste plastic and solvent into $57-worth of carbon nanotubes. It says TrimTabs can produce nanotubes at less than 4% of current retail prices.

He has been in contact with battery producers, in the US as well as in Europe. "Some materials used in batteries, such as the graphite anodes in lithium ion devices, are sourced from China so the possibility of a technology that enables the production of critical materials within a manufacturer's own operations is appealing, minimizing risks of supply chain disruptions," he says.

A potential game-changing application TrimTabs has its eye on is the growing market for silicon anodes for lithium ion batteries, which promise longer-range and faster-charging EVs than devices using graphite anodes today.

Silicon has the advantage that it can absorb more lithium ions and also move them across the battery membrane more quickly.

Its promise as the anode material in lithium ion cells led to research in the 1970s, before research into graphite. However, silicon swells and shrinks during charge and discharge leading to anode disintegration and other problems that impact battery life.

Since then, there have been multiple R&D efforts into nano-engineered silicon, some of which are finding their way into the lithium ion battery supply chain. In some of these, carbon is part of the solution.

TrimTabs focus is on making ultralong single walled carbon nanotubes at industrial scale. "Silicon is a terrible conductor, so the ultralong carbon nanotubes can help bridge the silicon, functioning as the conductive network in the battery. The longer the carbon nanotube the greater the conduction network. That is the logic for how TrimTabs can offer a differentiated solution for battery manufacturers," says Orbaek White.

TrimTabs will begin by supplying carbon nanotubes directly to potential customers, which have been third party tested, so that they can make samples and prototypes of products with its materials and provide feedback to help the company further refine the technology.

Orbaek White says: "We will spend the next two years codifying our production process, to fit it into two shipping containers, which can be delivered to customer sites and quickly set up. In this commercial model the customers have the equipment to produce CNTs in sufficient quantities, to their own specifications while TrimTabs keeps the 'recipe' proprietary."

TrimTabs will hold a funding round in early 2024. "Ideally we'd like an industrial partner that can provide funding support but also can bring experience to help support the commercialisation of this technology. A key question potential investor-partners have is whether the technology is scalable and the answer is yes, it is very scalable," he says. ■

Using acetylene black inside lead and lithium batteries is a proven technology, but there are still advances to be made in providing the feedstock, acetylene, writes Sara Verbruggen.

Better processes, better materials

For the past 100 years, most acetylene producers have relied on calcium carbide — limestone and coal — to produce acetylene and hence its derivative, acetylene black.

Even with advancements to the technology, coal-based acetylene and its downstream products remains very carbon-intensive.

Florida-based Transform Materials was founded in 2014 to commercialize a microwave-driven plasma technology to convert hydrocarbons into clean acetylene and hydrogen from different fossil fuel streams, though in future biofuels may also be applicable. All the carbon that goes into the process comes out as acetylene.

In May 2023 an agreement was signed between Transform Materials and Denka for the installation of a plant in Fukuoka, southern Japan, for making acetylene using Transform Materials' technology. This plant is in the design phase for anticipated start up in 2026. Transform Materials will work with Denka's engineers through the plant's installation and its start-up.

"There was lots of data exchange initially, followed by Denka engineers visiting our facilities in Florida to learn how to run and operate the process and to see how acetylene was produced," says Transform Materials CEO Kenn Flessner.

> Acetylene will be relevant to the development of advanced carbons because of its unique carbon-carbon triple bond

As electrification expands globally, demand for acetylene black is forecast to grow 8% annually, for use in EVs, as well as batteries for energy storage for storing renewable energy and also in transmission infrastructure, for insulating high voltage cables. However, the supply of acetylene remains limited.

"We aim to capture the growth. As part of that growth, we can supplant coal-based acetylene so companies can meet their goals to reduce emissions while meeting increasing demand. Acetylene will be relevant to the development of advanced carbons because its unique carbon-carbon triple bond," says Flessner

Transform Materials is courting interest from the advanced, or

“As well as acetylene black being conductive, acetylene opens new pathways to achieve different structures and for companies that are working on different carbon structures rather than just graphite, this appeals to them”

— Kenn Flessner, Transform Materials

CARBON BLACK: ACETYLENE BLACK

(NOT TO BE CONFUSED WITH SOOT)

Carbon black is an inorganic compound that forms from the incomplete combustion of heavy petroleum products. It is an adsorbing agent. There are a few subtypes of carbon black such as acetylene black, channel black, furnace black, lamp black, and thermal black. Heavy petroleum products are useful for its production such as various tars.

Carbon black is (yes) a black powder that is insoluble in water and containing only carbon atoms. All types of carbon black contain chemisorbed oxygen complexes — carboxylic, lactonic, quinonic — and their presence on the surface affects their volatility.

Carbon black is useful as a reinforcing filler for tires and other rubber products. as a colour pigment in paint, plastics, ink, but most importantly it is super-conductive.

Acetylene black is a type of carbon black. It is obtained from an acetylene thermal decomposition process. This is highly purified, and extremely conductive material being important in the production of dry cells, electric power cables, and silicon products.

The high purity of acetylene black, made from gaseous acetylene — which is cleaner and has much fewer impurities — makes it a highly suitable alternative to carbon blacks made from the heavy fuel oils used in the furnace process.

Minimizing metallic impurities and moisture helps reduce reactions that can potentially degrade battery performance and lifespan, while the hydrophobic surface area of acetylene black also plays a role in reducing moisture uptake helping maintain the integrity and efficiency of the battery.

These properties are relevant for both the advanced lead acid battery and lithium ion battery markets.

The high purity of acetylene black, made from gaseous acetylene — which is cleaner and has much fewer impurities — makes it a highly suitable alternative to carbon blacks made from the heavy fuel oils used in the furnace process.

engineered, carbons sector — dominated by a few global players, such as Cabot Corporation, Birla Carbon and Orion.

In addition to the licensing approach used with Denka, Transform Materials is also pursuing a build, own and operate model, where it would deliver a turnkey plant and run it to make acetylene and supply the gas to customers, which is the same model traditionally used by industrial gases businesses.

“One of the challenges companies face is that the structure and the morphology of the carbon produced is critical — this defines what makes the material work in a particular application,” says Flessner.

He says: “We get a lot of interest because the purity of our acetylene is very high. Starting with acetylene and going to advanced carbon structures is a lot cleaner and the materials have more interesting properties compared with other forms of carbon black.

“As well as acetylene black being conductive, acetylene opens new pathways to achieve different structures and for companies that are working on different carbon structures rather than just graphite, this appeals to them.”

The purity of Transform Materials’ acetylene is very high, not only ensuring a cleaner process for synthesizing advanced carbon structures but yielding materials with more interesting properties than other forms of carbon black.

“Interest from producers is around producing new types of carbon structures or replacing, or supplementing, their supply chains in case graphite materials are harder to come by in future.

“Because our process only requires two inputs that are easily accessible it can be produced on site at the point of use minimizing transportation costs and the carbon footprint that would otherwise be required for logistics.

For acetylene black production, the acetylene can be supplied at large scale, to replace calcium carbide methods, allowing producers to decarbonize production right away, like a drop-in process, with minimal disruption.

In other cases where we’re working with companies that are developing new carbon structures, then there is a scale-up process we have to go through. We can still support those companies and hopefully capture that future application.” ■

The automotive industry accounts for 14% of annual global CO^2 emissions, which means that over the next few decades improving fuel efficiency of internal combustion engine (ICE) will have a bigger impact on reducing oil consumption — therefore CO^2 emissions — ahead of EV mass adoption.

Using carbon to re-engineer lead's negative electrode

ArcActive was set up over a decade ago to develop a continuous process for arc-treating carbon fibre, patented as ArcCarbon. With this technology, the New Zealand-headquartered company has re-engineered the negative electrode of the lead battery to replace the lead grid with a non-woven carbon fibre fabric, called AACarbon, to improve DCA.

The company is commercializing its technology with lead acid battery makers. "We have a package of IP, spanning method of manufacture, supply chain, performance and business case, but it also involves some degree of optimization at each battery maker," says CEO Stuart McKenzie.

To incorporate the technology into the lead acid battery production, two changes in processes are required. These are the lug-making, which is attaching a lead strip to the carbon fibre fabric substrate, and pasting. Once pasted, ArcActive electrodes move through the rest of the manufacturing process without changes to equipment.

The Worldwide Harmonized Light Vehicle Test Procedure (WLTP) laboratory test is used to measure fuel consumption and CO^2 emissions from passenger cars. The key for DCA is the amount of CO^2 that can be saved using the battery. Conventional lead acid batteries save 1g CO^2/km. ArcActive saves 3.7g CO^2/km based upon the WLTP Type Approval drive cycle.

By improving DCA in the lead acid battery, ArcCarbon can reduce CO^2 emissions by around 3% per vehicle, at minimal additional cost to the manufacturer or the consumer.

"Each gram saved would typically require \$50/g, so ArcActive batteries are highly economic for CO^2 reduction," says McKenzie. "Performance can be enhanced by using additives, but ArcActive is not focused on this aspect. There is little advantage in improving DCA further than that already achieved."

"First formal automotive original equipment manufacturer trials begin in Q1 2024. Good progress is being made in key regional markets, but the regulatory settings of the US are particularly well suited for ArcActive's technology," he says. ■

THE ARCACTIVE ELECTRODE

ArcActive says its drop-in replacement electrode is durable enough to survive conventional manufacturing assembly processes, such as enveloping, CoS and cell dropping.

It starts with the ArcActive Grid, consisting of active material retained within a three dimensional carbon fibre matrix. A leady oxide paste is impregnated into the carbon fibre matrix in a continuous process to produce a durable composite electrode.

For AGM battery production in particular the electrode can be produced to application relevant thicknesses in the range 1.2mm-2.5 mm, with thickness tolerances of 50 µm.

ArcActive's electrodes can help maximize 12V batteries' capture of recuperated energy during braking events, with the stored energy used to power vehicle electrical loads. This reduces the fuelled alternator load, saving fuel and reducing CO^2 emissions. In a higher DCA it saves 4g CO^2/km, compared with 1g CO^2/km in a conventional DCA.

CO^2 or fuel economy certification is regionally dependant and is typically assessed using a vehicle dynamometer, executing a predefined drive cycle, or simulated trip.

The Worldwide Harmonized Light Vehicle Test Procedure (WLTP) defines a 30 minute drive cycle used in many regions, including India and China for vehicle homologation.

Examples of WLTP based test protocols include WLTD and WLT8 and in the latter DCA performance based on a battery incorporating ArcActive's electrodes is close to maximizing the performance of the recouperation system, assuming a 200A limit from the alternator, and 70Ah battery.

"The first formal automotive OEM trials begin this quarter (2024). Good progress is being made in key regional markets, but the regulatory settings of the US are particularly well suited for ArcActive's technology,"

— Stuart McKenzie

Pat Moseley outlines our progressive development of the understanding of the composition and structure of the materials in the positive active mass.

Non-stoichiometry and the hunt for hydrogen in the PAM of the lead battery

The discharge reaction of the active material on the positive plate of the lead–acid battery is generally summarized by the equation

$$PbO_2 + 3H^+ + HSO_4^- + 2e^- \rightarrow PbSO_4 + 2H_2O \qquad (1)$$

However, over the decades, there has been much speculation that the simple formula written here for lead dioxide does not tell the whole story and that the actual positive active material might be prone to some variability in composition or structural order that could influence its effectiveness in providing discharge capacity.

There are two separate crystalline forms of lead dioxide; there is general agreement that α-PbO_2 is orthorhombic while β-PbO_2 has been ascribed to the tetragonal rutile structure in all studies but one.

Positive plates fresh from the manufacturing process generally contain a small proportion of the α-form but are predominantly composed of β-PbO_2. Repeated deep-cycling results in the elimination of the α-form so that most of the discharge capacity over the life of a cycled battery involves only the β-variant.

The investigation of the active material on the positive plate of the lead–acid battery has continued for some 50 years. A full range of analytical and microanalytical techniques has been deployed in the pursuit of a clear understanding of this topic.

The sequence of the formulae shown in bold boxed text at the end of some of the following dated paragraphs traces the progressive development of the understanding of the composition and structure of the materials in the positive active mass (PAM).

1973. Two German scientists [1] acknowledging the variable stoichiometry, proposed the formula $PbO_{2-x}.H_2O$.

A team from the naval research laboratory in Washington DC [2] reported the results of NMR (nuclear magnetic resonance) and mass spectroscopic measurements and concluded that the properties of lead dioxide depend on the method with which it is prepared. If the material is formed electrochemically, as in the battery, then the product includes an amorphous component containing hydrogen whereas if it is prepared by a chemical route (eg a commercially supplied reagent) it contains no such component. The hydrogen in the electrochemical form was found to be present in two distinct configurations.

