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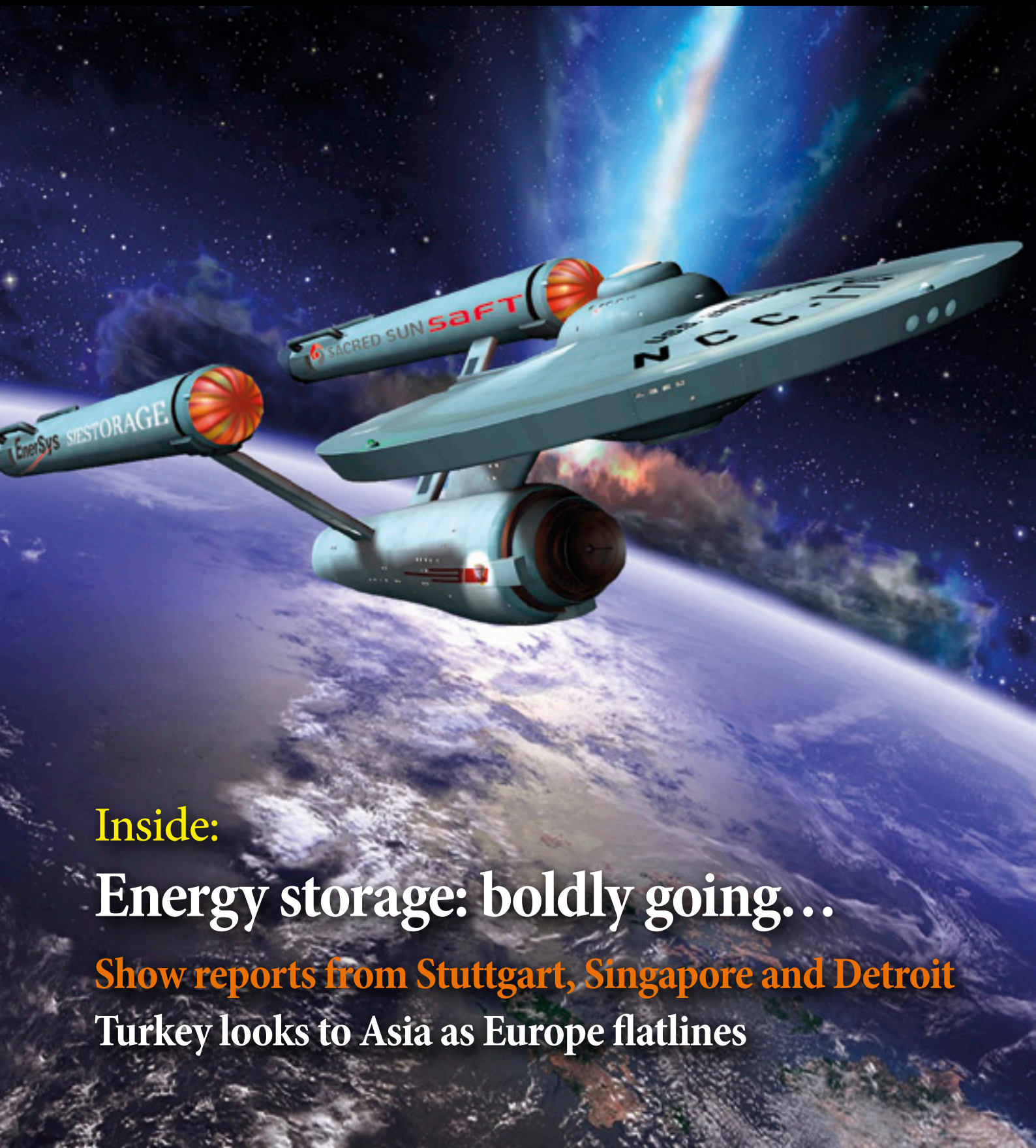

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The Holy Grail is within reach yet out of reach

It is with great delight I welcome you to the Autumn 2013 edition of Batteries & Energy Storage Technology, my first as editor.

I first joined Energy Storage Publishing in 2011 to help launch Critical Power Online, having previously been Associate Editor of Power Engineering International. BEST continues to attend the most relevant battery events and is very much open to invitations to visit you and your factories.

This issue looks in some detail at electricity storage, with a focus on Europe. It is a jarring cliché that storage is the holy grail of the electricity industry, but it is tantalisingly within reach.

In a distribution grid application offering primary (fast) reserve, lithium-ion battery storage is already in the money at today's prices, and prices are set to fall sharply in the years ahead.

In a recent note, *Battery storage – the next solar boom?*, Citi analysts forecast the price of large lithium-ion battery packs to decline by 35-50% by 2020 and perhaps as much as 65% by 2030, even without a technological breakthrough.

Battery storage not only offers frequency response, but investment deferment, time-shifting, load-smoothing, peak-lopping, demand-side response and back-up power.

And if batteries can be connected to PV installations and solar energy can be stored, storage could offer a predictable amount of year-round baseload, thereby minimising the need for capacity payments. Hence there is already an implied value for storage — the differential between negative energy prices, and potential capacity payments to constrained-off generators.

So with so much going for it, it is only a matter of time before battery storage conquers the world, right? Wrong.

In Europe, the nub of the problem is that regulations deem storage as a generation asset. Yet if storage could be classed as a separate asset in its own right, suddenly the business case can be put to the market.

Although this is obvious to everyone, it does not mean it will happen any time soon. Europe's transmission and distribution companies are an almost painfully conservative lot and changing grid regulations in a 28-nation European Union is akin to extracting teeth.

And this is why - aside from the plethora of largely tokenistic demonstration sites across the continent - the real storage action will largely take place not in Europe, but in the United States and East Asia.

Elsewhere in this issue, BEST visits the Asian Battery Conference in Singapore, The Battery Show in Novi, Michigan and Batteries+Storage/F-Cells in Stuttgart.

Meanwhile, Ruth Williams delves into Turkey's battery industry, explores a British university's project to bring DC microgrids to India and the latest developments in battery pulse charging.

Last but not least, Gerry Woolf wonders whether Germany will ever have a large volume, large format lithium battery maker.

Enjoy the issue.

Tim Probert
Editor

tim@energystoragepublishing.com

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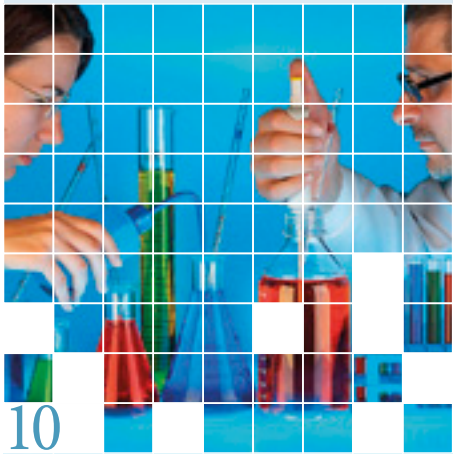
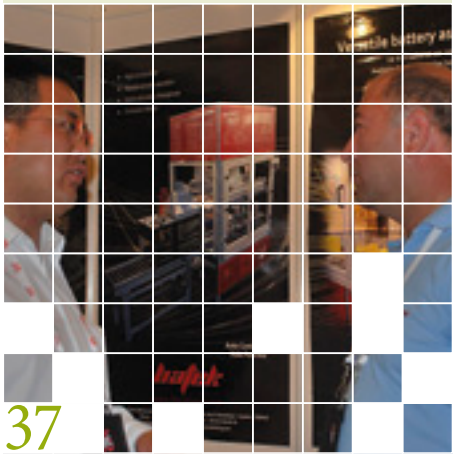
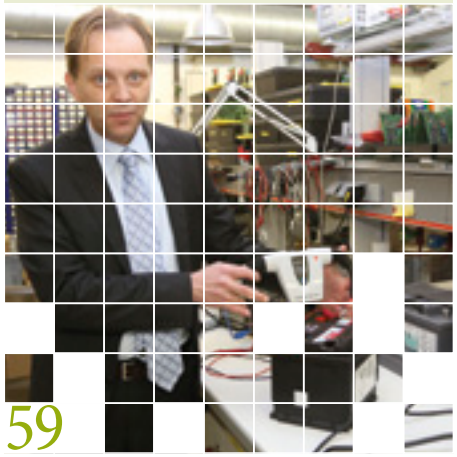
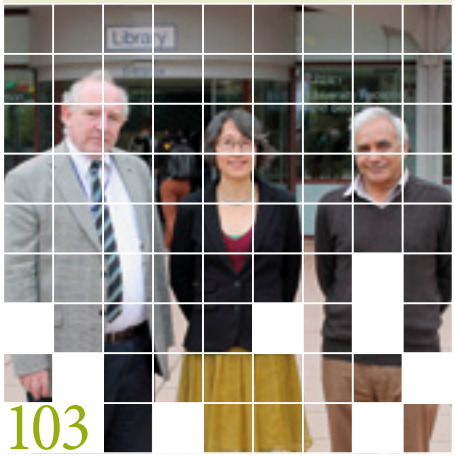
Regulars

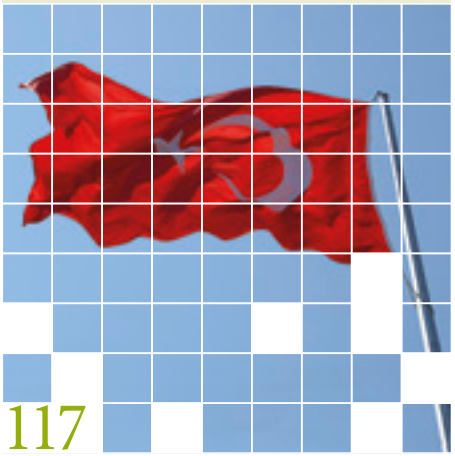
Features









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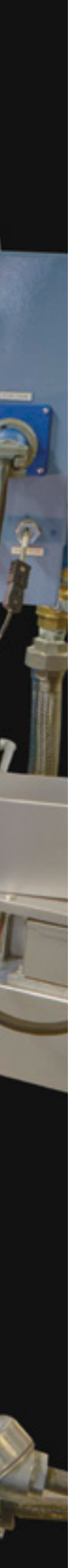

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Reflections on ABC15

I've commented before on the length of events in the battery industry. The fastest of all is unquestionably the Eurobat AGM— the pocket guide to what's new and what's not so new in the battery industry. It's over in a morning.

Racing ahead of that in the speed stakes as the fastest trade show in the world is BCI's Powermart— over in two hours and almost not worth putting a pop-up stand for.

But perhaps the event that languishes most in the battery sector is the Asian Battery Conference, for which one seems to hang around for at least five days waiting to hear what you already knew.

The lead-acid 'revival and resurgence talk' is mainly garbage — lead never went away. Back in the late 1990s, when the first big surge in Internet and cellular hardware took off, lead battery bosses couldn't quite understand why orders for industrial product came rolling in. They were surprised too when the orders fell with the dot-com crash in 1999.

It took one Bob Cullen of Hollingsworth & Vose, a great communicator almost in the Ronald Reagan class, to put matters in perspective. Today's lead battery meetings lack a commentator of Cullen's stature to bring all things into perspective in terms of technology, markets and industry sales forecasts— in other words, a good story with facts, delivered with style.

That said, the story which emerged this year and which we look at in depth further in the issue, is the one of additives.

Squeezing the last drop of performance from lead-acid and overcoming dynamic charge acceptance issues is probably the last great campaign in the lead-acid story as the technology reaches its energy density zenith.

Bring back Bob

There's a plethora of products— new carbons and lignosulfonates— battery Viagra— to be tested in performance trials over the next few years, all standing on the shoulders of some of the ALABC work we reported here in BEST years ago. It will make interesting and contentious reading as each battery maker seeks out the winning recipe for negative plate supremacy, in different operating conditions.

As for the trade fair, this year's show presented an even bolder Chinese machine-making contingent as lead-acid battery making grows ever stronger in the region— not just in China, but in Indonesia, Malaysia, Thailand and so forth. So it was a pity the show was so poorly attended on the second day and lacked verve.

With my own personal decision to spend perhaps half my time working from the Asian region in 2014, you can be sure that ESPL and BEST, in English and Mandarin, is the preferred partner to reach your customers and satisfy your information needs.

Gerry Woolf - Publisher

Nothing acts faster than additives...

Let's hear from you

Got an opinion on the above or anything else? Then share it. If it's battery standards or the answer to the ultimate question in the universe, BEST's readers would like to know.

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Musk defensive after Tesla fire

Tesla suffered a serious dent to its share price and reputation after an internet video showed flames spewing from a Tesla S involved in an accident in Seattle.

The fire occurred after the Tesla S struck metal debris, which became detached from a trailer travelling on the same highway. The object punched a three-inch diameter hole through the quarter inch armour plate protecting the base of the Tesla S.

The owner was nonetheless able to exit the highway as instructed by the onboard alert system, bring the car to a stop and depart the vehicle without injury. A fire caused by the impact began in the front battery module – the battery pack has a total of 16 modules – but was contained to the front section of the car by internal firewalls within the pack.

Vents built into the battery pack directed the flames down towards the road and away from the vehicle. When

the fire department arrived, it correctly applied water; but by puncturing the metal firewall, newly created holes allowed the flames to then vent upwards into the front trunk section of the car.

A combination of water followed by dry chemical extinguisher quickly brought the fire to an end.

Elon Musk, CEO of Tesla Motors, said: "Had a conventional gasoline car encountered the same object on the highway, the result could have been far worse.

"A typical gasoline car only has a thin metal sheet protecting the underbody, leaving it vulnerable to destruction of the fuel supply lines or fuel tank."

Dr Peter Harrop, Chairman and EV analyst at IDTechEx said: "It is no good saying that gasoline vehicles frequently fry their passengers: an estimated 194,000 highway vehicle fires occur each year in the USA alone, across all types of vehicles.

"People are peculiarly intolerant of any dangers from what they see as a 'new' technology such as electric vehicles, even though these have been around for over 130 years.

"Two out of 50 Boeing Dreamliners caught fire recently due to lithium-ion battery packs. The airliner is flying again but, at a recent conference, the containment of its battery sub-modules in ceramic tubes was deemed by a NASA expert to be inadequate on its own to ensure safety.

"Let me put it this way. Just as the Titanic was deemed unsinkable with its sealed compartments but an iceberg slicing a lot of them at once sunk it, so many sealed battery cells can be shorted by one lump of metal slicing them apart.

"Whatever the cause of this accident, lessons will be learnt and action will be taken. We are in the age of the lithium-ion battery and there is no going back."

Hydrogen re-fuelling network for Wales

The Welsh Government is making plans to establish a hydrogen refuelling network across the country, to establish a "hydrogen highway" along the M4 motorway between the major cities of Swansea, Cardiff, Newport and could even be extended to Bristol and London.

ITM Power, based in Sheffield, UK, has been awarded a £1m (US$1.6m) grant from the Welsh Government to assist with the establishment of the hydrogen refuelling infrastructure.