The team went on to suggest that the presence of hydrogen is essential for the material to be able to provide discharge capacity in a lead–acid cell. In other words, they proposed that the chemically-prepared, hydrogen-free, oxide is electrochemically inactive.

Chemically-prepared: PbO_2
Electrochemically-prepared: PbO_2H_x.

Thus, the location and function of hydrogen in the P.A.M became an important focus of research effort. The hunt for the lightest of all elements (and the one with the weakest X-ray scattering power) within the PAM has proved to be a far from simple task.

1982. A neutron diffraction investigation of the positive active material taken from plates cycled in both H_2SO_4 and D_2SO_4 [3] confirmed the presence of hydrogen at an overall concentration of 0.21 per formula unit. Rietveld refinement of the data was consistent with the β-PbO_2 structure, P42/mnm.

Unexpectedly the structure was found to have 3%-5% of vacancies on the Pb sites and it was concluded that at least some of the hydrogen is incorporated within the crystal structure thus retaining the possibility of charge-balance.

The hydrogen atom sites were not established however, perhaps because their site occupancy may be as low as a few percent. The balance of the 0.21 atom of hydrogen may reside in an amorphous layer on crystal surfaces.

A separate neutron diffraction study, this time in Australia [4] confirmed that the structure of the crystalline part of the positive mass is around 5% lead-deficient and provided evidence that some 30% of the active mass is amorphous. Significantly the amount of amorphous material was seen to decrease from an initial level of 33% to below 20% at battery failure.

Chemically-prepared: $PbO_{\sim 2}$

Electrochemically-prepared: Overall $H_{0.21}$:

70% crystalline ($Pb_{\sim 0.95}O_2$)
30% amorphous

1983: A study at the Atomic Energy Research Establishment at Harwell and the University of Oxford [5] provided chemical analysis evidence that only 91% of the lead in the electrochemically-prepared material is in the 4-valent oxidation state. The balance, which is expected to be 2-valent, is most likely to be confined to the amorphous matter. The lead in the chemically-prepared oxide is all 4-valent.

High resolution transmission electron microscopy provided both reciprocal space (diffraction) and real space (lattice image) evidence to illustrate the presence of structural defects and planar faulting within crystals of electrochemically-formed lead dioxide.

Chemically-prepared: $PbO_{\sim 2}$

Electrochemically-prepared: Overall $H_{0.21}$:

70% crystalline ($Pb_{\sim 0.95}O_2$) all Pb^{IV}
30% amorphous in which 2/3 Pb^{IV} and 1/3 Pb^{II}

1985. The team at CSIRO in Melbourne then proposed [6] that hydrogen could be incorporated in the PAM via a mechanism that involves surface hydrolysis during particle growth. Such a mechanism could account for the high levels of hydrogen observed in material taken from positive battery plates and would be consistent with the difficulty experienced at that time in locating hydrogen in the crystalline part of the PAM and with the very low level of hydrogen associated with reagent grade lead dioxide.

1987. A second NMR study, this time by the Australian team [7[, was restricted by experimental limitations to the surface and near-surface regions of particles but was nevertheless able to demonstrate that at least two distinct forms of hydrogen are present in the battery positive active material. The spectrum recorded for electrochemical β-PbO_2 resembled that for the stoichiometric oxy-hydroxide $Pb_3O_2(OH)_2$.

1989. Professor Detchko Pavlov and his group in Bulgaria turned to X-ray photoelectron spectroscopy (XPS) to study the near-surface regions of crystals of lead dioxide in the charged PAM [8]. They de-convoluted the O1s signal into the components attributable to oxygen bound to lead and that bound to hydrogen.

A comparison of the surface areas of the two constituent peaks indicated that more than 30% of the oxygen in the material that was sampled by the beam was attached to hydrogen. This finding may indicate 0.6 H per Pb in the surface layer, or even more if the thickness of the surface layer is less than the penetration depth of the XPS probe (a few tens of Å).

Chemically-prepared: $PbO_{\sim 2}$

Electrochemically-prepared: Overall $H_{0.21}$:

70% crystalline ($Pb_{\sim 0.95}O_2$) all Pb^{IV} and $H_{<0.21}$
30% amorphous in which 2/3 Pb^{IV} . 1/3 Pb^{II} and $H_{>0.30}$

2001. Collaborators from the University of Chicago and the Argonne National Laboratory carried out a neutron diffraction study [9] of two sets of materials from positive battery plates, one that was cycled with charging at a conventional rate and the other that was cycled with high rate charging. The results are shown in Figure 1.

In both cases the crystalline component was found to be lead deficient with departure from stoichiometry greatest early in life and decreasing through the first 250 cycles.

At that point the battery with conventional charging

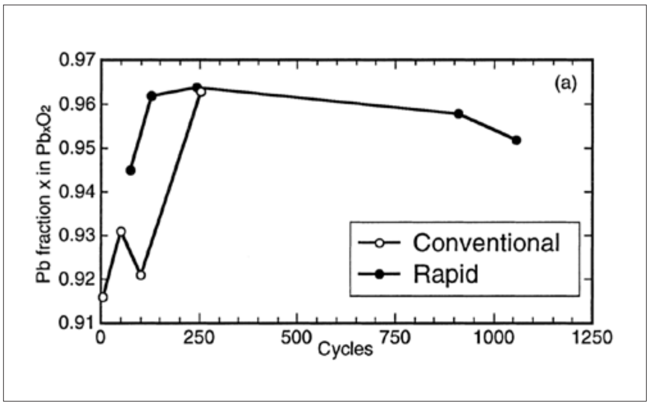


Figure 1. Pb stoichiometry in β lead dioxide at intervals during a programme of discharge/recharge cycling for 2 samples, one charged at conventional rate and the other exposed to rapid charging [9].

failed while the faster-charged battery continued to operate for a further 750 cycles. The nine neutron diffraction data sets were studied using difference Fourier techniques and on each map a negative peak was found that could be attributed to hydrogen because protium has a negative scattering length for neutrons. The site identified has eight symmetry-related equivalent positions (Figure 2).

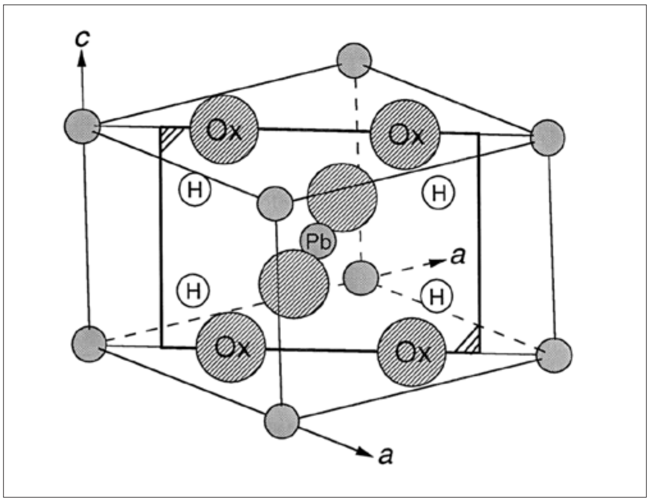


Figure 2. Atomic positions in one half of a unit cell of β-PbO2 grown electrochemically. The hydrogen sites are only sparsely occupied [9].

If the hydrogen content is related to the extent of the lead-deficiency the H-site occupancy must be very small and it is perhaps not surprising that it was not possible to refine the H-site parameters. Future studies using deuterated materials may be able to take the refinement forward.

2010. A new theoretical study [10] stressed the importance of incorporation of hydrogen into the positive active mass and anticipated that the presence of hydrogen exercised a powerful influence on the short-term behaviour of the electrode and on its pseudo-capacitive properties. Proton transport through the solid phase was proposed as a key element of the model for the first time.

2011. In a thorough theoretical and neutron diffraction study at the University of Oxford [11} it was found that β-PbO_2 is an n-type semiconductor with a band gap of ~0.2 eV and that the electron source for its conductivity is an oxygen deficiency that was measured at 1.6%. The neutron diffraction study was carried out on a pure commercially-supplied sample and is further confirmation of the difference between chemically- and electrochemically-prepared lead dioxide.

Chemically-prepared: $PbO_{1.968}$

Electrochemically-prepared: Overall $H_{0.21}$:

70% crystalline ($Pb_{\sim 0.95}O_2$) all Pb^{IV}
30% amorphous in which 2/3 Pb^{IV} and 1/3 Pb^{II}

2021. A new powder diffraction study [12] appears to contest the conclusion of all earlier neutron diffraction studies that β-PbO_2 is tetragonal. Distortion of some of the diffraction peak profiles, together with first principled density function theory calculations, led the authors to conclude that the structure is actually orthorhombic.

No mention is made in the paper of departure from stoichiometry and, since the samples studied were commercially-supplied materials, the study does not shed any additional light on the function of hydrogen in battery positive material.

A clearer picture

The agglomeration of results from the diverse range of analytical and microanalytical techniques that have been directed at the study of hydrogen in the PAM of the lead–acid battery have provided a clearer image of the composition and structure of the materials involved than was available 50 years ago. There is good evidence that lead dioxide prepared by chemical methods is fully crystalline but oxygen-deficient. Positive active material in the battery. however, is predominantly crystalline but is accompanied by an amorphous component that probably exists as a layer on exposed crystalline surfaces .

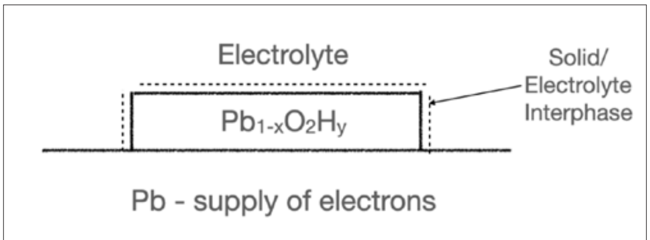


Figure 3. Schematic illustration of the relative locations of the materials that are present in the charged active mass on the positive plate of the lead–acid battery. The amorphous layer on the one crystal of oxide that is shown is labelled as a 'solid/electrolyte interphase'.

The crystalline part is quite distinct from the chemically prepared oxide as it is lead-deficient and contains hydrogen atoms at on sparsely occupied crystal sites. The amorphous layer contains Pb^{II}, Pb^{IV} and hydrogen. This composition is consistent with Pavlov's suggestion [13] that the discharge reaction (equation 1, above) takes place in three stages: a hydrolysis reaction followed by oxidation and then a reaction with acid, as in reactions (2), (3) and (4).

Over the years there has been much speculation that the simple formula used to explain the basic lead dioxide reaction does not tell the whole story

This sequence of reactions is seen as taking place within the volume of the amorphous material that forms a layer on the crystals of lead dioxide as shown in Figure 3.

$$PbO_2 + H_2O \rightarrow PbO(OH)_2 \quad (2)$$

$$PbO(OH)_2 + 2H^+ + 2e^- \rightarrow Pb(OH)_2 + H_2O \quad (3)$$

$$Pb(OH)_2 + H_2SO_4 \rightarrow Pb^{2+} + SO_4^{2-} + 2H_2O \quad (4)$$

Reaction (4) will be followed by precipitation of lead sulfate in accordance with the widely accepted "solution/precipitation" model.

Perhaps future research will be able to provide firmer information about the hydrogen sites in the crystal structure by investigating deuterated materials in greater depth. It may then prove possible to establish whether or not the variable Pb-deficiency shown in Figure 1 is a reflection of variable hydrogen content. ■

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The line can be configured at varying layout and utility requirements. BATEK battery palletizing solutions and data collection & monitoring system can be integrated into the supply.

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The line is incorporated with several systems for enhancing the reliability of the processing.

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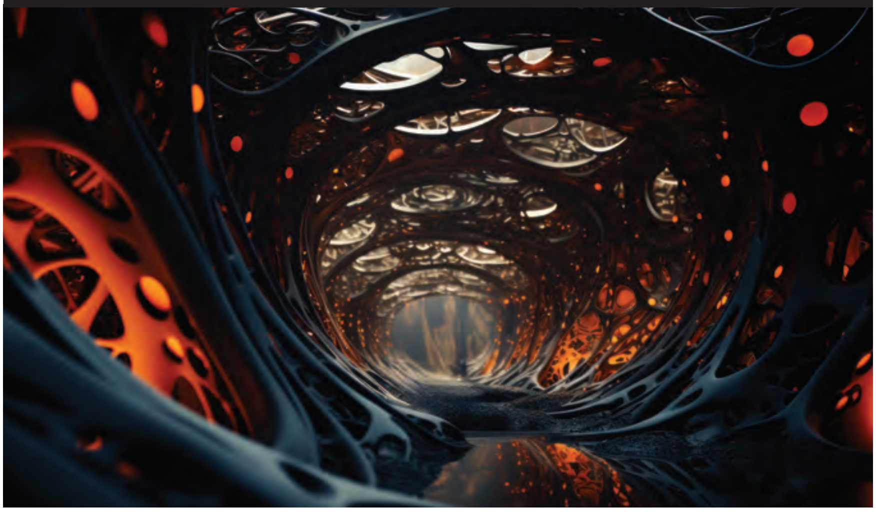
The line is supplied with the well appreciated BATEK after-sales support.