As part of the project, ITM Motive will establish an office in Cardiff with the ultimate intention of establishing a facility for assembly and after sales support across Wales. ITM will collaborate with the University of South Wales and Ynni Glan, a clean energy consultancy firm.

The Welsh Government hopes the refuelling stations rollout will promote the use of low carbon vehicles in Wales. To further show its support, the government recently joined the UKH2Mobility project, which is dedicated to establishing a UK-wide hydrogen network.

Metair to buy Mutlu

South Africa's Metair Investments plans to increase its presence in Europe through the acquisition of the largest lead-acid battery manufacturer in Turkey.

The manufacturer of automotive products said it has concluded an agreement to acquire 100% of Turkey's Mutlu Holding as well as 45% of Mutlu Plastik, which will trigger a mandatory offer to minority shareholders.

Chinese manufacturers unconcerned over shutdowns

China's Ministry of Industry and Information Technology (MIIT) has announced the first batch of companies meeting the State 'Lead-acid Battery Industry Access Conditions'. The regulations require the capacity of new, reorganised and expanded lead-acid battery manufacturers can be no less than 500 000 kVAh.

The first six firms to meet the industry access standards are: Wuxi Pufa Power Supply Corporation, Jiangsu Weisheng Power Supply Corporation, Jiangsu Suzhong Battery Science and Technology Corporation, and East Penn International (Wujiang) Battery Corporation, all in Jiangsu province; Jiangxi Xinwei Power Energy Science and Technology Corporation in Jiangxi province, and Camel Group Xiangyang Storage Battery Corporation in Hubei province.

A source in China told BEST: "The medium- and large-sized factories aren't worried about the assessment. They think sooner or later they will pass, because the regulations, even the laws, are flexible in China. So this announcement is not viewed seriously in the industry yet."

The assessment work began in July 2012; many factories have already passed the environmental inspection, which is the precondition for the new industry access.

The access conditions and other measures to clamp down on smaller Chinese lead-acid battery manufacturers have resulted in a sharp reduction in the number of manufacturers to around 300, down from 3000 just ten years ago. The first batch consisted of nine factories, of which only six passed the accessing condition.

Factories that do not meet the access conditions by the end of 2015 will be shut down, or have their production licence revoked.

JCI's Zwickau plant to be world's largest

Johnson Controls has expanded its Zwickau, Germany, battery plant with a €100m (US$136m) investment, making it the world's largest production facility for AGM batteries.

The plant's increased production capacity is now 6.6m batteries a year - four times the plant's output prior to the expansion.

The expansion is the direct result of increasing consumer demand for stop-start vehicle technology. Projections show that by 2018, roughly 80% of all new cars produced in Europe will be equipped with stop-start.

The expansion project included the addition of a production hall, a logistics building and four assembly lines, which feature the latest technological standards. The expansion has allowed Johnson Controls to double its employment at the site, from roughly 200 employees prior to the renovation to 400.

Halfords cuts stop-start replacement cost

Halfords, the UK's largest retailer of replacement lead-acid automotive batteries, has become the first national retailer to sell and fit replacement AGM batteries for stop-start applications.

Initially all Halfords stores will stock two AGM (absorbant glass mat) battery variants – like those fitted to models including the BMW Mini and 1 Series from 2007 onwards - which are compatible with the vast majority of micro hybrids.

The Halfords stop-start batteries are made by Yuasa and priced at £174.98 (US$280.14) including fitting and come with a warranty of four years, better than their standard three-year warranty for lead-acid batteries.

With most start/stop batteries only guaranteed just one year, Halfords believes there is a value for money requirement.

A spokesman for Halfords told BEST: "We've looked at the car manufacturers' stop-start battery warranties to identify which ones are shorter lived. Many stop-start cars are coming out of their warranty periods and consumers are beginning to shop around on price rather than automatically go to the dealership.

"Our research suggests our lower battery unit and labour costs make us 20%-40% cheaper than a main dealer - depending upon the vehicle brand," he added.

Halfords believes the two Yuasa stop-start AGM batteries offered cover 80% of micro-hybrid cars on British roads.

ILMC's Brian Wilson picks up International Lead Award

Brian Wilson of the International Lead Management Center (ILMC) was awarded the 2013 International Lead Award at the 15th Asian Battery Conference, in Singapore.

The annual award is presented to an individual who has made a major contribution through their working life to the lead and lead-acid battery industries. The award recognises Brian Wilson's role as Programme Manager with the ILMC in the field of environmental stewardship and risk management.

The ILMC is an activity of the International Lead Association and assists in the management of risks associated with lead across all aspects of the lead industry in developing regions and those in transition. A significant focus of ILMC's recent work has been the improvement of practices for the recycling of used lead-acid batteries in Central America, Africa and India.

Wilson said: "I have been most fortunate to meet and work with some remarkable people who share a vision for this world and our industry that takes us forward in a sustainable manner that provides essential services to our modern society and a clean future for generations to come."

The International Lead Award was conceived in 2002 and has been presented to a deserving individual during the course of one of the premier international lead-acid battery conferences – either the Asian Battery Conference or the European Lead Battery Conference.

Past winners: 2003 John E Manders; 2004 Jerome F Cole; 2005 Lan Lam; 2006 R David Prengaman; 2007 John L Devitt; 2008 Allan Cooper; 2009 L Pugazhenthy; 2010 Detchko Pavlov; 2011 Robert P Flicker; 2012 Norbert Maleschitz.

DOE funding for range extending flow battery

Researchers at the Illinois Institute of Technology have been awarded US$3.4M to develop a rechargeable nanoelectrofuel flow battery for electric vehicles. The US Department of Energy's Advanced Research Projects Agency is providing the funding to develop batteries that could extend driving range to 500 miles and recharge faster than existing EV batteries.

The idea is to use a high-energy density liquid with active nanoparticles to increase energy density but maintaining low-resistance within the battery.

The project is led by Carlo Segre, Duchossis Leadership Professor of Physics at the University, and collaborates with a team from Argonne National Laboratory.

The DoE has awarded a total of US$36 million to 22 projects in the Robust Affordable Next Generation EV Storage (RANGE) Programme.

JCI appoints new CEO

Johnson Controls has announced Alex Molinaroli is to be the company's President and CEO from October 1st.

Molinaroli, who has been with the company since 1983, will also serve as Chairman of the Board from January 1st 2014, when Stephen Roell will step down.

The new President has said he wants to lessen the company's business in car parts such as seats, dashboard displays, roof liners and other components. Instead he wants the company to be seen as a multi-industry company by getting into climate-control equipment and systems for hospitals, schools, offices and commercial buildings.

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Germany plans massive H_2 filling station rollout

A consortium comprising Air Liquide, Daimler, Linde, OMV, Shell and Total have agreed a plan for the construction of a nationwide hydrogen refuelling network for fuel cell-powered vehicles in Germany.

Known as the 'H2 Mobility' initiative, the six firms aim to expand the current network of 15 filling stations in Germany to 400 by 2023 at a cost of €350m (US$473m).

The ultimate objective is to offer a hydrogen station equivalent to at least every 90 km of motorway.

Daimler currently has about 200 Mercedes B-Class F-Cell cars on the road. It aims to introduce a fuel cell electric vehicle to the market in 2017, likely to be another B-Class.

Speaking at the F-Cell/Batteries+Storage conference in Stuttgart on 30 September, Daimler's Chief Environmental Officer, Professor Herbert Kohler said: "We are very satisfied with the 500-700km range of fuel cell vehicles and developing new hydrogen filling stations will be a big help to sell more cars." He added that the next 100 filling stations would be operational within four years.

The F-Cell/Batteries+Storage conference also saw the official launch of the state of Baden-Württemberg's 'Fuel Cell Cluster' in an ambitious attempt to make it a global centre of excellence for the hydrogen economy.

The 'cluster' will be co-ordinated by e-mobil BW, the state agency for electric mobility and fuel

cell technology in Baden-Württemberg. It effectively combines and supercedes the state-funded Cluster of Excellence Electric Mobility South West established in 2010 and federally-funded Living Lab BWe, set up in 2011.

Franz Loogen, managing director of e-mobil BW, said the cluster would help Germany develop cutting edge whole-line production techniques to be an exporter rather than an importer of fuel cell technology. "For example, Baden-Württemberg companies could develop techniques to reduce electrolyte filling time, meaning faster production and lower cost," he said.

Loogen added Germany's ambitions to turn wind power into hydrogen gas via electrolysis could boost local manufacturers of electrolysers. Meanwhile, e-mobil BW has published its roadmap, *Baden-Württemberg - Kompetenz* in *Elektromobilität* (Competence in Electric Mobility).

A123 shifts its battery focus

Troubled lithium-ion battery maker A123 Systems is to shift its focus from pure electric vehicles (EV) to hybrid vehicles due to the slow market for the former.

A123's new CEO Jason Forcier said new batteries for stop-start systems and hybrids would grow quickly as car manufacturers sought cheap ways to improve fuel economy. In contrast, the market for pure EVs will remain sluggish for many years, he added.

Expectations for the battery industry in recent years were "in the euphoria territory", but have since come down to a more sustainable level, he said. Forcier estimated that the entire industry is working at between 15% and 20% of capacity.

"We have decided to focus our efforts where the market is evolving more quickly," he added.

As well as making its 'AMP20 Lithium-ion Prismatic Cell' for pure EVs and plug-in hybrids, A123 also makes a 12V lithium-ion Nanophosphate battery marketed as a replacement for 12V lead-acid micro-hybrid car batteries.

A123 has a range of customers and vehicles, including General Motors Co's Chevrolet Spark electric car, BMW AG's 3-, 5- and 7-series hybrids and Daimler AG's Mercedes-Benz AMG vehicles. It also supplies batteries to Formula One race cars and Fiat SpA's Ferrari.

A123 was the first company to open an EV battery plant in the US to build batteries for electric vehicles under a government-backed programme. However, A123 filed for bankruptcy after ramping up production in anticipation of stronger demand for electric vehicles than materialised, followed by a costly recall of batteries and the failure of Fisker Automotive Inc., a maker of luxury plug-in hybrids, that was its largest customer.

Forcier still believes the Livonia, Michigan production facility was worthwhile.

"If it hadn't been for the government funding, A123 would have continued to build its capacity up in China."

Toyota e-Trike challenge

Is it a car, is it a bike? No, it's something in the middle. Toyota is soon to produce an e-trike, called the i-Road, which bridges the gap between e-bikes and electric cars.

The offering is fully electric, with two 2kW electric motors mounted in the front wheels and a range of 50KM provided by a lithium-ion battery, with a three-hour re-charge.

The two-seater trike is the reverse of a conventional three-wheeler, with two wheels at the front and one at the rear. The i-Road has rear-wheel steering making it handle much more like a car than a bike.

Although it is marketed as a transport option for the city, charging the battery for users who live in apartment blocks could be a bone of contention.

The i-Road is production ready, but not yet available to buy.

JCI reveals 48v Li solution

Johnson Controls has unveiled its first-generation 48V lithium-ion micro-hybrid battery at the International Motor Show (IAA) in Frankfurt, Germany.

Leveraging a dual voltage architecture, Johnson Controls' micro-hybrid battery system combines a 12V starter battery and a 48V lithium-ion battery, which it claims could provide up to 15% fuel savings in vehicles. The battery will be available for testing with key automotive customers this December.

The 48V battery is designed with the capacity to quickly capture energy from braking and can support higher loads such as air-conditioning and active chassis technologies. The 12V battery provides power to the vehicle starter, interior and exterior lights, and entertainment systems such as radios and DVD players.

The prismatic lithium-ion cells and complete systems for the prototypes will be made at Johnson Controls' facility in Holland, Michigan. The battery is designed with standardised components and size to help drive scale and minimise cost, it claims.

Ray Shemanski, Vice President and General Manager of the Original Equipment Group for Johnson Controls Power Solutions, said: "We expect micro hybrid technology will be adopted in Europe first, due to more stringent fuel economy and emissions standards, and then quickly move to U.S. markets in the next few years with global adoption starting in 2020."

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M+W develops mini dryroom for Li cell makers

M+W Group has launched a dryroom for the manufacture of lithium-ion battery cells.

The German firm says the M+W Isolator Dryroom makes it possible for the customer to obtain considerable savings in investment and operating costs thanks to so-called 'mini-environments'. M+W

says there is no more need for workers to enter the dryroom area as the process machines can be operated externally.

This extensive spatial separation of people and highly dry environmental areas ensures significantly more stable environmental conditions and considerable savings in the operating costs. At the same time, it minimises possible health risks that could be posed to staff remaining in the extremely dry air.

The extremely dry climate in the dryroom remains highly stable - a dewpoint can be achieved as a measure for air dryness at virtually -80°C (-112°F).

The new dryroom solution is a result of M+W Group's cooperation with the Karlsruhe Institute of Technology (KIT) focusing on dryroom technology and resource-efficiency.

India's CPCB tightens battery disposal rules

The Indian central pollution control board (CPCB) has told lead-acid battery manufacturers to set up collection points, individually or jointly, for used batteries from consumers or dealers.

Lead-acid battery manufacturers are required to promote public awareness about recycling used batteries. The collection and disposal of smaller batteries pose the greatest concern to PCB officials.

The industry has also been asked to file half-yearly sales and buyback figures to the board.

Recycling plant needs US$7.4m upgrade

Exide Technologies has agreed to set aside US$7.7 million to pay for new filters to lower its arsenic emissions and new piping for a stormwater system.

The move comes after California state regulators accused Exide of producing toxic air emissions that may have threatened the health of more than 100 000 people.

The deal means the state Department of Toxic Substances Control will drop its effort to temporarily close the plant, which officials moved to do in March after reports that elevated arsenic emissions posed an increased cancer risk to 110 000 people.

Under the agreement, Exide will replace the on-site underground storm-water piping with a more advanced double-walled system at a cost of more than US$4m. Construction is underway and is expected to be completed by the end of 2013.

Exide has also begun installing additional high-efficiency filters to reduce emissions and later, a separate device to cut organic emissions. Exide began furnace modifications early this year to reduce arsenic emissions.

The money will also fund previously announced tests for lead and arsenic in the soil and dust in the neighborhood around the plant, as well as making voluntary blood tests available to 250 000 people.

Approximately 25 000 lead-acid batteries are recycled daily, or around eight million a year.

"We continue to strive to make our Vernon plant a premiere recycling facility and consider the health and safety of the community and our workforce a top priority," Robert M. Caruso, Exide's Chief Executive said in a statement. "Exide has taken aggressive steps to install new equipment at the plant and those efforts have paid off in substantially reducing emissions."

The planned expenditures will bring Exide's total investment in environmental upgrades at the Vernon plant to more than US$18 million since 2008.

GM drops lithium-ion for lead

General Motors is eliminating lithium-ion batteries from its popular Malibu mid-range car in favour of a Johnson Controls AGM lead-acid battery.