Each December *Batteries International* asks leading figures in the battery and energy storage market for their take on the year gone by and the year ahead.

Navigating the future as a year of darkness and chaos descends



A grim headline reflection of what looks like a turbulent year ahead. But that's not the thrust of this section of *Batteries International*. Yes, there are real, chaotic and unpredictable times ahead but oddly enough the energy storage industry — from batteries that start cars or power cars to huge assemblies of megawatt hour installations — looks set to thrive.

That said the battery landscape of the year ahead is unlikely to resemble that of previous years.

For the reason to this, simply look around at the military, economic and political changes that lie ahead.

From a military perspective, there are two wars that immediately threaten the West's security of energy supply. Most of the shock-effects of the Russian war on the Ukraine were factored into the price of energy more than a year ago. But the likelihood of the US and Europe curtailing financial support to Ukraine could end in its defeat.

Meanwhile the seemingly heartless war of Israel again Palestine continues. Israel's justification for aggression is very real but its relentless bombing of Gaza is giving its regional neighbours, particularly Yemeni Houthis and the Hezbollah in Lebanon — both proxies for Iranian foreign policy — reason for trying to escalate the conflict.

A third potential war could dwarf these two if China chose 2024 as the year to annex (or re-annex) Taiwan. That would put the whole world on a war footing.

The US, and Europe to a lesser extent, are already in the early rounds of a trade war with China which looks likely to be a protracted one.

Where it concerns the battery industry such a commercial war is manifestly unjust. The Chinese saw the future clearly more than a decade ago and prepared — cleverly, and for the greater part, totally legally — for an eventual conquest of Europe's and the North American automotive industry. They bought up the resources and developed the technology.

Easily a decade ago BMW, for example, had an almost permanent team stationed in Ningde where CATL was ramping up production at an extraordinary rate. Apple too did the same, if in a more covert manner. And why Ningde? There was nothing comparable in Europe or the US.

Is it unfair for China to be, as this issue reports, to be almost a decade ahead in recycling lithium batteries? Or mass production of electric vehicles? Amid claims that these new Chinese EVs are subsidized by the government, one should also realise that their production costs are far lower.

And the last wild card is going to be a political one. Roughly a third of the planet across almost 60 nations will be holding general or state elections. For the major powers — India, Russia, the UK, Europe via the EU — some change will be inevitable and some totally unpredictable.

The Indian result is almost certainly going to be the re-election of Narendra Modi. Even if this were not to happen, Indian energy policy will continue on track with its Made in India slogan and surge into renewables and lithium storage.

For Russia, it's unlikely that the presidential elections will change the existing status quo and the country will continue to plough its solitary way as it prosecutes the war in the Ukraine.

For the UK, energy policy will broadly remain the same but there is a growing likelihood that the incoming Labour government (as seems likely) may soften some of its deadlines.

But the crunch elections will be the EU parliamentary ones to be held in June.

As the editorial in this issue explains in greater detail, this is more than likely to bring in a general shift to the political right and an increased likelihood that rule-making by the European Commission will be curtailed, thwarted and delayed.

The biggest wild card is certainly that happening in the US. The seemingly improbable survival of Donald Trump as a political hero makes him a more-than-likely presidential nominee going to fight it out with incumbent US president Biden.

Talking to US battery industry heads, the selection of either is rated 50:50, they simply say if Biden stays in power, US energy policy won't change. If Trump gets in, it will enormously. The battery business with its intimate connections with renewable energy thinking will be less in favour while petrochemicals return to favour.

Interesting times for us all. ■

Embracing the rapidity of change

Chris Pruitt, president and CEO, East Penn Manufacturing

The energy storage community is one that is continuously changing and evolving, and one could say quite confidently at a pace that's more rapid than most.

Whether we see change as for the better or for the worse, we must all face the fact that it can't be ignored and there is no way to properly grow without it.

For those of us within this community, how well we handle these changes and collectively rise to the challenge will make a big difference in our future roles.

It will be the difference between us being an even stronger and more relevant as complete solution providers or being dangerously discounted in key areas and underserving global energy storage needs.

Right now, we are facing a world hungry for energy like never before. It's going to take all of us working together to find solutions to help optimize it, conserve it, securely supply it, and sustainably store it.

Some in the marketplace would have us focus our complete attention on only one type of energy storage solution. Our world needs us to think differently. We need to challenge ourselves to broaden our horizons and work toward building relationships between technological offerings and their individual strengths so that we can meet exponentially growing energy storage needs that serve the greater good.

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Fortunately for all of us, the lead battery industry has paved the way in establishing an infrastructure that supports the essential power necessary for today's need but also one that will serve us well for the energy landscape of tomorrow.

This industry's highly successful circular economy needs to serve as a model so that other technologies can ensure that all our energy storage solutions have a sustainable plan for closed loop recycling that will properly support and protect our resources for future generations. ■

The irresistible drive into further automation

Mark Gardiner, TBS Engineering

In this era of rapidly advancing technologies many of which require increased performance in energy storage, the lead battery industry must continue its commitment to product development, automated production, safety and sustainability.

The move to advanced automation with higher accuracy, productivity and improved manufacturing processes significantly enhances operating efficiencies and will need to be embraced to ensure competitiveness. This aligns with moving operators away from exposure points as we strive to meet and beat the latest health and safety regulations.

Our industry along with many others is grappling with the shortage of skilled personnel, exacerbated by factors such as skill gaps, generational expectations and retirements. To bridge this gap implementing new technologies such as software designed for predictive maintenance preventing component failure and maximizing operating efficiencies will be imperative.

> Our industry along with many others is grappling with the shortage of skilled personnel, exacerbated by factors such as skill gaps, generational expectations and retirements

In response to the workforce challenges it is key that we have the confidence to invest in these technologies to assure productivity continues to improve and product consistency drives improving product performance.

Despite recognising the significance of technology, manufacturers across many sectors have been found to experience a form of 'technology paralysis' — the inability to decide between solutions. Suppliers need to assist manufacturers in choosing the right technology, enabling them to seize the future with Smart Manufacturing.

By solving the challenges we have today we are giving ourselves the ability to ensure our industries future and our futures in this great industry. ■

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OE adoption of premium batteries fuels demand in US automotive aftermarket

Mike Judd, CEO and president, Stryten Energy

We are seeing growth in the demand for automotive battery technologies such as enhanced flooded batteries and absorbed glass, as vehicles become more and more sophisticated. Half of new vehicles produced in model year 2021 included start-stop technology.

Advanced safety features and integrated infotainment are now standard in passenger vehicles that require higher performing batteries.

European automobile manufacturers relied heavily on AGM solutions to power start-stop vehicles until 2008, when a shift began to take place, resulting in what is now an even division between AGM and EFB. Today, approximately half of all vehicles in Europe use AGM batteries and half use EFB, but EFB is taking the market lead.

Since the US automotive industry typically follows its European counterparts by a decade or so, we are now seeing the expected utilization of EFB technology by US automotive manufacturers.

Another factor driving growth for advanced lead batteries is the fact that consumers are keeping their cars longer. With the average vehicle age now reaching over 12 years, there is more demand for car battery replacements over the life of the vehicle.

Added to that, consumers have seen a decrease in their vehicle's battery life because of the increased power demands of advanced safety features and electronic conveniences. The vehicle's battery must be able to continuously power all the electronic features simultaneously without suffering from cycling-related failures.

Today there is a wide range of lead battery options available to consumers, including standard flooded batteries, premium flooded batteries, and advanced lead batteries such as EFB and AGM. However, not all lead batteries are built with the same capabilities.

Conventional flooded batteries are forecasted to continue to decline in OE use, with the increased adoption of both AGM and EFB by auto manufacturers. Manufacturers such as Ford, Nissan, Toyota, Volkswagen and others are shifting to using EFB in multiple vehicle types to meet the performance demands of numerous computerized functions.

As these advanced lead batteries become the standard OE choice, US battery manufacturers and aftermarket retailers will need to provide a range of premium replacement battery options for consumers. Because of its increased battery life, high heat tolerance, durability and greater energy availability, EFB will continue to grow its share of the premium flooded battery market in North America in parallel with the increase in AGM demand. ■

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Technology that works straight from the box

Doug Bornas, chairman, MAC Engineering

During my time in the battery industry, I've seen new and different challenges springing up every year — and 2024 will be no different. In the age of consolidation where big companies seem to get bigger and smaller companies struggle to survive, innovation and new technologies will be the key to future success.

For MAC Engineering, we have to continually strive to stay up with what the customers need and want. Everything today is robotics, vision systems — basically multi-functional machines that require few to no operators. We have to find ways to make standard processes better, products better and the end result better and cleaner. So many challenges!

Customers don't have as much time to spend testing due to high demands and a labour force that is questionable on any given day. That means machine suppliers such as MAC have to produce cutting edge technology that is ready from day one — a daunting task to say the least. The challenges are real and we all have to take them seriously to survive and thrive.

With constant threats to the lead acid battery industry, from lithium to bi-polar to everything else, these technologies will continue to threaten our industry. We all have to be ready when the next great thing comes around as none of us will want to miss it.

Scary, difficult, exciting, challenging, these are the things we all get to look forward to in 2024. ■

We have to find ways to make standard processes better, products better and the end result better and cleaner.

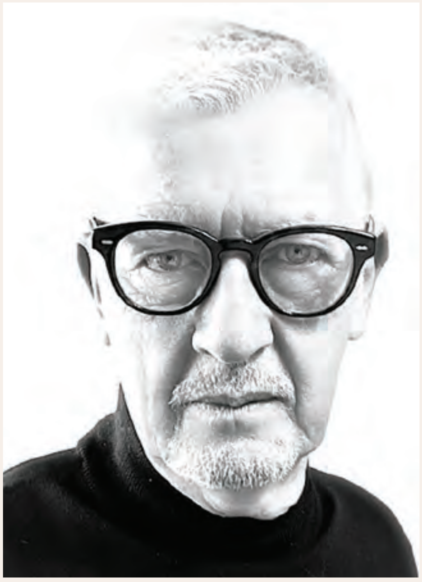
Life after globalization

Mike Dunckley, CEO, Catalyst Solutions, considers how the dual impacts of rapid technological change and international competition will affect the business.

At a macro level the era of globalization seems to have come and gone. It was a giant dream for humanity but events such as climate, politics, shipping costs and much more are drawing us back into older patterns of doing business.

North America and Europe — at the highest levels of industry — are trying to rebuild much of the manufacturing bases that they gave away to Asia.

For the battery industry the implications are considerable. Asia has grabbed the new battery industry opportunity and stormed ahead leaving North America (primarily the US) and Europe behind.



Like all new market opportunities there is an element of hype in these projections. Market analysts', specialists and the media in general all talk up the numbers. Every time I see battery forecasts the numbers seem to have grown to even higher than the previous one.

But now the US and Europe have woken up and are engaged in a catch-up and regional independence and security. In Europe we have a planned lithium capacity of 500GWh, and similar plans in the US. This eventual capacity is being directed to meet the growing demand for electric vehicles and energy storage.

Like all new market opportunities there is an element of hype. Market analysts', specialists and the media in general all talk up the numbers.

Every time I see battery forecasts the numbers seem to have grown to even higher than the previous one. As an old and hopefully pragmatic battery specialist and who has sold batteries as well as made plans, I wonder who are these customers and what will they pay.

In the end everything comes down to supply and demand. Too much capacity and the customer is in control, too little capacity and there is leverage for higher prices.

This said the battery industry has never been more exciting or different. It's now a place for young people to get involved and play a major part. Batteries have always played a major part in enabling the modern world, now they will play a critical part in what will be a societal rescue mission. As the well-worn phrase says, the future is electric.

And a global perspective! China plays a major part in the 'new' battery world. The Chinese government has encouraged and aided national investment both in batteries and electric vehicles. But the country will have too much capacity — sooner or later will need to consolidate its industry into a few major companies.

There are already some clear leaders such as CATL and BYD. We also know that the country has locked up much of the material supply chain.

India is emerging. The economists predict that it will be the next major area as the society wakes up and releases its pent-up potential. There are many opportunities in India though the government continues to create

The Chinese government has encouraged and aided national investment both in batteries and electric vehicles. But the country is starting to have too much capacity — sooner or later it will need to consolidate its industry into a few major companies

entry barriers for new entrants to the market. However, as India grows it will start to market its product aggressively in new other regions as well as feed domestic growth.

Europe, my area, is a complex one to understand. As I always point out to people who don't live in the region, we are many countries and many different languages and all are in the middle of an energy and security crisis.

These things represent complexity, but also opportunities. Europe is also taking a lead in the sustainable economy and in battery terms will mean material sustainability and stronger enforcement on recycling. These new challenges are complex for the industry but good for society in the long term.

2024 will be an election year in the US. The Biden administration has been positive in encouraging domestic initiatives and new funding programs. Business will move carefully throughout the year, waiting to see which way the country will vote.

Americans as a nation have always been progressive, entrepreneurial and resilient. As a society they are early adopters of new ideas such as EVs. Despite the political turmoil the power of the US is in its great innovation and will continue to be a major driver of market development including new battery technology ideas.

It's going to be a very interesting year. ■

Navigating the challenges for cost-effective energy storage systems in India

Amlan Kanti Das, senior VP, manufacturing, Luminous Power Technologies

India's aim to achieving net-zero emissions by 2070, along with a target of 500GW in renewable energy capacity, including 4 GWh of Battery Energy Storage Systems, signals a critical energy transition.

The goal of deriving 50% of power from renewables by 2030 to address power infrequency further highlights the nation's commitment to sustainable energy practices. Specifically, residential and commercial rooftop solar PV, along with BESS, will continue to be the major avenues contributing to India's mission of becoming "carbon-free," demanding a laser focus on cost-effective solutions.

However, the pursuit of cost-effective energy storage systems encounters multifaceted challenges, necessitating strategic interventions and enhanced technical expertise.

A critical concern lies in the current lack of comprehensive technical knowhow, underscoring the need for intensified research to unlock the full potential of existing ESS technologies in the battery segment—the key element of ESS. Dedicated research on advanced cell chemistry is essential to bridge the total cost of ownership gap between Li-Ion and lead acid battery chemistries whereas advanced lead acid batteries, for instance, hold promise in cost-effectiveness.

Raw material availability remains a central factor influencing the cost-effectiveness of energy storage technologies. Addressing this challenge requires a twofold approach: researching advanced materials and minerals abundantly available in nature and ensuring their long-term sustainability.

The pursuit of advanced materials is integral to achieving a substantial reduction in LCOS, aiming to reach the ambitious target taken by the government of Rs5.5 to Rs6.5 [roughly $0.07 to $0.08] per kWh.

Government-backed research initiatives and collaborations with industry experts become instrumental in securing a stable and cost-effective supply chain for raw materials. This holistic approach not only fortifies resource availability but also propels India towards self-reliance in the energy storage sector.

Government initiatives, including Viability Gap Funding, play an important role in overcoming financial barriers and expediting the widespread adoption of ESS technologies. The significant allocation of Rs3,760 crore emphasizes the government's commitment to fostering innovation and viability within the sector.

Complementary to this, Production-Linked Incentive (PLI) schemes and targeted investments act as catalysts for industry growth, stimulating economic viability and positioning India as a formidable player in the global energy storage landscape.

The path to cost-effective energy storage in India relies on the synergy of technical expertise, government support, and ongoing research. By prioritizing these pillars, India can strengthen its global leadership in renewable energy integration, securing a sustainable and economically viable future.

Luminous has embarked on the journey to achieve milestones by partnering Indian and international research firms, as well as emerging start=ups focused on novel materials. This collaboration aims to explore advanced and alternative cell chemistries, enhance Lead Acid battery technology, and strengthen existing capabilities in the BESS segment. ■

Political uncertainties ahead

Andy Bush, head, International Lead Association

One outcome of a turbulent 2023 is the desire of nations and businesses for greater security and economic stability as the impact of multiple issues and events take their toll.

The year ahead will see changes in the political weather in important markets, including the US and Europe, where elections will both discourse and have an impact on economic and social policy.

Despite the continuing insecurity and uncertainty, the challenge to accelerate the transition to a low carbon future remains a common priority, most recently set out at the COP28 climate talks which established a clear mandate to move away from fossil fuels in favour of more sustainable energy solutions.

All of which should strengthen support for industries that can offer secure supply chains, reliable manufacturing capabilities, plentiful and sustainable raw materials, and a commitment to innovation and employment.

Our industry and the products and applications we support tick these boxes and must be recognised as strategically important — part of an industrial infrastructure that acts as a foundation for any successful economy.

This year we have an opportunity to get these messages across to decision-makers from Brussels to Washington DC, ensuring a much greater appreciation of the true value of the lead and lead battery value chains, from our manufacturing capability, to our circular economy credentials; and from our commitment to innovation in battery research, to our contribution to achieving net zero ambitions.

And as a global industry we will continue to ensure we are aligned with efforts to promote sustainability and material stewardship in all markets — continuing the drive for greater responsibility, higher standards and more consistency in regulatory enforcement. ■

Balancing objectives and market dynamics

Celal Saricam, managing director, Batek Makina

We have been making efforts, ever increasingly, to explore how best the industry can transform itself into the one that offers a much better performing yet widely applicable energy storage technology.

Meanwhile, the cyclical headwinds that expose a threat to our strategies for complying with the ongoing evolution are becoming much more intolerable than ever and draining our resources. Therefore, it turns out to be essential that we should establish a well-adjusted balance between industrial objectives and market dynamics.

"Hybrid global markets" would be the best term for the prevailing order accelerated by the experience lived with the last coronavirus pandemic. On one side of the world, risks that augmented with the supply chain disruptions, changes in perception of free trade policies and geopolitical tensions made it much more realistic to revisit the efficiency of consolidated manufacturing.

However, deteriorations in manufacturing factors — especially in labour, energy and logistics, not to mention hikes in the cost of investment and land — oblige decision-makers to find better economies of scale to avoid shrinkage of the margins.

This eventually shall pave the way for a strategic consolidation. To put it into another word, market forces both for consolidation and fragmentation shall coexist for a certain period. Meanwhile, shifts in manufacturing locations are likely to accompany the aforesaid trend across the industries. The complexities arising from the web of factors will be on the top agenda of the executives who strive to create a brilliant future for their companies.

The developments anticipated in the lead battery are expected to accelerate investments in advanced manufacturing technologies.

Some conventional manufacturing systems, for instance, will have flaws in compatibility with the handling of upcoming battery plates.

Also keeping in mind the challenges emanating from external factors and eventual implications for automation requirements, it would not be a flimsy forecast to have a steady equipment business in the coming years.

Organizations with higher competence in perceiving the path of developments in technologies, and with much robust resilience in aligning themselves with the dynamism of the markets shall be better positioned to collect the benefits. ■

Need for a paradigm shift by politicians and regulators

Julian Gerstner, head of storage EMEA, BayWa re

In 2024, we expect positive sentiment around storage solutions to grow and, as a result, their increased development around the world. Currently, they offer the opportunity to bring stability and flexibility not just to the electricity grid, but to the energy market that ebbs and flows with unpredictable world events and varying market prices.

At times of low demand, they hold back the electricity so that it can be released again at times of high energy demand — reducing strain on the grid and at the long-term helping to reduce costs for end-users. Furthermore, storage systems also alleviate redispatch costs and reduce curtailment of wind and solar farms.

To fully take advantage of the opportunity storage presents, there are several challenges we must look to address this year.

First, we urgently need a paradigm shift in the political and regulator community on every level to acknowledge the importance of storage. A key component to this is increasing the number of studies emphasizing the cost-benefits and flexibility advantages of storage systems — directed especially to political decision makers.

We also need political regulation to grant storage systems priority access to the grid and create a market environment that offers ancillary services to make it a more economically attractive venture. The EU regulations in the RED III, as well as the planned approval of the new Energy Market Design, are steps in the right direction.

Storage is a stable, sustainable all-rounder and, simply put, the successful energy transition depends on it. This is why there must be tangible progress made in 2024, from regulators to communities to storage operators, so that together we can take advantage of the benefits storage has to offer. ■

A key component is increasing the number of studies emphasizing the cost-benefits and flexibility advantages of storage systems — directed especially to political decision makers.

More battery storage capacity than ever had been imagined

Scott Fink, president Sorfin Yoshimura

In 2023, I personally visited almost 20 countries and most of our Sorfin Yoshimura organization reengaged the world openly for the first time since the pandemic. We noticed that the world has changed drastically since 2020; geopolitically, economically, and socially. In addition, changes to our industry have also been profound during the last couple of years.

Pre-pandemic many industry colleagues worried about the future of lead-acid batteries in the face of new chemistries that perhaps more specifically addressed the performance requirements different battery applications will require.

Now, it seems to be more widely understood, that although there will be some cannibalization, most acknowledge that a truly electrified world has space for all battery chemistries. We are positioning ourselves for a future which requires more energy storage capacity than ever imagined.

That is an opportunity for lead-acid, lithium, sodium, zinc, flow, and other battery types that can be mass produced economically and sustainably.

Looking forward into 2024, we are overall quite optimistic and grateful to be supporting energy storage as the world electrifies. However, we remain targeted in our approach because the world is increasingly fragmented. We see significant opportunities in some areas while other areas remain stagnant.

To illustrate this point, look at the divergence in AGM battery demand in North America and Europe as compared to softening demand for flooded batteries. We are also seeing demand-driven growth opportunities in South Asia, India, the Middle East, and Africa while most of Latin America and SE Asia are under pressure and growth potential is minimal.

A regionalized world is replacing the global world that has characterized most of the last 20-30 years. This is having a tremendous impact on supply chains.

A regionalized world is replacing the global world that has characterized most of the last 20-30 years. This is having a tremendous impact on supply chains. Transitioning to a regionalized world has both challenges and opportunities which must be carefully watched.

The economic impact of higher interest rates in most of the world complicates new industry related development and that can slow the pace of penetration into the mainstream.

Our analysis was already very bullish about lead-acid but this element can support lead acid staying in a leadership position even longer than originally anticipated. ■

Staffing to be a future challenge as scale of investments sky-rises

Adam Moore, CEO, Event Partners

The battery industry of today is very different from when I launched The Battery Show for Smarter Shows with Steve Bryan in 2010.

In the US, lead acid manufacturing was dominant after a period of consolidation and talk of potential benefits (and threats) of the perceived boom in automotive applications for lithium ion was at a tentative stage.

EV joint ventures such as Johnson Controls teaming up with SAFT indicated the direction of travel for the EV revolution.

Meanwhile, Asia was in the driving seat for Li ion battery manufacturing, with Korean and Japanese firms dominating consumer electronics.

Western firms were determined not to let the expected auto manufacturing boom head eastwards — hence Barrack Obama's 2009 Recovery Act which for a while changed the status quo.

However, no one could have predicted the unbelievable growth in battery and automotive manufacturing in China, fuelled by state incentives.

As China took the lead, western firms also started to pick up investment — but became distracted on debating who should lead what, selecting applications and rebranding, as joint ventures came and went.

Fast forward to October 2023 and the EU sounded the alarm by launching a probe into alleged unfair Chinese EV subsidies.

I see a lot of similar challenges ahead, including managing the rapid, disruptive evolution of a key industry experiencing unprecedented investment. The difference today, however, is scale.

Estimates about the number of gigafactories to be built are varied but they will be on a scale never before attempted.

I believe staffing is a key challenge going forward.

Investment opportunities are there, but finding and training talented people to steer firms through an incredibly competitive market will be a challenging — hence the need for events such as the Battery Cells & Systems Expo, taking place at the NEC in Birmingham, England May 15-16. ■

Private sector investment gathers pace as energy transition advances

James Wood-Robertson, head of the energy & infrastructure sector at Shoosmiths.

The primary focus for 2024 in a year of worldwide elections is to accelerate momentum towards a net zero energy and infrastructure system, irrespective of geo-political upheaval. This is not without challenges, but the appetite for the markets for clean energy and EV projects remains keen.

Stakeholders and governments are rightly focussing on addressing the systemic barriers to renewable energy deployment and the net zero transition, but the drive from the private sector should only gather pace in 2024.

Before the conclusion of 2023, the European PPA market had already achieved a ground-breaking record, thanks to a market-driven procurement strategy that played a pivotal role in fostering the much-needed expansion of renewable energy capacity in the region.

However, with the energy crisis and the looming threat of high and volatile prices impacting businesses, there is an increasing trend toward securing long-term fixed price deals. This is especially true for businesses aiming to fulfil their climate change commitments by procuring clean, green energy.

Companies, by committing to acquiring a significant portion, if not the majority, of renewable power from a yet-to-be-constructed project for a duration of 10 years or more, find themselves financially obligated.

This commitment aids developers in obtaining funding for new eco-friendly projects without relying on traditional government subsidies and aligns with a growing preference for stable, long-term energy agreements.