The 2014 Chevrolet Malibu will use a stop-start system with a lead-acid battery to achieve the same fuel economy as the older model.

The new technology is standard on all 2014 models; EAssist was a US$1 500 option on 2013 Malibus.

The Malibu's new stop-start system uses a compact lead-acid battery in the trunk and a larger lead-acid battery under the hood to turn off the 2.5-litre, four-cylinder engine when the vehicle is stopped or idling.

A spokesman for GM said: "We found we could get the same results from a less expensive technology and at the same time save the customer money."

GM began offering eAssist technology as a fuel-saver in 2011, when it began offering the technology in a handful of vehicles. The company promoted eAssist as a mild hybrid system that uses a 115V lithium-ion battery and a 15kW electric motor.

GM last May recalled 38,197 Malibu, Buick LaCrosse and Buick Regal sedans equipped with eAssist systems to fix a defect the company said could lead to overheating or even fires in the circuitry that controls the system.

Enersys buys Purcell Systems

Enersys has acquired Purcell Systems, a manufacturer of thermally managed electronic equipment and battery cabinet enclosures, for US$115m.

Purcell Systems, based in Spokane, Washington, currently enjoys sales currently in excess of US$100m per year for customers globally in telecommunication, broadband, utility, rail and military applications.

Ecoult enters Cleantech 100 list

Ultrabattery developer Ecoult was named in Cleantech Group's 2013 Global Cleantech 100 as one of the world's top 100 private companies from a field of 6 000 nominated global companies.

Based in Sydney, Australia, Ecoult designs and delivers energy storage solutions based on the UltraBattery—an ultracapacitor and lead-acid hybrid. Ecoult scored well because Ultrabattery performs on key performance metrics required for grid-scale renewable energy support.

Ecoult's CEO John Wood said: "This recognition is a great honour for Ecoult and for our US parent company, East Penn Manufacturing. We are very fortunate to have an awesome technology to steward and to have assembled a fantastic team to take it forward."

The Global Cleantech 100 is derived from Cleantech Group's own data and research, combined with the weighted qualitative judgments of hundreds of nominations, and the viewpoints of a global 90-person expert panel. To qualify for the list, companies must be independent, for-profit, cleantech companies that are not listed on any major stock exchange.

GS Yuasa powers space travel

Batteries supplied by GS Yuasa are being used to provide electrical power to the Orbital Cynus spacecraft on its maiden voyage to the International Space Station.

Using high energy density LSE190 lithium-ion cells, the battery will provide power immediately after launch and during in-orbit operations.

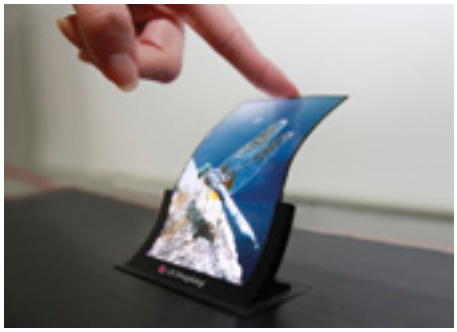
Yuasa is providing flight batteries for eight missions to the ISS until 2016.

Flexi-batteries from LG Chem

Korea's LG Chem is to manufacture of a series of flexible lithium-ion batteries aimed at wearable smartphones and other gadgets.

The so-called stepped battery, which stacks two batteries on top of another, started to be rolled out from the chemical firm's assembly lines in Nanjing, China in July, and is currently powering LG Electronics' flagship smartphone G2 sold outside Korea.

The design of the battery enables smartphones to make the most of the space within the devices by filling up so-called 'dead space'. The technology also increases the battery life.



The curved battery will facilitate products such as curved-screen smart phones and watches. The company has the exclusive patent for the technology that reduces physical stress when creating curved battery packs.

The mass production of curved batteries started in October and the batteries will power LG's next smartphone lineup, which is expected to be released in November.

Cable batteries are designed for bendable or wearable gadgets, and can even be tied into a knot. The waterproof features of the battery allow it to be used in wearable gadgets ranging from necklaces to smart watches, according to the firm.

Kwon Young-soo, president of the Seoul-based battery manufacturer, said: "LG Chem has succeeded in launching future batteries that have not existed before. This shall be the fundamental grounds for LG Chem to become a pioneer in the market."

Young-soo said that the applications of the new batteries were "limitless", including bendable smartphones, smart glasses and smart necklaces, which many global gadget makers had inquired or placed orders for them.

"Inquiries for the batteries are flooding in from global electronics gadget makers," the firm said, adding, "They are literally shocked by the latest jaw-dropping technology."

Global firms such as Apple and Google are said to be among the partners.

Brad Roberts of ESA passes on

Brad Roberts, the Executive Director of the Electricity Storage Association (ESA) died on October 15th following a recent illness.

Roberts, 69, was the Power Quality Systems Director for the Power Quality group of S&C Electric Company, as well as his work with ESA. He had more than 35 years of experience in the design and operation of critical power systems, ranging from single-phase UPS systems to medium-voltage applications.

He began his engineering work as a systems reliability engineer in the Apollo Lunar Module Programme at Cape Kennedy. He held senior management positions in two of the major UPS manufacturers during his career. Roberts was a senior life member of IEEE and had published over 50 technical papers and journal articles on critical power system design and energy storage technology.

Mr. Roberts was a member of the US Department of Energy's Electricity Advisory Committee. He had testified before the US Congress on the need for more energy storage in utility grids. He was a member of the University of Florida's College of Engineering Advisory Committee. He was a Senior Life Member of IEEE.

REDT installs flow battery

REDT has installed a 5 kW/60kWh vanadium redox flow battery system at the University of Evora, Portugal.

The project is part of the European Commission's Seventh Framework Project, which aims to develop improved methodology, management, efficiency and cost reduction for renewable energy generated from PV installations.

The system can deliver 2kW load for up to three days during periods of low solar output.

Cellulose key to 'fireproof' Li battery

Researchers at Abu Dhabi's 'future' energy Masdar Institute claim to have found a way to make lithium-ion batteries 'fireproof' and have filed a US patent.

Lithium batteries were blamed for the on-board fire that suffocated the pilots of UPS Flight 6, which crashed in the desert outside Dubai on September 3, 2010.

Dr Raed Hashaikeh, Associate Professor, at Masdar's Water and Environment Engineering Programme said they had found a way to make fire-prone lithium-ion batteries safer and cheaper using cellulose as the electrolyte.

Organic solvents in electrolytes that can heat up in case of short circuiting, deep charging or discharging or exposure to high temperatures were to blame for fires, Dr Hashaikeh said. By using cellulose— a chain of sugar molecules found in plant cell walls which gives wood its remarkable strength— lithium batteries will be better protected, he said.

The biggest advantage of cellulose, a thermally-stable substance, is its great abundance. "Cellulose is biodegradable and is a low-cost material," Dr Hashaikeh told UAE newspaper XPRESS.

Since cellulose is not conductive to lithium ions, the researchers tested different combinations, modified its structure in the lab to maintain its mechanical stability and at the same time make it conductive.

Finally, they were able to successfully come up with a chargeable coin cell battery around their lab-developed developed electrolyte.

"We are looking into scaling up into large batteries and 3D designs of batteries based on our developed electrolyte," he said.

The team's peer-reviewed paper on the cellulose-reinforced batteries was published in the Journal of Applied Polymer Science earlier this year and Journal of Membrane Science.

A patent application for the technique has been submitted to the US Patent and Trademark Office.

CA utilities angry over 'dirty' storage scams

California has led the US in the clean energy revolution, but now energy storage with PV is facing a backlash from the main utility providers.

The three largest utility companies in California– PG&E, Sempra Energy (SRE) and Edison International (EIX)– are claiming consumers who have a home PV system with energy storage could fraudulently sell 'unclean' energy back to the grid.

As battery storage is becoming prevalently installed with PV systems, the utility companies have suggested regulations do not cover the type of power being produced, stored and sold.

The big three are intending to introduce measures to verify that energy being sold to the grid has been generated by solar panels, not simply taken from the grid, stored in a battery and re-sold as 'clean' energy.

However unlikely it seems that a consumer would buy a battery system simply to earn a small income in this way; the loophole is yet to be addressed.

State and industry regulators are devising official guidelines for solar suppliers, customers, and the utilities to work to. The Southern Californian Public Utilities Commission will provide formal direction on the proper use in coming months.

This comes concurrently to the California Public Utilities Commission (CPUC) authoring a proposed decision to install 1.325GW of energy storage across the state by 2020.

Commissioner Carla Peterman has set out year-by-year procurement targets for SCE, SDG&E and PG&E.

The installed energy storage can come from any type of technology and can be employed for a variety of functions such as capacity, ancillary services and peak shaving.

PG&E and SCE are each required to install 580 MW of capacity and SDG&E must acquire 165 MW in total by 2020. The utilities would be allowed to own some of the energy storage capacity as part of their distribution system planning process.

This is the first time energy storage has been included in US State policy.

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Machines Manufacturer Expert for Lead Acid Battery Assembly Line and Finishing Line

Cast On Strap Machine for Car/ VRLA Battery

Specifications:

Model :	COS-32/62
Application:	To weld the group of plates
Production Capacity:	80-90pcs /hour (calculated by 70AH Car battery)
Operator Required:	Two operators (One is for loading, the other one is for unloading) Same Production Capacity Operator Required for Group Burning: Four Operators
Production flow:	Loading the plate groups and Lug Alignment—Lug Brushing, fluxing and Tinning—Cast on Strap –Unloading
Power Consumption:	AC38V/220V, 50HZ, 46KW
Air Consumption:	0.55MPa 0.2m³/min
Water Consumption:	20L/min, 0.2Mpa
Machine Weigh:	600Kg
Machine Dimension:	3800×3200×2000mm (not included the foundation bolt and dust collection hood)
Work Position:	four work position

Plate Enveloping and Stacking Machine for Car / VRLA Battery

Specifications:

Model :	SEPG-32/62
Application:	Realization of production of single plate to the group of plates
Production Capacity:	120pcs/min
Production flow:	Loading the plate in the first work position—Enveloping—Loading the plate in the second position—Loading the plate in the third work position—Plate groups alignment-Collection
Power Consumption:	3P AC 380V 50HZ
Air Consumption:	0.55MPa 0.2m³/min
Machine Weigh:	4000Kg
Feature:	Can wrap both positive and negative plate, Check the plate quantity more or less, suitable for different type of plate, with safety switch.
Machine Dimension:	10900mm × 4500mm × 2800mm

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Eagle Eye detector protects against hydrogen explosions

Eagle Eye Power Solutions has introduced a hydrogen gas detector, the HGD-2000, to protect battery rooms from hydrogen gas buildup.

The HGD-2000 Hydrogen Gas Detector allows users to monitor hydrogen gas buildup in storage rooms and facilities that house batteries - including forklifts, golf carts, backup power supplies, and battery charging stations. Charging lead-acid batteries emit hydrogen gas after reaching the 80% recharge point. This can become highly flammable when mixed with enough air; the lower explosive level for hydrogen is 4.1% by volume.

A sensor alerts the user if the concentration of hydrogen gas in the room reaches 1% by volume. A yellow LED will light and the 1% internal relay will close. A four second delay prevents false activation. If the concentration reaches 2%, the red LED will flash, the internal 80 db warning alarm will sound, and the 2% internal relay will close.

The HGD-2000 is suitable for both AC and DC power sources.

Pilot line for lithium entry

Solith, a division of Sovema, has introduced a pilot line for lithium-ion cell manufacture for under a million Euros.

The production machine allows companies developing new lithium-ion chemistries to produce sufficient cells and batteries for customer evaluation.

The pilot line makes pouch cell designs for large-scale storage or EVs, down to cell phone devices.

The line consists of an electrode-punching machine, a stacking machine for precise line up of the cell components, a blister-forming machine to create the pouch package, a trimming and tab-welding machine to join the cells together, an electrolyte filling system and finally, a sealing machine.

The formation system, which is 92% efficient, is bi-directional— so when testing cells, power is fed back to the grid. It includes an ageing module to ensure cells assembled for packs are properly matched.

For more info email: piergiuseppe.bernini@sovema.it

New model from Ross for mixing pastes and slurries

Ross has introduced the Laboratory High Viscosity Disperser mixer, which features interchangeable bow tie and paddle blades driven by a 2HP explosion-proof VFD-capable motor suitable for mixing pastes and slurries for multiple chemistries.

It is available for use with standard five-gallon pails, with larger capacity models up to 55-gallon drums, or up to 500 gallons for other vessels. The bench-top mixer blends fluids with vastly different viscosities and quickly re-suspends dense solids that settle during transport or storage.

The High Viscosity Disperser Model PBA-2 is offered with either an electro-mechanical lift or an air/oil hydraulic lift to raise and lower the blades.

More info: www.mixers.com

JCI Powersports batteries for US

Johnson Controls has launched its premium Varta AGM Powersports battery line in North America. The batteries are offered in 16 different group sizes for a wide range of powersports including motorcycles, ATVs, snowmobiles, UTVs, scooters and personal watercrafts.

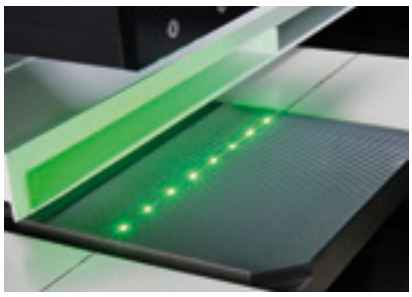
Lasers sharpen Germany's Li cell making abilities

German company Manz AG has developed a tool that may help German cell-making catch up with Asia.

Manz AG's latest ideas in lithium electrode slitting uses laser technology rather than blades. This eliminates tool wear, which makes a saving of 25% for production costs, and gives a superior finish to the electrode foil edge leading to less scrap.

The lasers can also be used to perform an ablation technique to help eliminate wrinkles resultant from the calendaring process- simply by burning raised elements of the electrode surface away.

More info: www.manz.com/products-services



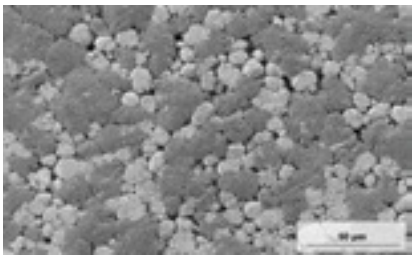
Heraeus electrode additive improves conductivity

German materials engineering firm Heraeus has launched Porocarb, a range of conductive porous carbon powder to improve ionic conductivity in electrodes for lithium-ion batteries.

The novel carbon particles were three years in development to achieve the pore-size distribution ranging from 10 and 1,000 nanometers and internal pore volumes up to 2.5 cubic cm per gram.

The pore size gaps mean the Porocarb additive can increase the capacity of a lithium-ion battery without affecting the size or, conversely, make a smaller battery with the same capacity. It is also a suitable catalyst support for fuel cells.