The challenges of policy and economic uncertainty pose a significant barrier to the swift advancement of EV readiness.

Furthermore, the growing availability of second-hand and ex-fleet EVs is poised to enhance the accessibility of electric vehicles. Major players are playing a crucial role in bringing EVs to a broader range of customers and geographical locations. Overall, there is a strong sense of optimism about the future of EVs.

In 2024, the focus of car manufacturers and EV battery producers will centre on incorporating new technologies and chemistries to decrease the cost of EV batteries. The shift to more cost-effective batteries in 2024 is expected to play a crucial role in enabling EV companies to further slash prices and devise more appealing pricing strategies for the mass market.

Charging at a power level exceeding 1000 kW, known as Megawatt charging, stands as a pivotal technology facilitating the electrification of commercial vehicles. This advancement is poised to open avenues for electrifying various other segments of heavy-duty transportation. The commercial deployment of Megawatt chargers is anticipated to start in 2024.

Over the past few years, the energy system has been undergoing major changes with the rise of renewable energy sources, decentralization of energy production and new technologies enabling more flexibility and efficiency.

These trends will accelerate in 2024, driving further innovation in energy trading platforms and business models.

A key development will be the continued growth of peer-to-peer energy trading platforms which allow businesses and consumers with solar panels or other renewable energy generation to sell excess energy to their neighbouring properties or back to the grid.

Blockchain-enabled platforms that allow automated, transparent P2P transactions are likely to encourage the growth of local of energy markets, matching local generation with consumption and being able to offer 100% traceable and matched renewable electricity to businesses and consumers alike.

Related to this, virtual power plants that aggregate and optimize distributed renewable capacity like batteries and EVs to trade or offer grid services will increase.

More homes and businesses will invest in smart energy management tech like home batteries, smart thermostats and EV chargers in 2024. This will drive the expansion of flexibility markets run by aggregators where consumers can get paid to shift energy usage to balance renewables' intermittent supply. New aggregator entrants and consolidation is likely.

> The shift to more cost-effective EV batteries in 2024 is expected to play a crucial role in enabling EV companies to further slash prices and devise more appealing pricing strategies for the mass market

Overall, the coming year will see accelerated innovation towards a more decentralized, digitalised structure with a greater diversity of platforms, marketplaces and business models emerging to enable cleaner and more resilient power delivery.

Key players will be those utilizing cutting-edge digital technologies like blockchain, AI and advanced analytics within their trading infrastructure and offerings. ■

Lead prices will remain firm next year — even though supply will overall exceed demand for the period, writes Joao Jorge, director of market research and statistics for the International Lead and Zinc Study Group.

Longer term trends in lead supply and demand balance/imbalance

Despite growing steadily since at least 1960, when the International Lead and Zinc Group (ILZSG) initiated its market monitoring and reporting activities, the outlook for lead demand has frequently been perceived by some analysts as somehow gloomier compared to other base metals.

Lead's negative image and the fact that it has been subject to increasingly stringent environmental regulation, particularly in Europe, have contributed to this perception.

In addition, it is undeniable that the ongoing trend in the automotive market in transitioning from traditional internal combustion engine technology to increasingly electrified powertrains is also raising concerns over a potential future reduction in the demand for lead from the crucial 12V battery market.

This is because a portion of hybrid and electric vehicles use smaller lead batteries that are only required to perform auxiliary duties and not to start an ICE as traditional starting, lighting, and ignition (SLI) batteries do.

These 12V auxiliary-only lead batteries require a smaller amount of lead compared to SLI units, which in the short term may negatively impact the demand for lead from the original equipment (OE) battery market segment, and in the longer term, that from the replacement battery market.

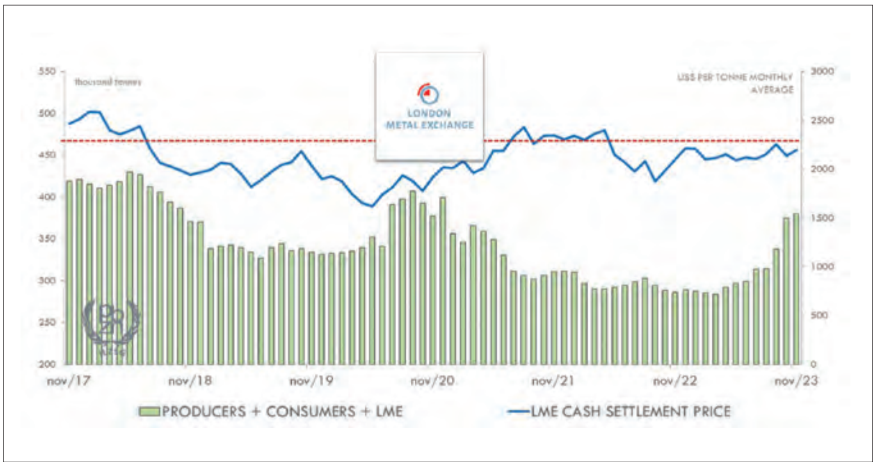


Chart 1: LME lead stocks and prices

Lead demand is not anticipated to rise substantially over the next decade, unlike other base metals such as copper or nickel — lead is not expected to benefit greatly from the decarbonization of the economy

The electrification of passenger cars has indeed risen robustly, particularly in China and Europe, although very recent data suggests it might be slowing down in some key markets.

According to Macquarie Research's recent projections, hybrid and electric vehicles will capture a substantial 62% of the new vehicle market by 2030, whereas the relative proportion of the traditional ICE vehicles will progressively fall.

However, a detailed study published by the ILZSG in March 2023 that includes an empirical predictive analysis based on forecast sales of light duty vehicles, demonstrates that this is not inevitable. The large battery replacement market, which is around four times the size of the OE sector in a mature automotive market, combined with the increasing demand for auxiliary 12V batteries used in hybrid and electric vehicles, could balance losses due to lower sales of vehicles with an ICE and the resulting fall in demand for new SLI batteries over the period 2023-2030.

Additionally, other important lead consuming industries, including E-bikes, telecom backup systems, cable sheathing of telecom and power underwater cables, and stationary energy storage systems, used for example by the renewable energy sector and in charging stations for electric vehicles, will also continue to support lead demand.

Although lithium-ion battery technology is capturing a significant share of the ESS market, there are several reasons why this market could be supportive to a growth in demand for lead-acid batteries over the next few years.

These include cost effectiveness,

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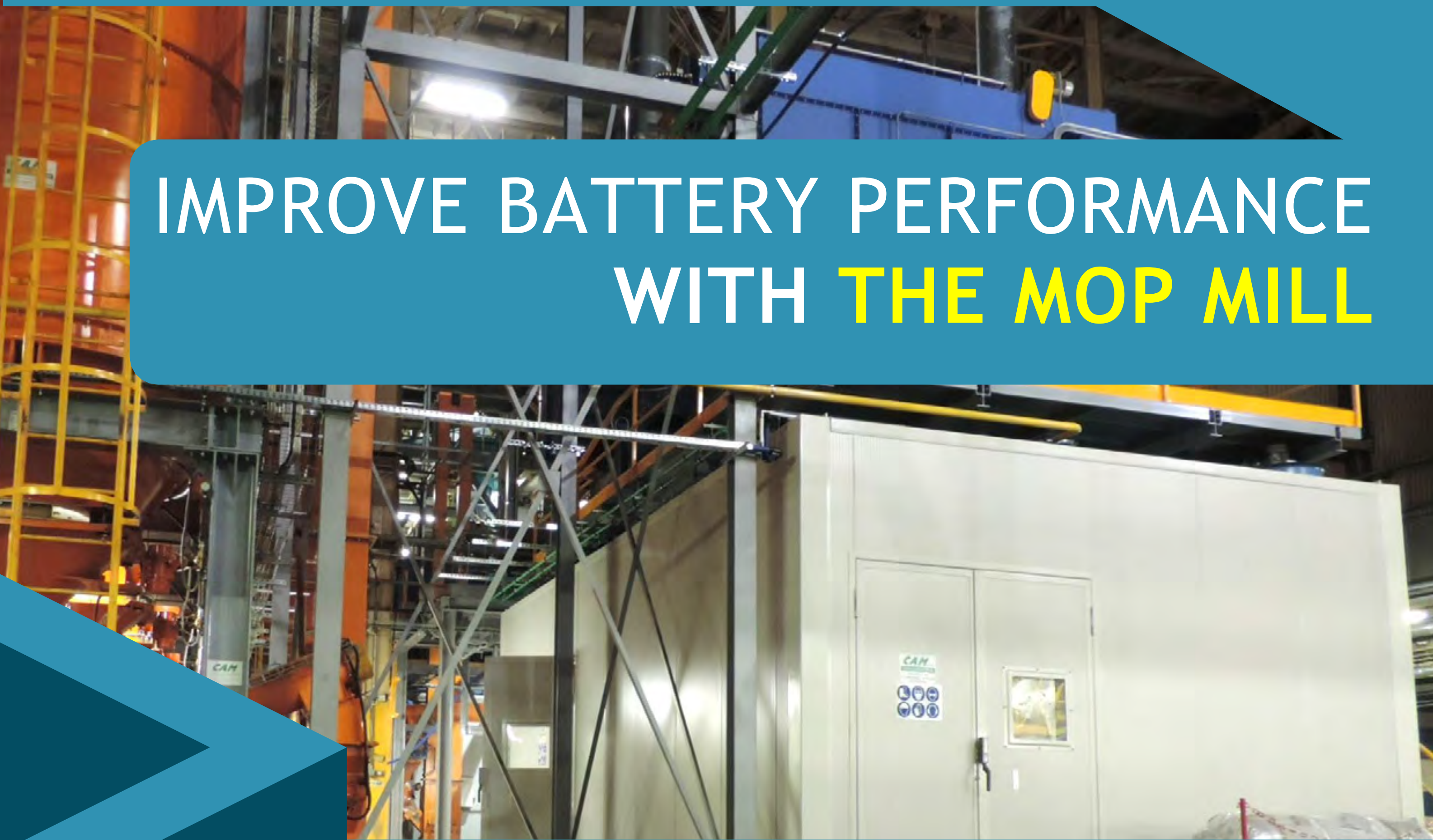

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safety and recyclability, with weight and power density not being critical issues for such applications.

Moreover, lead based battery technology is still evolving. AGM batteries, introduced a few years ago, allowed weight saving and enhanced reliability, durability and stability under adverse conditions. Further technical advances in lead-based batteries include the UltraBattery developed by CSIRO, the use of carbon additives to the batteries' positive electrode and Advanced Battery Concepts' bi-polar EverGreenSeal technology.

Lead demand is not anticipated to rise substantially over the next decade, since, unlike other base metals such as copper or nickel, lead is not expected to benefit greatly from the ongoing path to the decarbonization of the economy.

However, it is also not likely that it will decline significantly in the medium term, with reasonable and informed market projections suggesting that the demand for lead could rather resiliently sustain a limited rise at least until 2030.

Such expectations could nevertheless be exceeded if the lead acid battery industry succeeds in capturing a larger share of the rapidly rising ESS market. As a consequence, market predictions based on simplistic analysis that anticipate drastic reductions in lead demand in the short to medium term, will most likely be proven overly pessimistic.

Price trends

Lead prices are relatively immune to the economic cycle, especially if compared to its sister metal zinc or even copper. This is mainly a consequence of the significant share of the replacement battery segment in overall battery demand and the fact that the demand for replacement batteries is typically stable and predictable.

As depicted in Chart 1, the LME monthly average settlement price has remained stable over the last couple of years. In September 2023, the monthly average price reached a 17-month high of $2,253, but has since declined slightly.

LME stocks have increased in recent months to over 130,000 tonnes, nevertheless last November's average settlement price remained 4.1% higher than one year earlier.

There are no foreseeable reasons for the current price trend to change substantially over 2024. Global demand should rise slightly more rapidly than in 2023 and although supply is likely to exceed demand, the forecast surplus will be relatively contained.

Metal demand outlook

As shown in Chart 2, global demand for refined lead metal gained momentum between 1993 and 2013, mainly influenced by a notable rise in Chinese demand that increased by more than seven times over that period, supported by soaring sales of e-bikes and passenger cars that boosted demand for lead acid batteries manufactured domestically.

Growth in Chinese demand has subsequently slowed down and this impacted global usage due to the large size of this market that accounted for over 40% of the total in 2022.

Despite becoming more stable in recent years, lead demand in China has been supported by robust rises in the lead acid battery sector where exports

Simplistic analysis that anticipate drastic reductions in lead demand in the short to medium term, will most likely be proven overly pessimistic

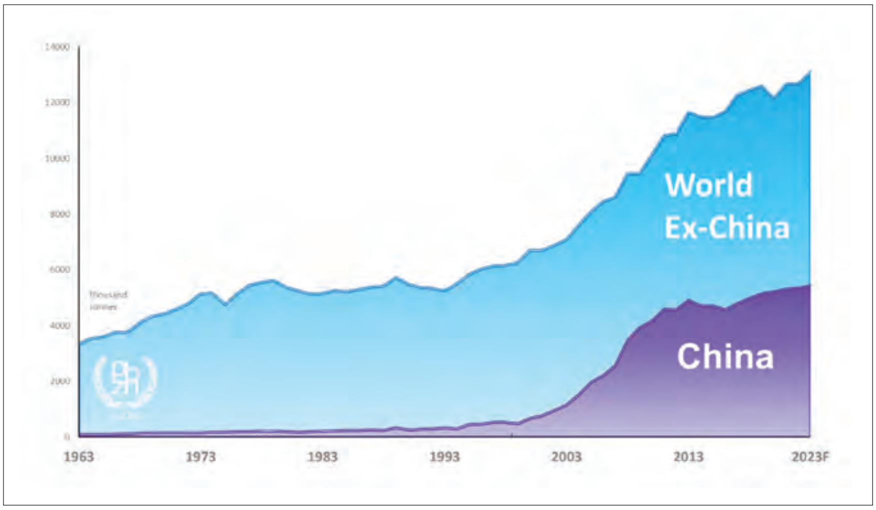

Chart 2: Long-term lead demand: China versus world ex-China

LEAD MARKET BALANCE

Having taken into account all of the information provided from its member countries on both demand and supply of refined lead metal, ILZDG's latest forecasts anticipate that global supply will exceed demand by 35,000 tonnes in 2023. In 2024, a larger surplus of 52,000 tonnes is expected.

World lead metal balance

have steadily risen in addition to sales in the domestic market.

After growing by nearly 6% in 2022, production of lead-acid batteries in China increased by 11.8% over the first eight months of 2023. The combination of a rapidly increasing domestic replacement battery market and steady exports of batteries is supportive to expected rises in Chinese demand over the next few years.

The ILZSG's most recent lead market forecasts for 2023 and 2024, put forward at its annual meetings held in Lisbon last October, anticipate that usage in China will rise by 1.9% in 2023 and by a further 2.4% in 2024. This indicates that this market will be the most important contributor to the forecast growth of 1.1% in 2023 and 2.2% in 2024 in global demand.

Europe is also a major consumer of refined lead.

Passenger car production in the EU was hit by the global pandemic, falling by 24% in 2020 and a further 7% in the following year.

In 2022, output partially recovered by 7%, however, the situation in some important European economies outside of the EU remained depressed, with car production falling by 10% in the UK, 67% in the Russian Federation and 80% in Ukraine.

The most recent data on passenger car registrations in the EU show an increase by nearly 17% in new car sales over the first 10 months of 2023, with European lead demand anticipated to grow by 3.7% in 2023. In 2024, a more modest rise of 0.8% is forecast.

Apparent usage in the US, another important lead consuming economy, fell substantially in the first half of 2023. Automotive production has been boosted by stronger demand, with new car sales rising by 13.4% between January and September, and as a result shipments of OE lead batteries have also risen substantially.

However, this rise was offset by a decline in the much larger replacement battery market of 3.5% over the first half of the year. ILZSG anticipates apparent usage in the US to decline by 6.4% in 2023, but to partially recover by 3.1% next year.

Elsewhere, apparent usage is forecast to rise in India, Mexico, Taiwan (China) and Vietnam but to decrease in the Republic of Korea.

In 2024, demand is forecast to rise in Japan and the Republic of Korea and most notably India, where demand is forecast to rise by more than 4%, after increasing by 6% in 2023.

The two-decade long Chinese super-cycle in lead usage that emerged 30 years ago won't be replicated in any other country in the near future

Although it is not likely that the two-decade long Chinese super-cycle in lead usage that emerged 30 years ago will be replicated in any other country in the near future, a few emerging economies in Asia, most notably India, will contribute significantly to the growth in global demand forecast for the short to medium-term.

Indian lead demand will outpace most other economies, driven by its huge population, rising urbanization rates, steady economic growth, and an emergent middle-class willing to buy new cars in a market where the penetration of new energy vehicles has been slow.

Additionally, the demand for power backup batteries by higher income households aimed at reducing the impact of frequent issues in the country's electric infrastructure, combined with ambitious goals in increasing non fossil fuel power generation in India over the next decade provides the lead acid battery industry with promising opportunities in the rapidly expanding ESS market segment.

Metal supply outlook

In terms of refined lead supply, ILZSG has recently forecast global output to rise by 2.7% in 2023, after declining by 1.7% in 2022. A 2.3% increase is anticipated in 2024. The share of secondary or recycled production (Chart 3) has risen steadily over the past six decades reaching 66% in 2022.

It is expected that this upward trend will continue, mainly supported by rises in Asia, where the share of metal refined from scrap, made mostly of used batteries, is lower than in other regions.

Production in 2023 is forecast to increase in Australia, China, India and, most notably, Germany, where Trafigura's Stolberg smelter was reopened in March after floods forced its closure in 2021.

Output is to increase in Taiwan (China) and the United Arab Emirates, where new capacity has recently been commissioned.

These rises will, however, be partially balanced by forecast falls in production in Bulgaria, where a fire at a smelter in the first quarter of 2023 negatively impacted operational capacity for a number of months. Likewise falls in Italy, the Republic of Korea and the UK, where shipments of lead bullion to be processed at the Northfleet unit declined over the first half of the year.

In 2024, metal supply is forecast to rise in Australia, Bulgaria, China, India, Italy, Japan, the Republic of Korea and the United Arab Emirates but to decrease in the UK and Canada, as a result of planned maintenance works that will limit production at Teck Resources' smelter. ■

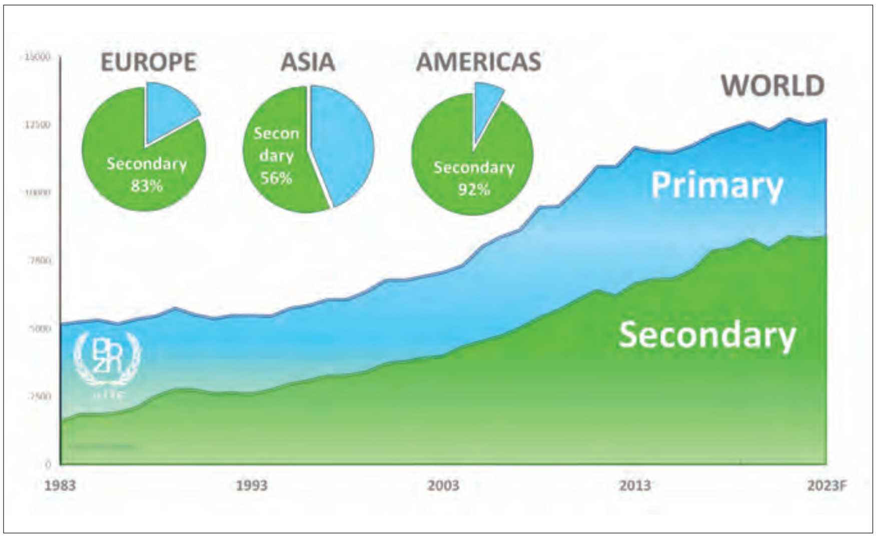

Chart 3: Primary versus secondary lead metal production

Advancements and challenges in V2G implementation

Rohit Tyagi and Abhinav Trivedi from Acuity Knowledge Partners explain the early stage benefits and huge potential V2G bidirectional charging can offer both grid operators and car drivers.

With the number of electric vehicles globally projected to reach 559 million by 2040, V2G technology is a promising solution that allows idle or parked EVs to function as distributed energy sources.

V2G technology enables bidirectional power flow between EVs and the electric grid, allowing EVs to not only charge but also to release surplus energy back to the grid when needed.

This capability enhances the overall capacity of electricity generation and contributes to the stability, reliability, and efficiency of the electric network.

As our energy ecosystems evolve, energy assets are becoming more intelligent and interconnected, with EVs actively participating in network balancing.

Significant advancements have been made in the development and implementation of various bidirectional converters within V2G systems. These converters play a crucial role in achieving highly efficient power conversion. As the adoption of these converters and charging stations continues to rise, it will facilitate the transition from conventional electric vehicles to V2G capable vehicles, ultimately leading to the creation of a greener environment.

Significant advancements have been made in the development and implementation of various bidirectional converters within V2G systems. These converters play a crucial role in achieving highly efficient power conversion.

Home charging	Shifting charging times during off-peak hours or adjusting charging patterns to minimize curtailment of variable renewable energy sources.
Workplace charging	Increasing the use of solar power by connecting EVs during daylight hours.
Public roadside charging	Increasing the use of renewable energy by connecting EVs during typical daytime periods.
En route charging	Limited flexibility for demand response due to short or non-existent surplus connection times.
Depot charging	Fleet predictability and load management present significant opportunities for load shifting, curtailment reduction of variable renewable energy sources, and bidirectional charging, due to larger battery capacities and existing fleet control.
Battery swapping	Continuous bidirectional interaction with the grid and aggregated capacity can facilitate the integration of variable renewable energy sources. Battery charging management can contribute to reducing the aging of assets.

Table 1: V2G related opportunities by charging use case

Benefits of V2G integration

Vehicle-to-grid technology allows electric vehicles to address the gaps in renewable energy generation and provide grid support during peak hours or peak shaving. EV owners can customize the timing and volume of their vehicles' energy import/ export to align with their lifestyle and driving patterns.

V2G offers EV owners simplified control, reduces stress, provides flexibility for both owners and the grid, promotes energy efficiency, and enhances grid stability.

For example, according to OVO Energy, when low wind speeds threatened to cause an electricity supply crunch in the UK in November 2020, V2G users plugged in their vehicles, allowing 150 EVs to feed power back into the grid, this provided 0.4MW of power. A fraction of the 740MW shortfall but a demonstration of the potential that V2G has.

Ultimately, this technology has the potential to revolutionize power systems and unlock new smart grid opportunities. For network operators, V2G can help avoid costly infrastructure upgrades, ultimately reducing electricity costs for all consumers.

V2G provides additional revenue opportunities for EV manufacturers by tapping into the additional market created by the V2G customer segments.

Nissan and Mitsubishi have taken the lead by introducing V2G-compatible car models. Nissan's Leaf e-NV200 models and Mitsubishi's Outlander PHEV iMiev models can be discharged using vehicle-to-grid stations. Other models with V2G capabilities include Kia EV9, Cupra Born and the Mitsubishi Outlander.

For network operators, V2G can help avoid costly infrastructure upgrades, ultimately reducing electricity costs for all consumers.

More manufacturers will soon introduce V2G-compatible models. For example, Ford plans to commercialize V2G with its F-150 Lightning electric pickup truck, while Hyundai is doing the same with its IONIQ 5 model.

From a technical perspective, V2G technology can transform the power sector in three main ways:

Optimising grid infrastructure: With EVs spending a significant portion of their lifetime in parking zones, their idle periods and battery storage capacity make them an attractive solution for grid flexibility. Each EV has the potential to function as a microgrid-connected storage unit, offering a wide range of services to the power system. V2G charging can mitigate EV-induced demand peaks at the local grid level and adjust the load curve to integrate variable renewable energy sources.

Flexibility in power system operations: V2G charging of EVs can impact the integration of VRE in real-time grid balancing and long-term network expansion plans. It involves adjusting EV charging levels to maintain steady voltage and frequency, increasing self-consumption of locally generated renewable electricity, and reducing reliance on the main grid.

Enhancing resilience in disaster-prone areas: In regions susceptible to extreme weather events, such as cyclones or floods, utilising EVs as mobile power units can enhance energy resilience. V2G can provide power back to the grid or specific buildings such as emergency shelters, hospitals, critical facilities, or entire neighbourhoods during power outages.

Regulatory advancements

In terms of technical standards, specific regulations are required for each inverter configuration to ensure safe operations and interconnection.

Despite its benefits, the implementation of V2G technology is limited. V2G is a relatively new and evolving concept, with many projects still in the pilot stage of development. However, this is rapidly changing as it increasingly becomes a commercially profitable venture, leading to the emergence of more V2G companies.

Several V2G pilot projects have been initiated with diverse objectives and services. For example, the Leaf to Home project in Japan involves 4,000 chargers for emergency backup, Fiat-Chrysler V2G in Italy includes 600 chargers for load balancing, and OVO Energy V2G in the UK operates with 320 chargers for energy arbitrage.