When added to electrode slurries, high-porosity areas remain after the electrode compression. This leads to more effective ion kinetics while keeping the overall electrode density high. This makes it possible to double the thickness of the electrode layer without lowering performance.



Pore size distribution improves ionic conductivity.

For more info see: www.heraeus-porocarb.com

48V micro-hybrid battery from AllCell

AllCell claims the passive thermal management system will keep the battery temperature below 40ºC, even in hot environments.

AllCell Automotive has released a 48V micro-hybrid battery it claims can keep itself cool even in hot, parked car; a contributing cause of battery deterioration.

The battery uses a heat absorbing material to protect overheating cells and a composite phase change material (PCM) for thermal management. This is made from wax and graphite materials that absorb and distribute heat, even if the battery is not in use.

Absorbing heat and limiting the maximum temperature extends battery life and eliminates the need for cooling systems.

For more info go to: www.allcellautomotive.com

Sacred Sun microgrid eliminates gensets

Chinese battery maker Shandong Sacred Sun has recently completed a 1.274MW photovoltaic power generation project at Beiji Island, a land reclamation project in China.

The energy storage component is made up of lithium iron phosphate and lead-acid battery systems operating in parallel, to take advantage of the different charge/discharge characteristics of the chemistries and extend the service life of the system.

The system has eliminated the need for diesel generators to provide electricity on the island.

The microgrid on Beiji Island features dual chemistry storage.

Saft takes off into aircraft handling

A Saft Lithium-ion battery system is being used to power the first hybrid tractor for maneuvering large aircraft between hangars and passenger gates at airports.

The contract, with German aircraft tractor specialist Kalmar Motor, is the first of its kind to demonstrate the potential of using hybrid technology in the airport ground-handling sector.

The battery system for the Kalmar Motor TBL 800 will use Saft lithium-ion batteries and BMS. The TBL 800 is suitable for large wide-bodied aircraft and will be trialled at German airports shortly.

The ground-handling sector is facing the challenge of lowering emissions and using energy efficient technologies.

Versatile two channel testing from Arbin

Arbin has developed a tester series, called the EVTS-X, that is the most versatile tester on the current market. The new model's versatility stems from its suitability for a wide range of voltages from -400V to 800V and up to 600 Amps.

As with other Arbin test systems, it features independent test channels capable of running complex, user-defined test schedules in multiple current ranges. There are two high precision channels for powerful regenerative testing for electric vehicle and grid storage applications.

For higher current applications, test channels can be operated in parallel, which allows users to double the current capacity of their test system. The channel series mode provides users with the ability to test an expanded range of battery packs with a single piece of test equipment.

The EVTS-X features discharge booster mode configuration which lets users reverse the polarity of one channel in series with the second test channel allowing for an extreme negative voltage testing range. This mode provides one test channel with a full negative to positive voltage range for over-discharge, reverse-charge, and other specialised R&D testing.

For more info go to: www.arbin.com

EIRICH celebrates 150 years

This summer Maschinenfabrik Gustav Eirich GmbH celebrated the 150th anniversary of its founding in 1863. Family-run EIRICH has, in the words of the managing directors, remained young at heart for 150 years. This, along with supportive employees, has been highly instrumental in the success and the long tradition of this company.

The anniversary celebrations included the opening of a company museum at EIRICH's headquarters in Hardheim, Germany that traces its history from small workshop to global engineering enterprise.

Anniversary celebrations included the unveiling of a sculpture.

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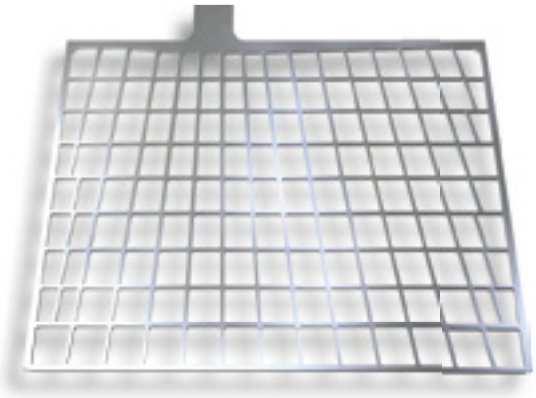

The **Sovema PunchPlus®** is the innovative "oil-free" punching machine which doesn't require **any lubricant** during the punching operation: so, there is **no need to wash** the grids, **enabling a significant drop of production costs and environmental impacts**. The machine performs the **punching cycle in 10 milliseconds** without heat production and provides the **maximum flexibility in the grid design** at same time allowing an **easy mould change**. Designed to work with a continuous strip flowing, it punches up to **600 grids per minute**.

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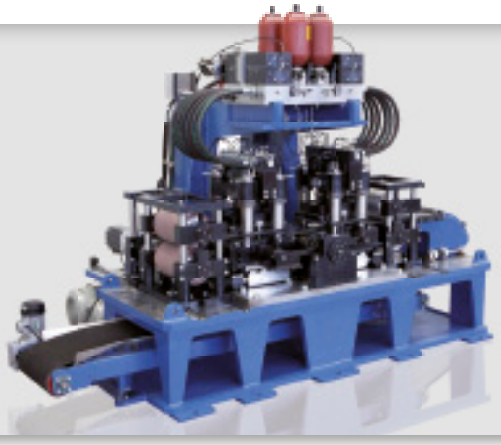

ESPL's BEST magazine Lead-Acid Award 2012 to Sovema S.p.A.
for the most innovative lead-acid process technology
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Asian Battery Conference 15: Preaching to the converted

The biennial Asian Battery Conference returned to Singapore for the first time since 1987. My how it has grown! Editor Tim Probert finds an up-beat conference, excited by the possibilities of carbon additives for lead-acid, let down a little by too many videos and too much lithium-ion paranoia.

The last time the Asian Battery Conference (ABC) was in Singapore, the film '*Dirty Dancing*' had just been released and Madonna was top of the charts with '*Who's That Girl*'. Back in 1987, ABC was a different beast: a highly technical conference of the old school with only 150 in attendance.

ABC is now an 'event', where possibly everybody who's anybody in the lead-acid battery world tends to show up. A record-breaking 712 delegates attended ABC15, smashing the previous best of around 600, from over 40 nations.

The commercial attraction of ABC is a double-edged sword. It appears exhibitors who fork out for a booth may also get first dibs on the conference, and so the presentations were split into three main categories: insightful; those rather painful presentations by Chinese students reading their slides aloud word-for-word as if from an English class school textbook; and blatant advertising.

The networking opportunities are superb yet the conference suffers from too much puff, and certainly too many videos. Video can enhance a presentation, but when it amounts to little more than 'Introduce Company X; Introduce Product Y; Press 'Play'; ***"Any questions?"*** it rather defeats the purpose of a conference.

While the show enjoys being a showpiece of the lead-acid battery industry, it is not clear if much business is conducted at ABC or whether suppliers are merely talking to other suppliers.

That said, it is a comprehensive conference, running the gamut of lead-acid, from the price of lead to next-generation batteries and everything in between, so there is something for everyone.

Being a lead-acid show, delegates and speakers seemed all-too-keen keen to talk down lithium-ion. Eco-Bat's Ray Kubis almost gleefully highlighted the well-publicised events—***did anyone say Boeing 787***

Ahmet Tolga Önen, Uğur Gündüz and Ismail Eren Ünlü of Akumsan.

Dreamliner?!— since the last ABC in 2011. The perceived easy-ride lithium gets in terms of recycling— "not good enough!"— continues to be a bugbear of the lead-acid community.

Part of this is jealousy. As I blogged on the BEST website recently, the relationship between lead-acid and lithium-ion is like that between a slightly aging actress and a young starlet. The younger woman gets most of the attention – Electric vehicles! Power tools! iPhones! – and the aging actress looks on with some bitterness and envy.

Yet the lead-acid industry has no need to be so defensive. It may be aging but it has still by far the biggest box office, and will continue to do so for some time to come. And as ABC15 demonstrated, carbon additives— the Botox of batteries— are prolonging their beauty.

Buzzy atmosphere

ABC15 kicked off in earnest with a cocktails-and-canapes network reception the previous night, which was positively buzzing and led to a genuine sense of occasion. Day one of the conference began with insight into the global lead market. ***Conclusion?*** Up, up, up all the way in terms of demand. Asia is the centre of the battery world, with two-thirds of the market. Asia has 60% of the lead-acid battery market and 90% of the lithium-ion market.

Global demand for lead is set to rise from 11m tonnes to 15m tonnes over the next decade, with growth coming from Russia, Asia and Latin America, although North American output is forecast to halve. Asian demand is seen growing 7.1% per year against barely 1% for the rest of the world.

The urbanisation of China and India— which will see a combined 355m people living in their cities by 2025 – is at the core of the anticipated demand. This will have a knock-on effect on demand for cars, two-wheelers and telecoms.

In the short term, consolidation among US smelters is driving regional tightness and may push the United States to renew imports, drawing in supply from the rest of the world and lifting premiums in Asia and Europe. Helen Matthews of consultancy WoodMackenzie expects the global lead surplus of around 100,000 tonnes this year halving in 2014.

WoodMac sees lead prices, currently trading at around US$2,100/tonne, rising US$100 higher next year, and in a US$2,200-2,400 band for the next few years. Neil Hawkes of analysts CRU said international US premiums paid on top of LME prices to obtain metal, are around US$0.10-0.12/lb (US$220 to US$265 a tonne), but could rise US$0.15 next year.

Chinese problems continue

Yet while demand for lead continues to be strong, not everything is totally rosy in the Asian battery world. Increased performance has reduced demand for replacement market for forklift trucks, while growth for new e-bikes in China is seen as flat at best, with negative growth likely.

E-bikes, dubbed a 'silent killer' because they are difficult to hear until it is too late, are being banned in several major cities due to a large number of road accidents. With e-bikes comprising one-third of the Chinese battery market this could have a significant effect, though the huge existing fleet requires new batteries every two years and so the replacement market will remain reasonably firm.

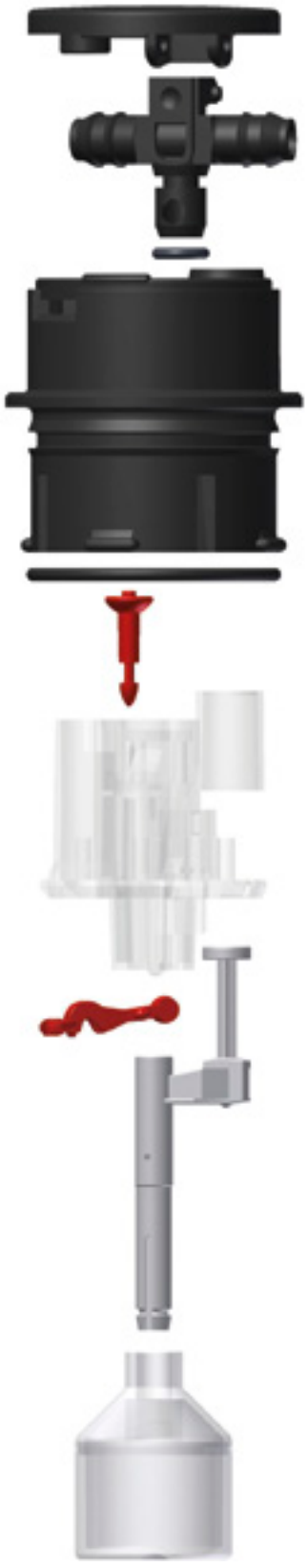
China may have culled its battery manufacturers to just 300 from 3 000 in ten years, but the "environmental storm" was far from over, warned Dong Li, CEO of Leoch Battery Shenzen Group – China's fifth largest battery firm.

Chinese battery manufacturers, not wishing to commit suicide, have made a collective decision not to apply for a license to continue operations, fearful of a Government yet to make certain of its new regulations. With everyone waiting for everyone else to apply, the Government has delayed the process until next year.

Many Chinese firms fear the reaper and the impasse is exacerbated by the ban on banks lending to small and medium-sized battery firms and there are big challenges ahead.

Sustainable – yeuch!

Continuing the environmental theme, Kubis went big on



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demonstrating how lead had improved its 'sustainablilty', that dreadful catch-all - yet pretty meaningless - term, plucking out a brilliant stat that a 1957 Chevy pumped out the same amount of lead – 8.8 lb – over 15,000 miles as the 12,500 tonnes/year Quemetco recycled lead facility in Indianapolis today.

The imminent closure of the only primary lead smelter left in the United States— Herculaneum in Missouri— not to mention the declining North American primary lead market in general, offers an opportunity to the secondary lead market, and don't they just know it.

David Prengaman of Eco-Bat is marketing its 'SuperSoft' secondary lead as a direct replacement for Herculaneum primary lead, boasting of its almost identical purity, except – joy of joys! – its higher bismuth content. Whether Eco-Bat's offering will match the price of Herculaneum's soon-to-disappear output is another matter.

Special mention must go to Brian Wilson of the International Lead Management Centre (ILMC), who scooped the 'International Lead Award' gong, which is, of course, a medal. Wilson has spent many years encouraging lead recycling techniques in developing nations, tirelessly negotiating with government departments in India— an almost thankless task— and Africa.

Wilson regaled the audience with the time he spent in Russia at a smelting plant. As a vegetarian, all he would eat was cabbage fritters, while his Russian comrades would demand endless slabs of meat. Such was his appreciation of their cabbage fritters it brought offers of marriage from what Wilson described as attractive yet put-upon dinner ladies, though quite what his Russian brothers and sisters made of his all-too-probable flatulence, we were not told.

Celal Saricam MD of Batek Engineering (right) with one of the many visitors to his stand during the show.