Challenges in bringing the technology to market

While V2G technology offers several benefits, it also faces some hurdles that are important to consider. The following challenges need to be addressed to ensure the successful implementation and scalability of V2G technology:

Battery technology and battery management systems: EV cab aggregators or fleet operators may lack direct control over the battery technology and BMS of the electric vehicles in their fleet. Varying battery chemistries and BMS capabilities across different EV models makes it difficult to standardize V2G operations across the entire fleet.

Bi-directional charger availability: The existing charging infrastructure may not support bidirectional charging, requiring upgrades to chargers and car dock ports to enable V2G capabilities.

Programmable logics for smart charging and discharging: Developing programmable logics that enable intelligent charging and discharging synchronized with the grid infrastructure requires specialized expertise and software development.

Understanding local or regional grid infrastructure: Grid conditions and peak or off-peak situations can vary at the local, regional, and national levels. Understanding the intricacies of the grid infrastructure is crucial for effective V2G operations.

Net smart metering for energy accounting: Accurate energy accounting is essential for V2G operations, and implementing net smart metering for bidirectional power flow can be a complex undertaking.

Partnership with vertically integrated battery technology company: Developing an energy management system and modelling energy exchange pricing requires expertise and a deep understanding of battery technologies and grid operations. Partnering with vertically integrated battery technology companies can be advantageous in this regard.

Vehicle-to-grid technology is in its early stages and is still heavily dependent on the widespread use of electrical vehicles and the availability of infrastructure. As it evolves and favourable policy and regulations are implemented, V2G has the potential to revolutionize power systems and boost resilience and stability of energy infrastructure. ■

STANDARDS FOR THE FUTURE

The Institute of Electrical and Electronics Engineers (IEEE) 1547 standards cover interconnection matters, the Underwriters Laboratories (UL 1741) standards address Electric Vehicle Supply Equipment (EVSE) safety and functionality, and the Society of Automotive Engineers (SAE) standards handle EV and vehicle functions. Third parties or manufacturers can conduct testing.

While these standards may seem technical, establishing manufacturing, safety, and operational guidelines is crucial for scaling the industry and realising its full potential. With these standards in place, EV charging can become more intelligent, efficient, and convenient. This will lead to a significant increase in EV battery capacity for energy management in the coming years.

V2G provides revenue opportunities for EV manufacturers by tapping into the additional market created by the V2G customer segments.

Rohit Tyagi is assistant director, consulting and corporates and Abhinav Trivedi, is delivery lead, ay Acuity Knowledge Partners

Automated quality control offers key direction in mass manufacturing

Inadequate inspection of batteries can result in serious safety issues and decreased battery performance. SAM — scanning acoustic microscopy — is one way to inspect batteries for microscopic cracks, defects, separations and delaminations.

With battery production booming, manufacturers are increasingly integrating SAM inspection tools into their process to catch defects at an early stage.

For battery manufacturers testing various components for flaws before shipping is crucial to prevent potentially serious safety and performance issues.

This need will only increase, as production volumes ramp up. The global battery market is forecast to expand at a compound annual growth rate of 15.8% from 2023 to 2030, with lithium-ion batteries gaining most of the market share by 2024, according to Grand View Research,

The need to assure quality is driving the adoption of non-destructive battery inspection techniques such as SAM, which provide detailed insights into the internal structure of battery cells to identify cracks, defects, separations, and delamination in the materials.

SAM, which can identify defects as minuscule as 50-microns, is extensively embraced in the semiconductor industry as a metrology technology for failure analysis and reliability detection. Now the same high-speed technology is being applied to testing and failure analysis of battery cells.

SAM is a non-invasive ultrasonic testing method that direct focused sound from a transducer at a small point on a target object.

The sound hitting the object is either scattered, absorbed, reflected, or transmitted. By detecting the direction of scattered pulses as well as the 'time of flight,' the presence of a boundary or object can be determined as well as its distance.

Depth-specific information can be extracted and applied to create two- and three-dimensional images without the need for time-consuming tomographic scan procedures and more costly X-rays," says Hari Polu, president of OKOS, a Virginia-based manufacturer of industrial ultrasonic systems.

The images are then analyzed to detect and characterize flaws such as cracks, inclusions, and voids.

Given the rising demand for batteries, there is now a need for an automated method to inspect all the batteries during manufacturing.

The challenge, however, is performing 100% inspection at sufficient throughput speeds to remove materials with defects that fail quality requirements. "As with other inspection systems, increasing scanning speed traditionally meant sacrificing scanning image resolution," says Polu.

Recent advancements in SAM technology are changing this.

"While a conventional 5MHz sensor could take up to 45 minutes to inspect a battery's components, an advanced phased array with 64-128 sensors and innovative software to render the images reduces inspection time to five minutes with more granular detection of small impurities or defects," says Polu.

By increasing inspection speed, there is no longer the need to be limited to selective sample testing during in-process quality control.

Although SAM has long been utilized for this type of inspection, the testing involved a handheld unit or a multi-point inspection. "Now it is more feasible to conduct 100% inspection of the entire surface/interface," says Polu.

In addition, these advances also facilitate the detection of not just gross defects, but much smaller defects, to drive highly consistent, high yield products.

"Advanced, phased array SAM systems make it possible for battery manufacturers to move to a higher level of failure analysis," says Polu. "In the past, detecting a 500-micron defect was the goal; now it is a 50-micron defect." Moreover, the need is not for test sampling but inspection of all items.

As important as the physical and mechanical aspects of conducting a scan, the software is critical to improving the resolution and analyzing the information to produce detailed scans. Multi-axis scan options enable A, B, and C-scans, contour following, off-line analysis, and virtual rescanning for batteries, which result in highly accurate internal and external inspection for defects via the inspection software.

Polu says that the company's software-driven model enables them to drive down the costs of SAM testing while delivering higher quality inspection results at faster speeds.

"With more sensors and advanced software to interpret the information at very high resolutions, battery OEMs can inspect 100% of the materials utilized at a level one to two orders of magnitude better to discover flaws that were previously undetected. This will increasingly become the industry's best-in-class standard," says Polu. ■

WHY THE INSPECTION NEED?

When manufacturing battery cells, defects can occur that require detection so the product can be removed before shipping. Microscopic cracks can occur in the electrode materials or the separator, potentially leading to reduced performance and safety concerns.

Inconsistent coating on electrodes can lead to short circuits or reduced capacity. Gaps between layers in a battery cell, such as the separator and electrodes, can result in uneven charge distribution and potential thermal issues. Delamination between layers of materials within a cell can compromise its structural integrity

Inadequate battery inspection can pose serious dangers. Certain defects, especially those that lead to internal short circuits, can result in safety risks like overheating, fires, or even explosions. Additionally, defects can cause a decrease in battery capacity, efficiency, and overall performance. Insufficient battery inspection may also lead to costly product recalls and damage the reputation of the manufacturer.

Long Beach, California

Intersolar North America

January 17-19
Long Beach, California. US

Intersolar North America and Energy Storage North America is the premier U.S.-based conference and trade show focused on solar, energy storage, and EV charging infrastructure. Dedicated to accelerating the energy transition, the combined event delivers actionable education, invaluable networking, and an immersive exhibit hall experience — which includes the popular Solar Games installer competition.

Join 6,000+ energy leaders and 300+ exhibitors in Long Beach, CA, to help shape the next phase of our clean energy transformation.

Contact
Diversified Communications
E: ISNAinfo@divcom.com
www.intersolar.us / www.esnaexpo.com

MRAI 11th International Indian Material Recycling Conference

January 23-25
Kolkata, India

Over the past decade, Material Recycling Association of India has organized 10 successful International Indian Material Recycling conferences. With your continuous trust and overwhelming support, MRAI is pleased to announce its 11th IMRC 2024 Convention & Exposition in Kolkata, India.

MRAI 11th IMRC 2024 Convention & Exposition will focus to bring Indian and International Recyclers under one roof for networking and showcasing their business interest, products, technologies, services, new innovations, perspective, etc.

The Conference will accommodate 2500+ Delegates and 130+ Exhibitors representing Recycling Fraternity.

Contact
Metal Recycling Association of India
E: mail@mrai.org.in
www.imrc.mrai.org.in/index.html

San Diego, California

IEEE Eelectrical Energy Storage Applications & Technology Conference

January 29-30
San Diego, California, US

EESAT has been the premier technical forum for presenting advances in energy storage technologies and applications since 2000. This forum is now sponsored by the IEEE Energy Storage and Stationary Battery (ESSB) Committee, under the IEEE Power and Energy Society, with continuing support from the DOE Office of Electricity and the national laboratories.

The technical program will highlight advances in electricity storage technologies including new battery chemistries, such as flow, sodium, zinc, and other battery designs, flywheels, hydrogen storage, PS, CASE, and novel approaches such as demand response as storage programs.

Contact
IEEE MCE
www.cmte.ieee.org/pes-eesat/

Solar Finance and Investment Europe

January 31-February 1
London, UK

Returning for its 11th year, Solar Finance & Investment Europe Summit will bring together the brightest minds representing funds, banks, developers, utilities, government and industry across Europe and the UK on a programme that is solutions-focused from top to tail. The event is designed to enable leaders at the forefront of solar investment and deployment in Europe to scale, learn and land themselves industry defining partnerships.

We will showcase the latest insights on European markets, solar-related technologies and winning strategies from the best in the business. Join us in discussing next steps for the industry.

Contact
Ollie McCullough, Solar Media
E: omccullough@solarmedia.co.uk
www.financeeurope.solarenergyevents.com

RE+ Northeast

February 13-14
Boston, Massachusetts, US

RE+ Northeast's primary mission is to deliver on the missions of both SEIA and SEPA in a way that strengthens the solar energy industry domestically and globally, through networking and education, and by creating an energetic and engaging marketplace to connect buyers and suppliers.

The event focuses on the exchange of ideas, knowledge and expertise for furthering solar energy development in the Northeast United States.

Contact
Smart Electric Power Alliance
E: customerservice@re-plus.com
www.re-plus.events/northeast/

NAATBatt Annual Conference

February 19-22
Carlsbad, California, US.

NAATBatt 2024 will be the top networking and market intelligence event in the North American advanced battery industry in 2024. Top executives, scientists and investors use the NAATBatt annual meeting to renew acquaintances, see new companies and technologies and hear about the latest developments in the industry.

Joining NAATBatt International is a great way to build relationships in an industry that will help shape the 21st Century. Vehicle technology, renewable energy, light aviation, maritime propulsion systems, robotics, weapons systems, medical devices, consumer electronics and the Internet of Things will all depend on electricity supplied by advanced battery technology.

Contact
NAATBatt International
E: info@naatbatt.org
www.naatbatt.org

Jain temples, Palitana, Gujarat state

SAVE THE DATE

The Smarter E India — ees India

February 20-23
Gandhinagar, Gujarat, India

With three parallel energy exhibitions, The smarter E India is India's innovation hub for the new energy world. It presents cross-sector energy solutions and technologies and reflects the interaction of the solar, energy storage and electric mobility industry.

The smarter E India addresses all the key areas along the value chain and brings together local experts and international stakeholders in the energy future.

Contact
Solar Promotion
E: brijesh.nair@mm-india.in
www.thesmartere.in/home

Energy Storage Summit

February 21 – 22
London, UK

The Energy Storage Summit is renowned for its quality, breadth and expertise, featuring an all-encompassing range of strategic and technical sessions on the adoption and deployment of storage.

The Summit plays a pivotal role in the journey to propelling the industry into the next stage of its development, providing an unrivalled platform to develop the right partnerships and create business opportunities of all sizes.

Contact
Solar Media
E: energystorage@solarmedia.co.uk
www.storagesummit.solarenergyevents.com

ACI's Battery Recycling Europe

February 28-29
London, UK

The conference will bring together Battery Recycling industry experts, collection scheme operators and battery manufacturers to learn, share and discuss the current and emerging topics in the Battery Recycling industry.

The two day event will give you an insight on the newest recycling technologies, latest updates in policy and regulations, and commercial benefits of recycling spent power batteries.

ACI's Battery Recycling Europe will also showcase future opportunities in the Battery Recycling Market and blend together inspirational keynotes, informative sessions, and wonderful networking opportunities.

Contact
Active Communications International
E: luca@acieu.net
www.wplgroup.com/aci/event/battery-recycling-europe/

Battery Japan

February 28-March 1
Tokyo, Japan

BATTERY JAPAN is the world's leading international exhibition for rechargeable battery, showcasing various components, materials, devices, finished rechargeable batteries for rechargeable battery R&D and manufacturing. It is held twice a year in Tokyo (Mar.) and Osaka (Sep.)

Contact
Reed Exhibitions
E: wsew.jp@rxglobal.com
www.wsew.jp/hub/en-gb/about/bj.html

Interbattery

March 6-8
Seoul, Korea

InterBattery is Korea's only battery industry exhibition that simultaneously accommodates the fast-growing mobile market, automobile industry, as well as ESS and EV markets.