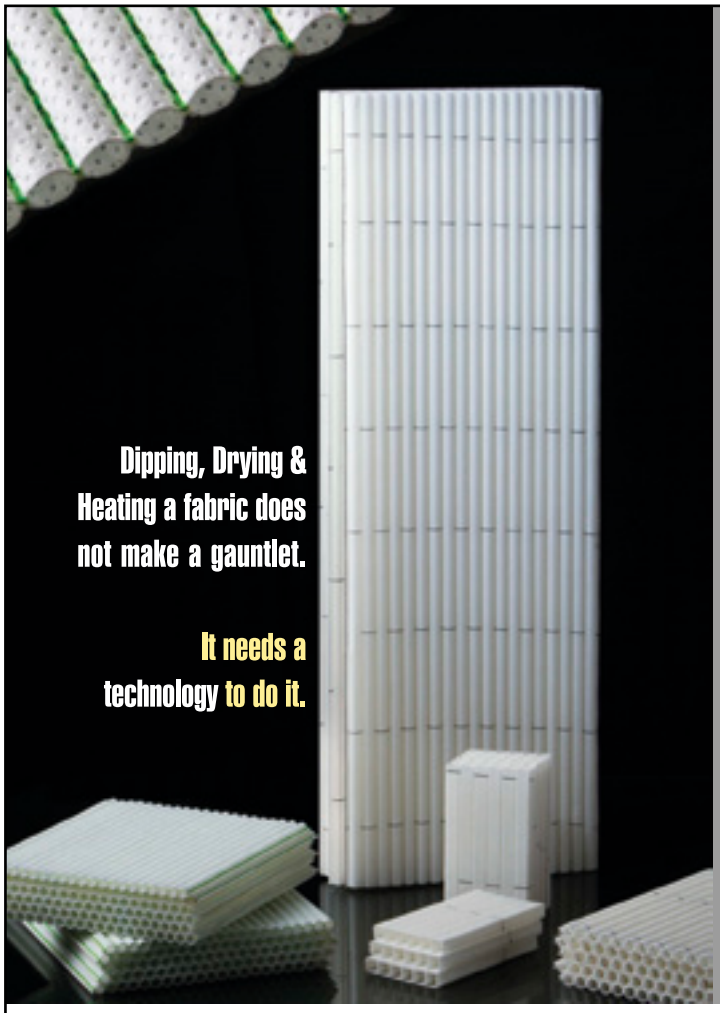
Patchy presentations

It is doubtful whether Ajou University's Jeongbin Lee will look back on his presentation at ABC15 with relish. Presenting research on the charge/discharge behaviour of an absorbent glass mat lead-acid battery, which was simultaneously very brief yet 'thorough', the audience proceeded to bombard with questions poor Jeongbin— whose English was somewhat less than fluent— to fill the time, and he walked off the stage somewhat dazed and confused.

Jun Furukawa will probably not look upon ABC 15 with fondness either. One by one industry heavyweights took potshots at Furukawa's patchy Ultrabattery presentation.

NorthStar's Gunder Karlsson queried how Furukawa had magically solved the problem of acid stratification. The

Tapas Ranjan Ghosh and Yasowant Roy of KE-Technical Textiles PVT Ltd.



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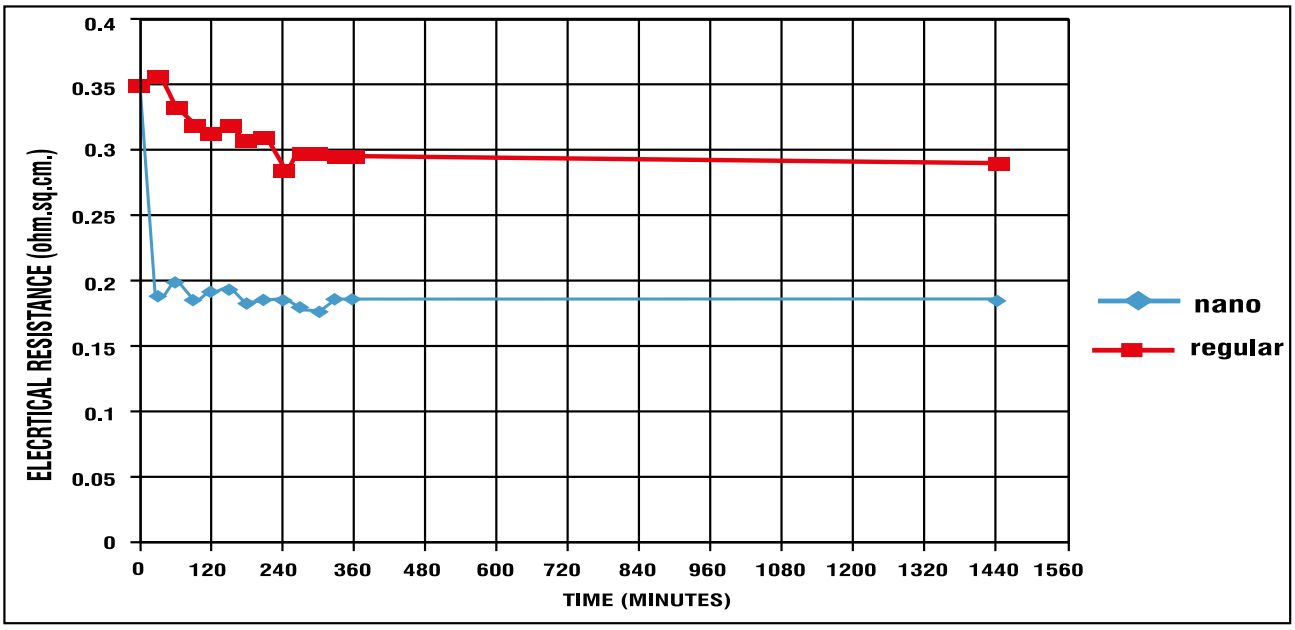

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International Lead Zinc Research Organisation's Boris Monahov questioned the performance of the positive plate, while a representative of Exide wondered how cycling life apparently improved with greater depth of discharge.

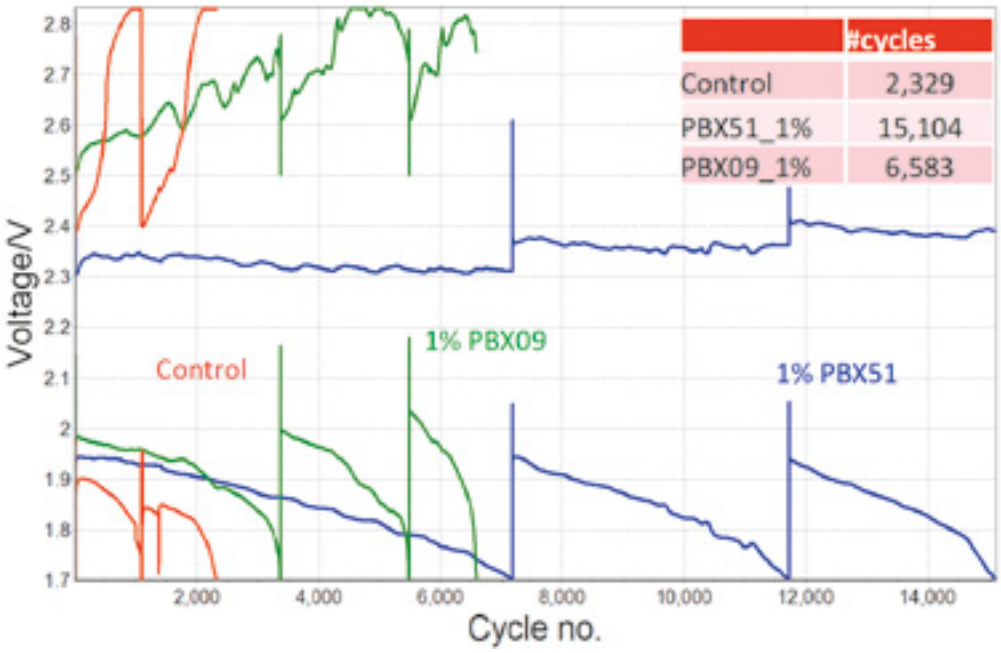
Maybe the questioners are not keen on seeing the Ultrabattery progress, or maybe it was just a duff presentation with more holes than Swiss cheese. Whichever the case, Furukawa's Ultrabattery is already on the market and appears unlikely to be going away.

Ultrabattery got two goes at ABC15. John Wood of Ecoult, owned by East Penn, boasted of its sexiness as a dual-purpose UPS/frequency regulation system, mainly for data centres, which in return for a US$1.5 million per MW investment, could earn around US$250 000/year for balancing services. Wood was tight-lipped over its new customers, but we'll find out soon enough.

The author was also disappointed with Abertax's KD Merz presentation on coupling solar PV with, among others, lithium-ion energy storage batteries, as it appeared to conclude it needed a CHP unit to make it work. Funny that!

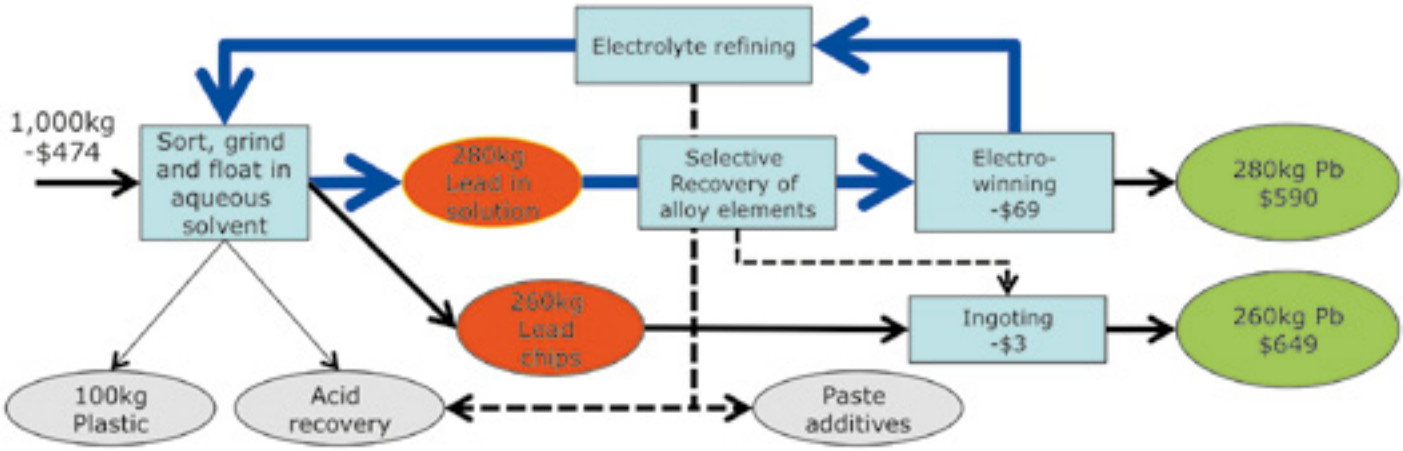
Alan Cooper of ALABC was much more satisfying with an excellent presentation on converting various VW Passats to a micro-hybrid with 12V and 48V lead-acid batteries in conjunction with an integrated starter charger and electric supercharger.

This award-winning programme has real potential to be deployed in the commercial field as an inexpensive way to increase performance while reducing emissions, even though fuel efficiency may be compromised. Again, though, one had the suspicion that here was another case of being seen to preserve the relevance of lead-acid against the young upstart, lithium-ion, and hearing of a stalled project run by Hyundai – but using a car made by arch-rivals Kia – deflated the optimism somewhat.



Above: HRPSoC cycling test results with Cabot carbon additives. 4.8h AGM cell, 5% DOD with 3c rate, 1 min@50% SOC; 2.83V-1.7. Courtesy: P Atanssova, Cabot.

Below: Applied Intellectual Capital's vision of commercial-scale 'smelterless' lead battery recycling. Courtesy: S Clarke, AIC.



- Costs: $567/Tonne of batteries recycled
  - Batteries, labor, electrical energy, residuals treatment and disposal
- Revenue: $1,239/Tonne of batteries recycled
  - Assuming lead as the only source of revenue

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More 'Lead Ain't Dead'

The second day continued the theme of 'lead ain't dead'. Geoffrey May of Focus Consulting expects lead-acid to dominate for at least the next 20 years, bolstered by demand for stop-start batteries, which will be in the majority of all new cars sold within the next ten years. We shall see.

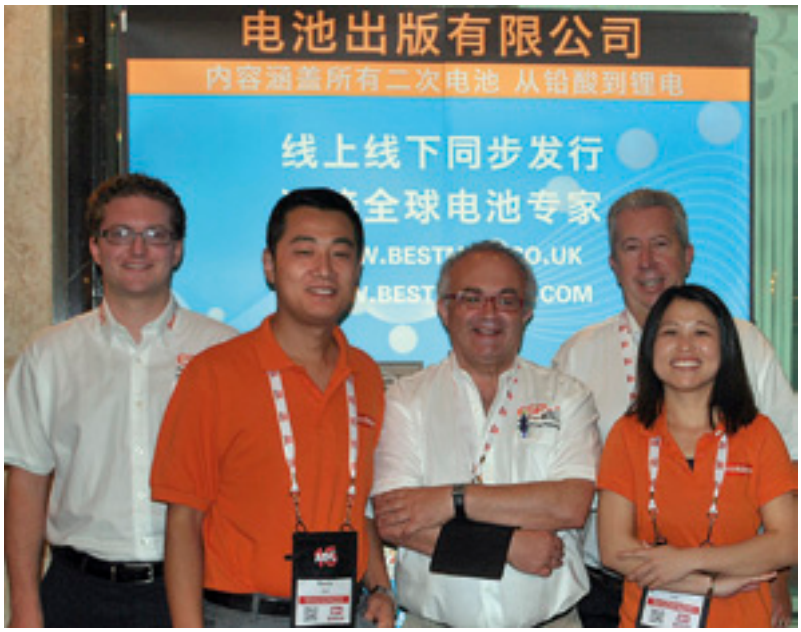
Perhaps again with lithium-ion in mind, NorthStar's Gunder Karlsson presented his research on thermal runaway in VRLA— research that was actually conducted more than a decade ago. Once more, it was an obvious example of '*Lead-acid 1, Lithium-ion 0*', because thermal runaway in lead-acid cells is really a thing of the past.

Meredith Block of the Blacksmith Institute (BI) – having recounted a project in Senegal to clean up some gruesome levels of lead in villagers' homes - told of progress in China, which is not quite so offended by the thought of Westerners poking their noses in their business as it once was. The University of Zhejiang, which has received a grant to research lead clean-up, approached the BI, and work is set to commence in November at lead battery manufacturing and recycling facilities in Chanxing County, Zhejiang Province.

Batteries Plus' director of quality assurance Oz Rahman made an interesting presentation on how his firm, a major battery retailer with over 600 stores in the USA, sources its batteries, of which 75% come from Asia.

According to Rahman, visiting an Asian battery factory is like stepping back in the past, with antiquated facilities and techniques which usually don't cut Batteries Plus' mustard. Only one-third of Asian batteries sampled pass their tests in Shenzen and Milwaukee, and Rahman was clear: if you want to sell batteries to me you need better quality control with better verification data.

Tim Probert, Kevin Sail, Gerry Woolf, Les Hawkins and Zhai Yali of ESPL.



Additives Day

Day three was, mainly, 'additives day' and certainly the most academic. While carbon additives show enormous potential, they are not without drawbacks, primarily high-rate discharge and high water loss. There is strong evidence that decreased high-rate discharge and higher water loss are due to partial adsorption of lignosulfonate on the carbon surface.

Developing the right carbon additive for advanced lead-acid batteries is not easy; there is no one-size-fits-all solution due to the differing depth of cycling for various applications, be it e-bikes or stop-start.

Paolina Atanassova of Cabot seemed very proud of their carbon black additives, which she claimed improved cycling rates by 300-1000%. Quite how carbon additives improve dynamic charge acceptance and cycling life so dramatically is not fully understood, and this came through in Paolina's presentation, though maximising the surface area using the minimal volume of carbon black is the general rule of thumb to success.

However, maximising the surface area of the negative active material (NAM) while lowering carbon black additives can result in depolarisation of the negative plate, while raising carbon content leads to a big water loss headache. Atanassova said Cabot was surprised by profound test results showing when the overall concentration of lignosulfonate in the negative plate paste is appropriately adjusted, high-rate discharge performance and water loss can both be restored to an acceptable level.

The Bulgarian revealed Cabot is testing new carbon additives for lead-acid batteries resulting in a significant dynamic charge acceptance performance improvements, and is close to releasing highly promising trial data results.

For many, carbon additives are a case of suck-it-and-see. New Zealand is not renowned for its battery expertise but a start-up – ArcActive – is giving it a shot. ArcActive's schtick is developing negative plates based on arc-treated carbon fibre loaded with

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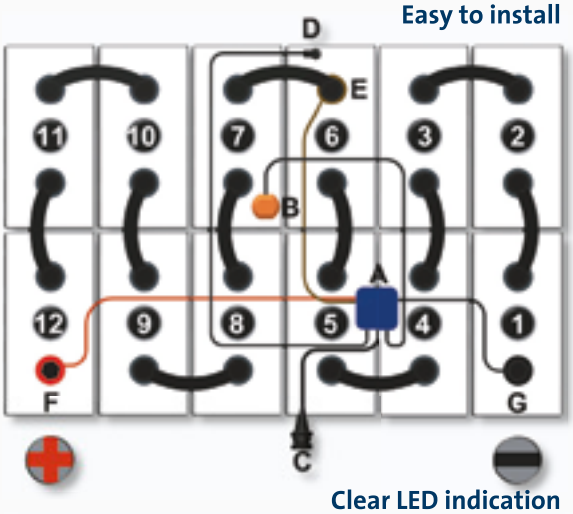

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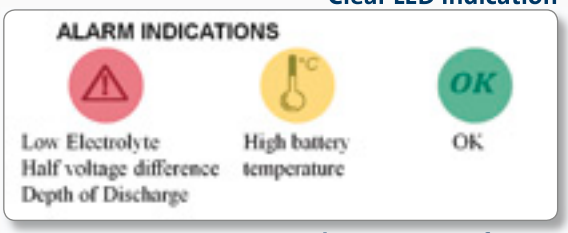

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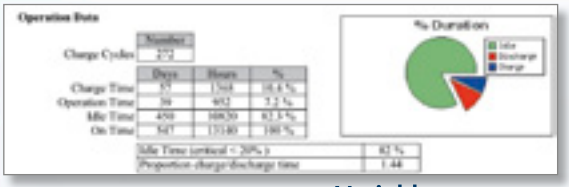
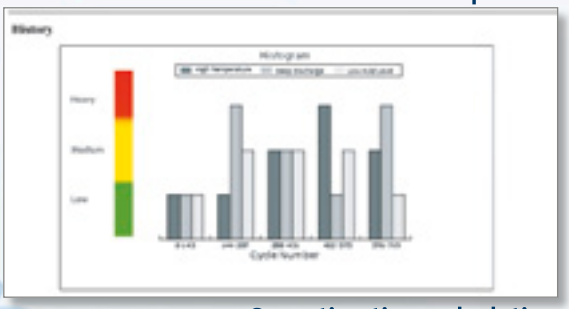


Variable sequences



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Smelterless lead recycling?

Around 220 delegates attended the 3rd Secondary Lead conference, which was a big jump on the previous show and for what is a pretty niche event which took place two days before ABC15. There was good feedback from delegates and Australian event organisers Conference Works were pretty excited about the prospects for 2015.

Perhaps the most interesting presentation was by Britain's Stephen Clarke, CEO of California's Applied Intellectual Capital (AIC). Clarke unveiled 'smelterless' lead-acid battery recycling via an all-aqueous process incorporating a new electrolyte.

Due to environmental issues, it's becoming difficult for lead-acid battery manufacturers to be 'hivers' of lead and conduct on-site recycling with a smelter. China is making it illegal for manufacturers to own recycling facilities, making it hard to be vertically integrated.

AIC's objective is to produce an automated, closed loop recycling plant using an all-aqueous process with no waste gas, liquid or dust emissions. Lead oxides go in and lead comes out via a new, non-toxic, biodegradable electrolyte. As there is no CO_2, SO_2 or lead dust emissions from the process, Clarke suggests 'smelterless recycling' may not even require a permit.

AIC got into this when it worked in Hawaii to recover lead, lead oxide and lead sulphate from coral sands at the Pearl Harbor burial ground on behalf on the US Navy. Being calcium carbonate, coral sand is more soluble than lead, lead sulphate and lead oxide, so AIC developed an aqueous solvent extraction technique, a closed-loop process re-uses the solvent and the development of a novel plating process to preserve the aqueous solvent.

Despite the success of the project, AIC found no wider marker for taking lead out of soil and the work gathered dust on the shelf for the best part of ten years. In 2012, AIC revisited the concept to adapt it to lead-acid batteries.

Clarke insists AIC is not a firm of "white-coated lab rats" and it has built a 1-2 tonnes/day prototype as proof of concept. The pilot works by dissolving and plating lead rather than melting it, a 2000 year-old technology; the lead chips are melted into ingots and then split into two streams primary and secondary lead – the tricky bit.

AIC's modelling estimates the process has an all-in cost of US$727/tonne, earning revenue of US$1174/tonne. At commercial scale, at a US$20m capital cost for a unit processing 40 tonnes/day on-site, revenue of US$1239/tonne would accrue from US$567/tonne costs.

lead NAM to enhance direct charge acceptance.

The carbon fibre is heated to around 3 500°C - you cannot get much hotter without vaporising it; it has taken the Kiwis ten years to optimise the process and they say it is worth the effort. Having initially sought to harness the technology for supercapacitors, it wisely decided to pursue a hybrid lead-acid/supercapacitor battery instead.

ArcActive is targeting 80A DCA from a 25 mA/cm2 superficial area with nine negative plates and 17 plates, using a simple leady oxide/vanadium/barium sulphate paste. Working with Focus Consulting's Geoffrey May, who doled out some 'tough love' to improve ArcActive's poor performance, the New Zealanders have improved its CCA data from 170mA/cm2 at -18°C to 390 mA/cm2, though CEO Stuart McKenzie is not quite sure exactly how...

The New Zealanders have obtained NZ$10m (US$8.5m) – a whiff of an oily rag, as they put it – but they say it has attracted the attention of a number of suitable manufacturers. Watch this space.

Meanwhile, Angel Kircher of *Laboratoire de Stockage de l'Électricité*, part of France's CEA, and erstwhile student of the Institute of Electrochemistry and Energy Systems, Sofia, presented the results of a study into carbon honeycomb current collectors for lead-acid batteries operating in high-rate partial state-of-charge (HRPSoC) applications such as hybrid electric vehicles.

The upshot is HRPSoC operation without irreversible sulfation of NAM comes at the cost of disappointing energy efficiency due to the thickness of the plates (3.5mm), as well as high water loss. Moreover, the Faradic efficiency of about 99% results in disappointing micro-cycling results.

The HRPSoC cycling of the negative plates proceeds with a Faradic efficiency close to that of the positive plates. Thus the negative plates become sulfated after about 50 capacity turnovers. The sulfation is highly reversible, however, and the capacity of the negative plate is completely recovered even after only five HRPSOC schedules that involve several deep cycles.

As ever, NorthStar's Gunder Karlsson probed deeper and ascertained that Kirchev had not made any attempts to observe the size of lead sulphate crystals after NAM sulfation. Kirchev said this information would be available "sooner or later", without suggesting when.

To summarise a decent show and few would have left ABC15 too disappointed, but then again the author wonders if many left enlightened, even after a three-day marathon.

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Exportweltmeister in lithium and fuel cells? Germany's big ambitions

Editor Tim Probert visits Stuttgart's Batteries + Storage event, part of World of Energy Solutions, and finds Germany has no shortage of ambition to become an *exportweltmeister* in lithium-ion batteries and fuel cells.

Between 2003-2008, Germany was the world's largest exporter. As the boom turned to bust, Germany slipped to third place in the global race, but it is currently challenging the USA to reclaim second place.

Germany's export success is heartening to those living in certain European nations who went down the route of more or less abandoning any hope of being a leading exporter, believing that making things should be left to Asia.

Germany clearly demonstrates that European nations can be leading manufacturers despite relatively high wages, regulations and, dare I say it, trade unions. As long as you can make something people want, people will buy it.

That is the confidence, some might say, arrogance of Germany. She has no doubt that while other countries can make things cheaper, Germany makes them best.

This lies deep in the German psyche. At World of Energy Solutions in Stuttgart, an umbrella for three events – F-cell, Battery+Storage and E-Mobil Baden-Württemberg Technologietag – the air was thick with German ambition.

This rather worthy event swarming with regional politicians had a sizeable show floor of around 100 exhibitors and a well-attended, high-level conference programme. For the two streams of batteries/energy storage conference sessions, at least, it was difficult to find a seat if you arrived late, which— heaven forfend! – BEST was not.

German energy storage

The sessions were split approximately 50-50 between serious academic research and commercial (though no less interesting) presentations. Undoubtedly the pick of the energy storage conference sessions was by Karlsruhe Institute of Technology's (KIT) Dr Andreas Gutsch, who made an engaging presentation on integrating electrochemical storage with solar PV.

Interestingly, KIT's research on suitable battery chemistry for the heavy-duty cycling needed for a grid-connected storage system providing ancillary services found, at present costs, the only one not out of the money is lithium-ion. Anything offering fewer than 3 000 cycles would not cut the mustard, apparently ruling out lead-acid even at a total cost of ownership at €500/kWh (US$675), while vanadium redox flow would never see enough action to be cost-competitive.

Dr Gutsch finished his presentation by warning that many of the companies exhibiting their lithium-ion home and business energy storage systems downstairs were selling potentially dangerous equipment due to a lack of ceramic protection.

If those companies continued to do so at the 2014 event, he would

start to name names. They have been warned!

In the author's prior existence as a writer/editor about power generation, a sound maxim was that a technology should only be taken reasonably seriously if the big boys like General Electric, Alstom, Mitsubishi and Siemens were offering it to the market.

While not a manufacturer of energy storage batteries like GE with its Durathon product, Siemens, one of Germany's exporting crown jewels, of course, offers a packaged lithium-ion energy storage system called Siestorage. Dr. Wolfgang Weydanz, who heads up Siemens' energy storage research said it had booked several orders in recent months, primarily as a back-up power device.

Dr. Weydanz is looking "intensively" at a lithium-ion supercapacitor hybrid and is attracted to the prospect of "cheap chemistries" for redox flow batteries for medium-term storage applications. Eventually, he says, redox flow's costs could be comparable to pumped hydro on kilowatt-hour basis. At present, Siemens' lithium-ion Siestorage system weighs in at around €1 500/kWh.

Fuel Cells

But I digress. The main thrust of the conference was about German ambition to be a world leader in e-mobility and its associated technologies.

Not content with being the world's leading exporter of cars many people lust after— be they Mercedes, BMW or Audi— Germany now wants to be an *exportweltmeister* in fuel-cell cars and fuel cells.

Daimler, which launched an electric van powered by an 860kg battery pack in 1972— the LC306— showed off its Mercedes B-Class F-Cell car. The B-Class F-Cell has a range of around 400km, does 0-60 miles per hour in 7.9 seconds with a top speed of 170 kmh, and has zero carbon emissions.

The drawback, of course, is the price. The car is not for sale, only lease for 'special projects', but with comparable vehicles costing €80 000 (US$108 000), it is not the kind of car you'd buy for your son/daughter for their 18th birthday present.

Yet Daimler appears to be serious. Well, semi-serious. It will launch in 2017 a fuel cell vehicle, although it has yet to be decided which 'class' (though probably a B-Class).

Furthermore, in conjunction with Air Liquide, Linde, OMV, Shell and Total, it has developed an 'action plan' to install 400 hydrogen refilling stations in Germany by 2023, up from 15 now. The idea is that nowhere in Germany will be further than 90km from a hydrogen refilling station.

This plan will cost €350m and, realising that no-one will buy a fuel cell car if they cannot refill it – the scheme should go a long way to making fuel-cell dreams a bit less dreamy.

Simultaneously, the state of Baden-Württemberg unveiled its Fuel Cell Cluster— an attempt to make Stuttgart a global centre of hydrogen excellence like Ulsan in Korea or Vancouver in Canada.

Daimler is headquartered in Stuttgart, so this makes sense. What is not clear is whether Stuttgart can be a centre for fuel cell production.

As Daimler's Chief Environmental Officer Professor Herbert Kohler acknowledged, Germany has some catching up to do with Korea, the USA and Canada, which have been investing (and subsidising) in fuel cells for many years.

Korea in particular is by far and away the leader in solid oxide fuel cells, which look to be a very promising technology for both e-mobility and stationary power applications, both crucial to Germany's '*Energiewende*' or energy transformation.

What seems more likely is that Germany could become a world leader in the manufacturer of machinery and fuel cell production techniques. The author has visited

Little doubt that 'energy storage' is a firmly established buzz phrase.

fuel cell production facilities and was struck by the potting shed nature of some firms' operations.

Germany is always looking for new markets to be a 'world leader' and developing high-tech production techniques for fuel cells may be one such opportunity. The same may also be true for Germany's lithium-ion ambitions.

Germany's lithium-ion batteries

Germany wants to be the world leader in e-mobility, targeting one million electric vehicles on the road by 2020. This means in turn it wants to be a world leader in lithium-ion batteries, especially cells.

Despite the high mountain to climb, it is the job of the *Kompetenznetzwerk Lithium-Ionen Batterien* (KLiB)— Lithium-ion Batteries Network of Expertise— to help make this happen.

KLiB believes in Germany's golden opportunity to become a leading player in large lithium-ion cells, indeed, it was formed with the express aim of the country becoming a lead manufacturer and provider of lithium-ion batteries and cells.

All the industries which are necessary to build up lithium-ion cell production are there in Germany, be they chemical, automotive and of course battery manufacturing industries. Germany almost has the full supply chain to develop a successful lithium-ion cell industry except, crucially, a major cell manufacturer.

This is rather unfortunate as it is estimated that 60-80% of the value of lithium-ion batteries is in cell production. Furthermore, 50% of cell costs lay in production. So it is plain to see Germany has a great deal of catching up to do if it is to gain sufficient knowledge to reduce the cost of cells, and in turn drive down battery pack and electric vehicle costs.

Have container... will fill with batteries. Major players including Siemens and AEG are doing just that.

The organisation has grown from 16 members in 2009 to 50 in 2013, 42 of which are companies but the rest being R&D institutes. The membership almost but not quite covers the full lithium-ion value chain.

Dr Michael Krausa, managing director, looks to the progress made in consumer lithium-ion cells in the 14 years since Sony launched the 18650 back in 1991 to 2005, when capacity increased by a factor of three while the price reduced by a factor of eight.