Visiting Interbattery allows buyers and manufacturers to interact with one another whilst learning about the newest products and trends in the Korean and International markets.

InterBattery has served itself as an exclusive business platform showcasing the battery industries forthcoming prospects since its first launch.

Contact
COEX
E: interbattery@coex.co.kr
www.interbattery.or.kr

Seoul, Korea


London, UK

National Energy and Sustainability Conference 2024

March 12 – 14
London, UK

The Institute of Government & Public Policy's Second National Energy and Sustainability Conference 2024 is a two-day event that centres around energy transition and the evolving energy landscape within the public sector.

This conference will bring together thought leaders and industry experts who will explore economic growth opportunities, funding options for green projects, and strategies for upskilling the workforce to meet growing demand for greener jobs.

The event will also explore critical topics like the transition to zero-emission vehicles, promoting green public transportation, advancing sustainable building practices, environmental protection, and the road map to achieving net-zero emissions by 2050.

Contact
Institute of Government & Public Policy — IGPP
E: info@igpp.org.uk
www.igpp.org.uk/event/The-National-Energy-and-Sustainability-Conference-Mission-Zero/

International Battery Seminar and Exhibition

March 12-15
Orlando, Florida, USA

Founded in 1983, the International Battery Seminar & Exhibit has established itself as the premier event showcasing the state of the art of worldwide energy storage technology developments for consumer, automotive, military, and industrial applications.

Key thought leaders will assemble to not only provide broad perspectives, but also informed insights into significant advances in materials, product development, manufacturing, and application for all battery systems and enabling technologies.

As the longest-running annual battery industry event in the world, this meeting has always been the preferred venue to announce significant developments, new products, and showcase the most advanced battery technology.

Contact
Cambridge Enertech
E: ce@cambridgeenertech.com
www.internationalbatteryseminar.com

The Distributed Energy Show

March 13 – 14
Telford, UK

The Distributed Energy Show is a free to attend exhibition and conference that will bring together the entire supply-chain focused on distributed energy resources and provide visitors with a comprehensive array of technologies and systems to enable them to generate, store, manage and distribute their own power and heat.

Contact
Event Partners
E: lana.mercer@event-partners.com
www.distributedenergyshow.com


Orlando, Florida, USA

BTF China

April 1 – 3
Shanghai, China

BTF China 2024, The 13th Shanghai International New Energy Lithium Battery Technology Fair will take place from April 1 – 3, 2024 at Shanghai New International Expo Centre and is expected to attract more than 800 exhibitors and 65,000 incoming buyers to the fair.

Topics to cover:
Power batteries • Energy storage batteries • Raw materials • Battery manufacturing equipment • Battery testing • Battery recycling, etc

Contact
Qiyang Exhibition Service (Shanghai) Co., Ltd
www.btfchina.com.cn/en/

International Advanced Battery Power Conference

April 9 – 11
Munster, Germany

The Advanced Battery Power Conference offers an excellent platform for companies, research institutes, universities and individuals to present their work and results in the field of battery technology to a broad specialist audience.

Interested parties who are not be able to attend in Münster will have the opportunity to participate online via the Digital Campus hdt+.

Contact
Haus Der Technik — HDT
E: hdt@hdt.de
www.hdt.de

Energy Tech Summit

April 10 – 11
Bilbao, Spain

Join Europe's premier climate tech event, now with a sharper focus on enabling resources for the clean energy transition. Recognized at the #1 industry conference, Energy Tech Summit connects impactful investors, disruptors, and government leaders.

In 2024, we're bringing the summit Bilbao, the heart of innovation. Get ready for a dynamic new format designed to inspire, connect and amplify your impact. This is your chance to be part of the solution, explore markets and leave with business ideas that make a difference in the fight against climate change. Join us for an unforgettable event and be part of a movement pushing boundaries in the enrgy industry.

Contact
Future Events, UAB
E: info@energytechsummit.com
www.energytechsummit.com

Dubai

Abu Dhabi

Intersolar & ees Middle East

April 16 – 18
Dubai, United Arab Emirates

Take your chance to join the most powerful platform in the MENA region Middle East Energy (MEE), Intersolar, and ees, the leading energy exhibitions are joining hands to co-deliver an outstanding renewables and energy storage event at Middle East Energy.

Renewables and energy storage at MEE is the largest gathering of solar and renewable energy industry professionals in the Middle East & Africa, offering the most effective trade focused platform to international manufacturers and distributors looking to meet regional buyers.

Contact
Solar Promotion International
E: stunz@solarpromotion.com
www.intersolar.ae/home

World Future Energy Summit

April 16 – 18
Abu Dhabi, UAE

WFES (World Future Energy Summit) is a global industry platform connecting business and innovation in energy, clean technology and efficiency for a sustainable future.

WFES Expo hosts over 850 exhibiting companies from more than 40 countries; The Future Summit; the unique WFES Forums, covering everything from disruptive technologies to future cities; a set of ground-breaking WFES Initiatives; and WFES Hosted Events, where individual growth markets come under the spotlight.

Contact
RX Global
E: worldfutureenergysummit@rxglobal.com
www.worldfutureenergysummit.com

SAVE THE DATE

BCI 2024 Convention and Power Mart Expo

April 21 – 24
Fort Lauderdale, FL. USA

BCI brings together the leading battery manufacturers and recyclers in North America and around the world, and establishes technical standards for battery manufacturing and actively promotes workable environmental, health and safety standards for the industry.

Each year hundreds of lead battery industry executives gather at the industry's premier event, the BCI Convention + Power Mart Expo, for three days of networking and exposure to valuable industry knowledge. Past convention presentations have included global regulatory and legislative updates, lead markets analysis, the BCI Failure Mode Study, and industrial and transportation batteries outlooks.

The 2024 event will be an electrifying experience like no other – with stimulation speakers, dynamic panel discussions, exciting industry forecasts and numerous networking opportunities – culminating in a grand Centennial Celebration.

Contact
Battery Council International — BCI
E: info@batterycouncil.org
www.convention.batterycouncil.org

Battery Tech Expo

April 25
Silverstone, UK

The Battery industry is on the cusp of a power revolution with big technology companies investing heavily in the next generation of battery development and energy storage.

The Battery Tech Expo will provide a unique opportunity to showcase the latest products, technologies and services covering the Battery Management Systems, EV Battery, Battery Storage, Battery Development/ Discovery, Commercial and Mobile Power Device sectors.

Contact
10fourmedia
David Reeks
E: david.reeks@10fourmedia.co.uk
www.batterytechexpo.co.uk

RE Battery

May 7 - 8
Bologna, Italy

RE-BATTERY 2024 is Southern Europe's largest international trade fair for battery producers, recycling companies, raw material suppliers and the entire battery supply chain: on collecting, sorting, processing and reusing batteries, electric vehicles, e-mobility systems and e-waste.

Main topics discussed will include recycling technologies, materials recovery solutions, green electronics, sustainable materials, non-toxic substitutes and end-of-life / reuse strategies, as well as regulatory and business models to help reduce the environmental impact.

RE-BATTERY 2024 will focus on lithium-ion batteries from e-mobility transportation, stationary applications, electric vehicles and mobile and charging products, but also lead-acid batteries and e-waste from electronics.

Contact
A151 srl
E: events@e-tech.show
www.re-battery.show

Advanced Automotive Battery Conference — AABC Europe

May 13 – 16
Strausbourg, France

Take part in this game-changing event where battery technologists from leading automotive OEMs and their key suppliers explore development trends and breakthrough technologies shaping the future of vehicle electrification.

As more European nations and international automotive OEMs invest in their commitment to vehicle electrification and eMobility, the 2024 AABC Europe event propels that momentum forward, presenting unparalleled coverage of the research and development that helps drive outcomes and supports the next generation of electric vehicle batteries.

Contact
Dave Mello
Cambridge Enertech
E: dmello@cambridgeinnovationinstitute.com
www.advancedautobat.com/europe

Battcon

May 14 – 17
Miami, FL. USA

The Consortium for Battery Innovation has been appointed to manage the prestigious Battcon energy storage conference in the United States.

Battcon is an annual stationary storage battery conference showcasing developments in all battery chemistries which has been held in Florida for more than 25 years.

The event, which attracts more than 400 delegates plus exhibitors, acts as a professional development and networking opportunity for the design, selection, and application of stationary, utility and energy storage battery systems.

Contact
Consortium for Battery Innovation
E: battcon@batteryinnovation.org
www.battcon.com

Battery Cells and Systems Expo and Conference

May 15 – 16
Birmingham, UK

Battery Cells & Systems Expo is a free to attend exhibition and conference showcasing international manufacturers, users and the entire supply chain working to increase battery performance, cost and safety.

The show will bring together automotive OEM's, electric utilities, battery cell manufacturers, system manufacturers and integrators along with the entire manufacturing supply chain.

Co-located with Vehicle Electrification Expo, the show will benefit from the rapid growth in the manufacturing of electric and hybrid vehicles in the UK along with the significant investments being made in domestic battery manufacture and research. Featuring a global list of exhibitors and speakers, the entire world of battery manufacturing and integration will gather in the heart of UK manufacturing, Birmingham.

Contact
Lana Mercer, Event Partners
E: lana.mercer@event-partners.com
www.batterysystemsexpo.com

Eurobat Forum

June 4 – 5
Brussels, Belgium

The Eurobat Forum is the annual event of the association of European automotive and industrial battery producers, bringing together more than 100 key European automotive and industry stakeholders, including senior company executives, policy-makers, association and NGO representatives and more.

In 2024, the two-day event will take place on 4 and 5 June in Madrid at the Hotel Melia Princesa.

Contact
Gert Meylemans, General Manager
E: gmeylemans@eurobat.org
www.eurobat.org

The Battery Show Europe

June 18 – 20
Stuttgart, Germany

The Battery Show Europe provides attendees the chance to explore the latest products and solutions at the largest trade fair in Europe. The only place to find all your supply chain contacts in one place — from raw materials to battery recycling.

Join Peers at the Leading Meeting Place for the Advanced Battery and H/EV Technology Community and meet manufacturers, suppliers, engineers, thought leaders and decision-makers for a conference and trade fair focused on the latest developments in the advanced battery and automotive industries.

Contact
Informa Markets
E: thebatteryshowcs@informa.com
www.thebatteryshow.eu

International Automotive Recycling Congress — IARC

June 19 – 21
Antwerp, Belgium

Calling all automotive recycling industry specialists! IARC 2024 gives you the unique opportunity to hear and exchange with industry leaders and pioneers in a privileged business environment.

IARC is the international platform for discussing the latest developments and challenges in circular economy and automotive recycling.

We bring together up to 300 decision-makers from the automotive and recycling sectors – car manufacturers, metal suppliers, traders, recyclers, shredder operators, and policy-makers.

Contact
ICM AG
E: info@icm.ch
www.events.icm.ch/event

ees Europe

June 19 – 21
Munich, Germany

Discover future-ready solutions for renewable energy storage and advanced battery technology at ees Europe! Europe's largest, most international and most visited exhibition for batteries and energy storage systems is the industry hotspot for suppliers, manufacturers, distributors, and users of stationary electrical energy storage solutions as well as battery systems.

In 2024, more than 450 suppliers of products for energy storage technology and systems will be present at ees Europe and the parallel exhibitions of The smarter E Europe taking place in Munich. The exhibition will be accompanied by a two-day energy storage conference where leading experts delve into current questions of this industry.

Contact
Solar Promotion GmbH
E: thesmartere@fwtm.de
www.ees-europe.com/home


Munich, Germany


Glasgow, Scotland

International Flow Battery Forum — IFBF

June 25 – 27
Glasgow, Scotland

In June 2024 the IFBF will hold its thirteenth in-person conference in Scotland, supported by Invinity Energy Systems and Flow Batteries Europe.

Over three days the conference will feature talks, panel sessions, open discussions, networking breaks, a poster session, conference dinner and a local site visit. We will discuss the latest innovations, policy updates and market challenges for the development of the flow battery sector.

Business leaders, policy makers, developers and researchers will share information and forecasts around the thriving world of energy storage and the important role of flow batteries.

Contact
Swanbarton
E: info@flowbatteryforum.com
www.flowbatteryforum.com

Battery Recycling Conference and Expo

June 26 – 27
Messe Frankfurt, Germany

Battery Recycling Conference & Expo 2024 is the must-attend event for battery producers, recycling companies, critical raw material suppliers, and the entire battery supply chain to come together on a single platform.

Discover the latest innovations and solutions to create a circular economy for used batteries and help create sustainable supply chains for the future.

Contact
Transglobal Events
E: info@trans-worldevents.com
www.batteryrecycling-expo.com

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Contact Karen Hampton: karen@batteriesinternational.com or call +44 7792 852337