Krausa believes the learning curve for large lithium cells has only just begun. "The German lithium-ion cell production industry is far away from being the lead provider in cells and not strong enough to compete at present," he says.

"Germany is in the valley of tears. On the other hand we shouldn't forget we have the capability to overcome the problems, and several federal funding programmes to strengthen our research institutes."

Krausa says that by coordinating the existing supply chain to pool Germany's expertise, KLiB will go a long way to helping the country achieve her lithium ambitions.

"The supply chain needs to share its experience. In my opinion, dialogue between the chemical and automotive industries is essential. It's a completely different world for both."

Hydrogen-fuelled buses are the ubiquitous totems of all EV events and this show was no different.

Krausa laments the popular misconception in Germany that batteries are somehow a low-tech industry: "Many people in Germany don't see batteries as a high-tech industry, but they couldn't be more wrong. We need to change this view."

KLiB is not merely a coordinator, its working group on measurement techniques is said to be particularly strong, and is highly active with R&D institutes to develop new materials. It also lobbies the German government to fund lithium-ion infrastructure, and to this end it has been successful.

KLiB's largest project is a test cell production line at the ZSW Laboratory for Battery Technology (eLaB) in Ulm, part-funded by the Federal Ministry of Education and Research (BMBF). The production line will have the capacity to produce 70 000 22Ah prismatic, hard-cased coiled cells per year.

It is also in discussions with the ministry to commence a study into automotive battery safety with the ultimate intention of developing safer technology along the supply chain. To this end, KLiB will host a conference, Batterieforum, in conjunction the research ministry and member companies such as BMW in Berlin on 29-31 January.

Krausa does not suggest German companies develop brand-new chemistries but rather adopt, adapt and improve the capacity of lithium-ion, which he believes will be around for the next 30 years.

"It's not like making a new 'handy' [cellular phone], a new chemistry with a new generation of materials takes 15 to 20 years before it hits the streets," he says. KLiB does not plan on making the same mistakes as the Americans did by building lithium-ion battery factories for invisible customers.

"It's not easy to start this. Ultimately it requires a German company to take things into their own hands and become a lithium cell manufacturer. Maybe we need more time to bring the right partners together.

"Maybe KLiB's objectives will fail but it is not completely unrealistic. It is right to have a plan and a goal to become a global leader."

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The case of the missing battery company

German e-cars do for buyers what the Japanese cannot— make them attractive, sexy and likely to sell. Sadly there is no German large volume large format lithium battery maker. Will there ever be one, asks Gerry Woolf?

German car manufacturers expect big EV sales, but this is equally good news for Asia.

BMW is rubbing its hands at the thought of more sales than it expected with its i3 electric car, which goes on sale in the UK in November priced with prices starting at a mere £25K. There are already 8000 orders worldwide and according to CFO Friedrich Eichiner, the company will increase production in 2014.

Too bad then that perhaps 50% of the value in the vehicle— the batteries—are Korean. They are made by Samsung.

Audi's plug-in hybrid, known as the e-tron, is also just coming to market in 2014. Its lithium-ion batteries are made by Sanyo.

VW is offering the staggering 261mpg Volkswagen XL1 diesel hybrid. We're not certain about the makers of its energy storage solution, but we can guess.

Go through the whole list of plug-ins, pure electrics and hybrids coming to market in the next couple of years and it's pretty well understood that other than the microhybrids with lead-acid based stop-start VRLA (made in Germany by JCI), the batteries are almost certainly Asian.

No wonder the Germans are worried.

If BMW and Audi are the vanguard of making electrified cars a market success, then the Germans are set to lose to imports half the potential value of these vehicles for a decade or more.

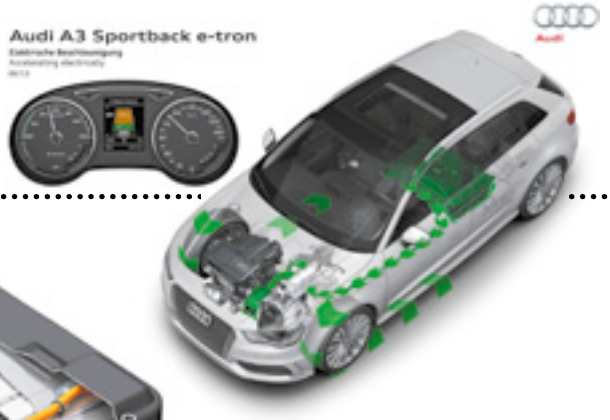
German advanced battery making is hardly out of the starting gate. Today there are just three players players: loss making Li Tec— the joint venture with Daimler and Evonik, loss making Litarion, the battery component supplier— also part of the Evonik group.

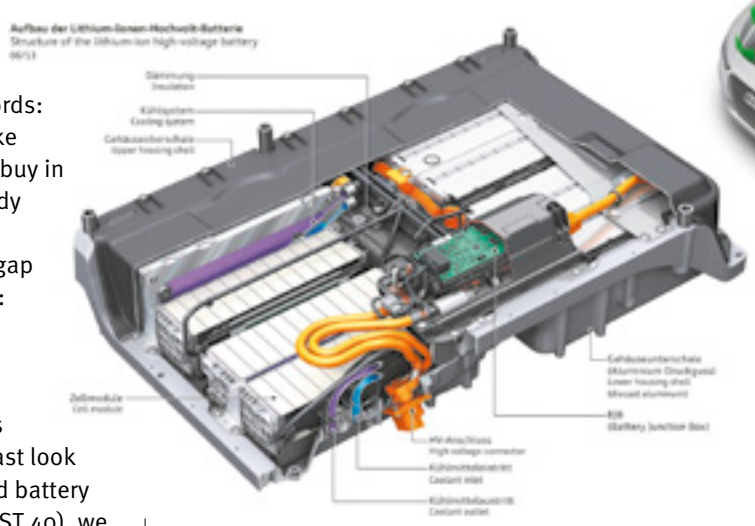
Then there's Liontec— a tiddler with just a handful of employees. We mustn't forget Gaia batteries, which formed a joint venture with Enersys in 2011 but the website doesn't list a collection of order stories which would suggest a great future in the advanced automotive market.

Walking around the Batteries and Storage show in Stuttgart last month there were German battery pack makers yes, but no sign of a German A123 or a Panasonic.

Where are the big boys? German owned BASF, a typical latecomer, came on the EV scene a couple of years ago but has been picky about what it wants to do. There is more money to be made in making components for advanced batteries, it believes.

Latest battery news from the company: BASF is spending US$25m to expand its R&D site at Beachwood, Ohio, to include cathode materials research, and chemical and process engineering. The expansions will increase the number of employees at the site by 40, to 90. "Our investment in Beachwood will allow us to focus on developing new battery materials that can provide higher energy density, greater power, increased safety, and lower cost," says Andreas Fischer, V.P.





Audi's lithium battery system made by Sanyo: Vorsprung durch Japanese technik.

of battery research and electrochemistry at BASF. Or in others words: "We're not going to make cells that no one wants buy in volume. That's somebody else's headache."

The German lithium gap is appreciated certainly: but it's going to need a gargantuan effort to fill the void. To date only the German tool makers are benefitting: In our last look at the German advanced battery industry this Spring (BEST 40), we covered the ubiquitous presence of Digatron formation and testing system sales in Aachen through the University and the associated e-mobility companies based there.

In September Manz AG, won an order worth around EUR 5m (US$6.8m) through its battery division, to advance the development of near-series production processes and new materials for standardised prismatic lithium-ion batteries at ZSW— the Centre for Solar Energy and Hydrogen Research Baden-Württemberg.

The research line is a strategic project run by the German Federal Government's National Electric Mobility Platform. The intended focus is to increase the quality and safety of the batteries and reduce production costs, thereby accelerating the establishment of a strong cell and battery industry in Germany.

Manz has a lot to offer as an advanced toolmaker in the field of lithium-ion technology. In Stuttgart the company presented its technology for laser cutting electrode foils— far and away in advance of anything the rest of the world has to offer.

Dieter Manz, CEO and founder of Manz AG, said in a company statement, "We are delighted that we, as Germany's leading engineering company in the field of lithium-ion batteries, are able to support the research project with our know-how. This union between the ZSW and a host of renowned industrial companies is a powerful statement about this technology's future viability."

What Herr Manz doesn't say is that thanks to the quality and imagination of German automakers, the e-market may come faster than German battery making is geared up for.

Experts are assuming that battery capacities in the automotive sector are likely to grow with an average annual growth rate of 59% to 19 GWh by 2015 and 49 GWh by 2020. The growth prospects in the stationary electricity storage segment are similarly positive: capacities of 2 GWh for 2015 and as much as 10 GWh for 2020 are being forecast. Dieter Manz is correspondingly optimistic: "Over the next few years I see excellent growth potential for our company in the battery division. If the market continues to develop positively, the battery division could achieve a range of revenue similar to that of our currently booming display division in three to five years."

It would be nice if some of his customers were European or preferably, for the sake of the German auto industry, German.

From where this author is sitting, there doesn't look like there's much chance of that.

There's no shortage of willing helpers— paradoxically from Korea. ***Who helped the Samsungs and the LGs of this world conquer the battery markets?*** Tool and machine makers of course.

Song Yon Eum of Itochu explained how the company had focused on increasing speed of production and indeed speed of installation, putting in formation calendaring and assembly lines in as little as six months from orders being placed.

The firm has made electrodes wider and faster than anyone else. The subtext was obvious: ***they've done as much as they can in Korea are there any German firms interested?***

This writer thinks Mr Eum will return to Korea a little disappointed. Germany has a half complete jigsaw puzzle of all the pieces needed for an advanced e-mobility industry: Great car makers, training, advanced tool makers in test and manufacture but no 'wow chemistry' and no company with advanced cell making experience in volume. That was obvious when I made my first visit to ZSW a decade ago; Germans were observers on the lithium-ion front— not combatants. Without a volume lithium-ion player in its borders, German automakers will continue to buy their chemistries and cells from Asia to the long-term detriment of European automanufacture. ***Unless the likes of Siemens et al are doing something very clever and in secret?*** But those sentiments belong to another time.

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Pulsed charge technology gets lead-acid dancing to the beat

Battery charge pulsing is not new; finding a successful and repeatable way to manipulate crystal growth to reduce lead-acid battery sulfation is. Now WaveTech has brought to market a product that does just that. Ruth Williams talks to the CEO to find out more.

Anyone who has worked with or used lead-acid batteries knows the problem of sulfation. During discharge sulfuric acid in the electrolyte reacts with lead dioxide to form lead-sulphate.

Under optimum operating conditions this would be absorbed into the electrolyte during recharge. Over time the lead-sulphate crystalises on the negative electrode, which impedes charge acceptance until the battery becomes unusable.

Worse, the crystals do not pass into the electrolyte, as they should, to strengthen it. Up to 80% of batteries suffer degradation and reduced life-time because of sulfation. Stationary batteries and ones which have sat unused for a long period of time are most prone to the problem.

Dag Valand CEO and co-founder of WaveTech.

Applying a high current pulse to the battery can reduce, although not eliminate, sulfation. Norwegian company WaveTech has developed Crystal Control Technology (CCT) delivered by the BEAT (Battery Enhancement And Treatment) system.

The BEAT is a pulsing device that can alter the molecular structure of an electrode to promote favourable crystal growth while preventing and/or dismantling undesirable crystal formations.

The company's CEO, Dag Valand a Norwegian scientist working in Germany, was one of the first in Europe to work with battery pulsing in the 1990s. At the time scientific consensus saw pulsing as unreliable because the results could not be repeated. Valand knew it was worth further study: "I saw a preliminary possibility that had not been developed by anyone else".

In 2001 Valand met Dr. Ove Aanensen, a fellow Norwegian physicist, with whom he started the company to develop Crystal Control Technology from a hypothesis based on Valand's previous work on battery pulsing and Aanensen's expertise in crystal growth.

The application of CCT introduces an electrodynamic manipulation of the electrochemical processes during charging. Through the influence of specially modulated voltage pulses, extra energy is applied to the ions so the undesirable accretions of larger lead-sulphate crystals are slowed considerably, while the growth of desirable lead-dioxide crystals is increased during charging.

So what effect does this actually have?

"Basically we only help the battery do what it is supposed to do in charging. We don't alter anything, it just makes the process more efficient, by controlling the process you can get more charge into the battery," Valand said.

The BEAT unit is placed on top of a battery during charging. It sends a modulated pulse form, which Valand says is matched with the inner chemistry of the lead-acid battery. "Here, we realised, there is a little window of opportunity to make some changes," he said. These changes can be made with the energy levels of the ions, which are the building blocks for crystals. As they reach a higher energy level, the higher velocity rate ensures more lead-dioxide crystals begin to

form and the lead-sulphate crystals are broken down.

"Everything we do is to lift the energy levels of the ions," Valand explained. The ions improve both processes: in a stable state of imbalance nothing takes place—which is the problem with ordinary charging— periods of over-voltage on the electron surface draws ions towards existing crystals, coating the plate. But raising the ions' energy level with pulsing means the ions are much more likely to settle in different places on the electron, creating a more even distribution of crystals.

Valand stressed the combination of knowledge and methodology: "Our core know-how is how to promote a desired crystal growth and simultaneously prevent unwanted crystal growth. It is important to know how to reproduce the results." This is the issue that Valand says previous attempts have struggled to master, having a method that is reproducible.

The first use battery pulsing came from the British military back in the 1950s. Since then researchers have taken a trial and error approach to crystal technology. WaveTech approached the research with a scientific method, as Valand explained: "Sometimes working like this you get good results and sometimes not. ***The biggest challenge is to see, if this should work, why would it work?*** And what should happen."

Valand said when studying pulse formations it would quickly become apparent whether a pulse will be useful or not, but this way of working did not yield guaranteed results. "Maybe seven or eight theories over time have been put on the table but we can't really make use of those because they can't be repeated," he said.

Valand and Aanensen have been the first to dedicate substantial time, money and energy to understanding how and why different methods work.

The outcome is something that Valand said is one of a kind: "We have patents that confirm

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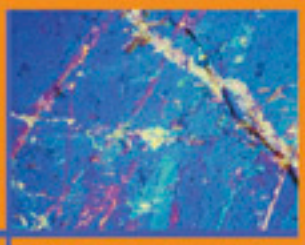

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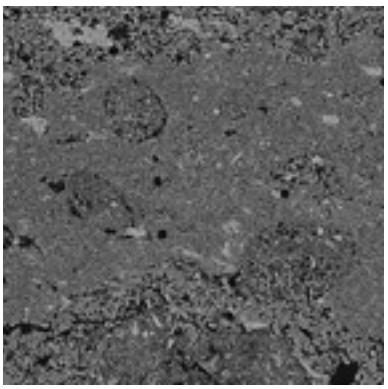
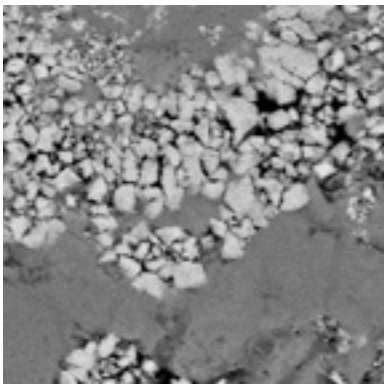


Left, a new PbO_2 electrode without lead sulphate crystals and, right, an electrode coated with lead sulphate crystals that have caused irreversible damage. 80% of lead-acid batteries are damaged in this way.

we are unique. We are unique in the scientific documentation of the work, it is a method based on science. The reproducibility and the start of the verification process confirm the way we have been working."

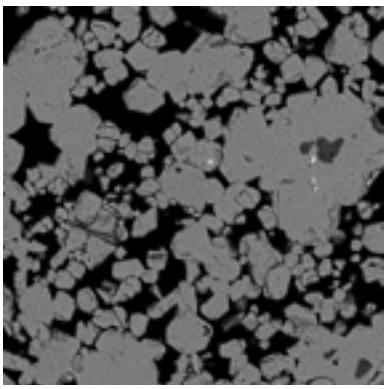
WaveTech has had results from independent laboratories that confirm what the company had expected, as well as feedback from customers that backs up the claims the company had made.



Pics above and below: Electrode images from a report by Sintef Materials and Chemistry, Electrochemistry and Ceramics, of Trondheim Norway, the study, called "Charging of lead accumulator with pulsed current," was headed by Ann Marie Svensson.

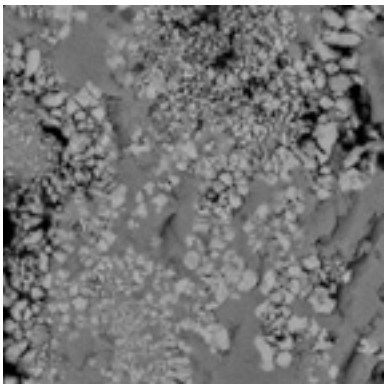
The crystals on the left have formed on an untreated electrode in larger clusters, while on the BEAT treated plate on the right the crystal formation has smaller crystals that are more homogenously spread. The effect of the Crystal Control Technology gives the PbO_2 electrodes a more compact structure and lower porosity in the reaction layer compared to standard charged electrodes.

"Our claim is that CCT can double cycle life— this has been verified by independent laboratories and by field-testing," said Valand. He went on to outline the advantages of this, doubling cycle life can reduces costs by 50%. The battery maintains its original capacity for twice as long compared to a battery that does not have the BEAT device attached. Valand said it behaves like a new battery for much longer: "We have seen batteries can have up to 300%



more capacity in the tests we have done (compared to batteries with no BEAT attached). But if you have a 100A battery, it doesn't become 300% of that, but over time it doesn't decay."

The life expectancy of a battery using CCT will, of course, vary on the application, but a battery with a two year working life could become four and be able to deliver up to 300% more capacity during its lifetime.



Impressive stuff, especially when you consider the potential applications— consider lead-acid batteries at telecom backup sites in India. The higher temperature and unstable grid supply puts lifetime expectancy of a lead-acid battery at only two and a half years, with 30% requiring replacing every year.

WaveTech has a major field test underway in India at a telecom site with a 48V battery pack used for back-up power at a transmitter tower. The test involves a battery manufacturer specialising in the telecom field and a service provider in the segment. The tests have been running for nine months so far with, according to Valand, "very encouraging" results.

WaveTech joined the Advanced Lead Acid Consortium earlier this year, Boris Monahov, programme manager said of the company: "They have a very good approach to dealing with the undesired crystal formation in lead-acid batteries. It uses very little energy to slow the crystal growth and can be used on small or large batteries. I have seen the cycle life double and the capacity increase by 15–30%. I expect they will have commercial success very soon. Dr Aanensen and Valand are the brains behind this and the engineers make it happen. Being based on scientific study means they have been more successful than previous attempts."

The CCT is now at a marketable stage in the form of the BEAT (battery enhancement and treatment device), which is available to buy as well as up to 4,000 units in use at test locations around the world. At the moment, the BEAT can be applied to up to 36V batteries with field tests underway for 48V and above. The technology is scalable so, in theory, could be applied to any battery size and voltage.

More than a decade on from Valand and Aanensen's original hypothesis, the company has moved from being a pure R&D venture to having products available to buy with results from independent tests that back up what they have claimed, that crystal control will improve battery health and life. The company has achieved what previous attempts have failed at before, by dedicating time and thought to understand the process that occurs during battery pulsing.

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There's nothing new under the sun at The Battery Show

Ruth Williams reports from the third Battery Show in Novi, Michigan.

Bitrode Sovema drew the crowds to their stand with a fully restored 1916 Detroit Electric Brougham built by Anderson Electric Car Company, an electric car that has (with dedicated restoration) stood the test of time. Detroit Electric was revived in 2008 and intends to launch an updated version of its all-electric classic model.

After a 'slow show' in 2012, there were fears that this year's Battery Show in Novi, Michigan would not pull a crowd. But with more than 200 exhibitors and high footfall, the organisers have turned the show around and brought in the punters.

But not everything is what it seems. The indigenous US 'advanced' battery sector is not solid. Most of the 'Obama money' went into the construction sector's stomach, building battery factories. But electric car sales have been slow, to say the least and the batteries are not being made. ***So what to do? Pump sufficient hype into the sector with an 'event' and maybe something will happen?*** That has to be the real *raison d'etre* of The Battery Show.

The exhibition area featured more than 300 battery and electric vehicle exhibitors who reported higher visitor numbers than the previous year.

As something of an all things to all men event it is hard to know who could benefit from exhibiting and attending. While the word on the trade floor was of a resounding success, the conference was a little less inspirational. There was a heavy electric vehicle feel; even the non-EV specific tracks involved a lot of automobile talk. But it was more warmed up leftovers from others' battery banquets.

As with so many other conferences this year, the message was, lead has a secure future for years to come, while the same problems of cost, safety and recyclability surround lithium-ion. ***Is that what you had to pay US$800 for?***

The ubiquitous Christophe Pillot of Avicienne gave a US-centric view of the EV market, saying sales of EVs and hybridised cars are expected to be around five million in 2015.

But with the true cause of thermal runaway still unknown, safety concerns are hampering EV sales. Back at base, we think it's the poor value proposition of a pure EV. Defects in one in ten million cells makes safety a major problem; Pillot said the winning lithium-ion technology would do so for safety reasons.

More optimistic are the anticipated sales of micro-hybrids, which could reach as many as 35 million in 2020, and the energy storage source of choice is lead-acid. Lithium-ion developers should remain positive that the number of batteries in EVs would have greater capacity than all the cellular phone batteries in existence today.

Regarding the cost issue, Dan Radomski of Detroit-based Next Energy stressed the need to lower battery costs by strengthening the US domestic supply chain. By manufacturing more battery pack components in the USA, Asia's dominance in cell production could be contained.

This point was echoed by Joe LoGrasso, Engineering Group Manager of General Motors, who said US OEMs must invest in assembly and technology within the US. The same argument was made and reinforced by Prabhaker Patel of LG Chem.

Larry Thomas, CEO of Primet Power, highlighted the decreasing cost of a lithium-ion battery over time, with little or no change to the cost of materials. He said this is the largest single cost and it never decreases, while everything else is squeezed to make savings. Therefore, savings must be made during processing— the cost of transforming base ores into value added materials could be lowered. Thomas argued this point in our 'Second Opinion' column in the Spring 2013 edition.

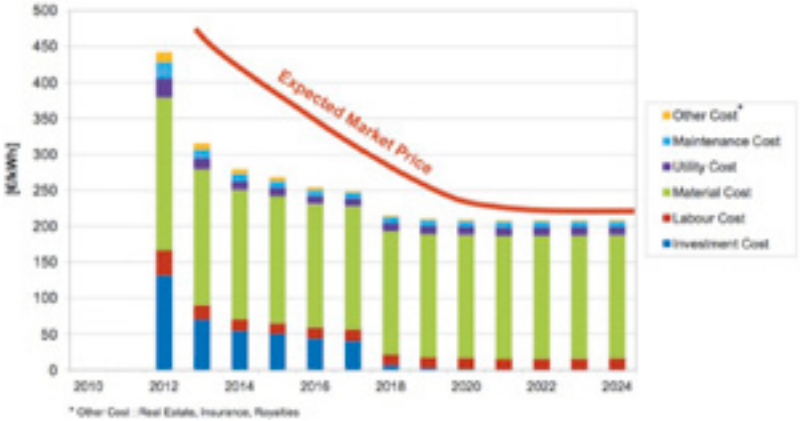
But is lowering costs happening fast enough to make electrified vehicles affordable? Lead-acid remains the only current viable option for electrical energy storage in micro-hybrid vehicles. The same message was heard at ABC15 in Singapore the week before The Battery Show took place. Again nothing new.

And lead-acid is sitting comfortably.

It's all about packaging

As for safety, Dr Ignacio Osio, Programme Manger at Bayer Material Science, pointed out that laptop fires no longer grab headlines but the change has been made to casings— not chemistry. Similarly, following the Boeing battery fires that dominated headlines this year, changes were made to the casing to be 'fit for flight'. The packaging of cells and battery packs are designed to contain catastrophic failures, and even if they cannot be prevented, safety requirements by Underwriters Laboratory limit the hazards.

Battery Cost Items and Development



Chris McCay of Tiax.

BEST has long reported Tiax's years of investigating how to mitigate internal short circuits. Chris McCay said the only way to prevent an internal short leading into thermal runaway was early detection with an advanced BMS. A new system from Tiax detects even the small defects that are not detected by most monitoring equipment.

By preventing a single cell from reaching thermal runaway the advanced battery management system should be able to halt the cascading effect. The system allows users to extract data from damaged cells to enable better understanding of what occurred.

Janet McLaughlin of the Federal Aviation Authority said rather than avoiding shipping hazardous

Left: Larry Thomas highlighted material costs for lithium-ion technology will remain static whilst investment costs will reduce.

Janet McLaughlin of the Federal Aviation Authority.

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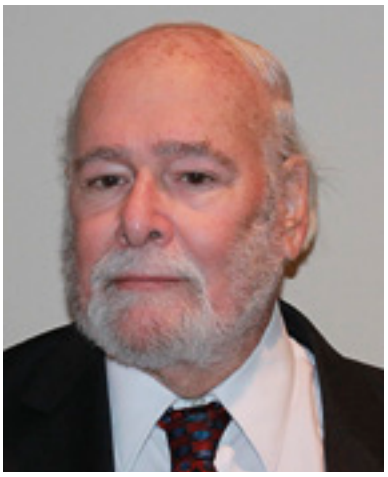
materials as cargo, there are now hundreds of lithium-ion batteries on all flights. She said the FAA intervenes at every step to ensure a system is sound and there is redundancy in both the packaging and cargo-level safety systems. She concluded, continued research into packaging, involving all stakeholders, is essential for aviation safety.

There was also nothing new on the EV safety front. Phil Gorney of the National Highway Traffic Safety Administration bemoaned the current safety standards as irrelevant because they are adapted from shipping and transport regulations. To be appropriate for vehicle safety, the issues of thermal propagation and containment, short circuits and vehicle immersion and the discharge of stored energy must all be incorporated.

He cited the 16 Fisker Karmas that caught fire following submersion at a dock during Hurricane Sandy as an example of the danger that 'stranded energy', as he put it, could be present after an incident. It should be noted, however, that 331 vehicles experienced battery fires, but were contained by steel casing.

Dr Timothy Ellis, VP of R&D at RSR Technologies and member of the SAE Battery Recycling Committee, discussed the problem of recycling, calling it 'an impossible task' to regulate and recycle because there are so many new chemistries, recycling capabilities had simply not caught up.

Ellis highlighted the need for clear and consistent labelling which would aid recyclers to assess the type of anode and cathode in each cell. Further confusion arises with the multiplicity of pack shapes and cell types brought to smelters that have deal with anything from telecom and industrial to automotive batteries.



Imre Gyuk, Programme Manager for grid energy at the US Department of Energy.

And what can usefully be recovered is still very much open to question.

The area that the US is succeeding in is grid-scale storage; Imre Gyuk, Programme Manager for Grid Energy at the US Department of Energy gave a run through of success stories the department is involved with, many of which have previously been covered in BEST.

The strong message from him was that electrochemical storage is here and it's big. The DoE has invested US$185m in projects to demonstrate technical feasibility, gather cost data, stimulate regulatory changes and encourage other projects to follow. The deployment of energy storage projects around the world has doubled since 2011— impressive and hopeful. No wonder the government isn't being asked to do any more!

Take Beacon Power for example [see Summer BEST Page 67] the DoE funded project has built facilities and had a law passed for frequency regulators to get paid twice the previous amount. This has added value to speed of response, not just capacity offered, to make frequency regulation a commercial venture from the beginning for the supplier.

In the US, policy regulations are as important as technological progress, the recently passed STORAGE 2013 Act (Storage Technology for Renewable and Green Energy) provides a 30% investment tax credit of up to US$1M to businesses installing on-site storage. This, said Gyuk, is more than anyone could have hoped for five years ago.

When asked why customers are not actually buying more storage, he said it was his belief utility companies are remaining conservative to protect customers' money. Therefore improving perception and a change of culture is needed to drive the market forward.

The problem is that no one wants to buy batteries, despite the market being valued up to US$20bn by 2020. The market sees the costs without seeing the value. The frequency regulation market has now shown a return on investment but storage capacity alone is yet to do the same.

To correct this, a target has been set by the Joint Centre for Energy Storage Research (JCESR) called 5:5:5. Jeff Chamberlin who works with JCESR on behalf of the Argonne National Laboratory explained the aim to increase electrochemical energy density by a fifth and reduce costs by a fifth— both targets being met in the next five years.

For grid-scale storage this means lowering the costs to US$100 per kWh, so clearly this won't be using lithium! Some of the ideas the JCESR team has to achieve this include a non-aqueous redox flow battery with energy density ten-times greater than an aqueous battery, and developing an all-organic flow battery using lithium tetrafluoroborate ($LiBF_4$).

Chamberlin said the advanced chemistries they are investigating could enable technologies to achieve 5:5:5, but JCESR is remaining chemistry-agnostic.

Another institution to be making gains is Argonne National

Laboratory. Daniel Abraham, who works in the Chemical Sciences and Engineering department, discussed his work in material synthesis.

This includes electrode fabrication, optimising electrode composition and fabrication conditions to improve cell performance, with the aim of preventing solid electrolyte interphase formation on plates after cycling. Although Abraham's work is forward thinking, he said himself that additives and composites are not new and it is time to think differently to make gains in electrochemistry.

His idea is to look to biology rather than chemistry. Such as the use of antioxidants that trap and neutralise harmful radicals could be applied to battery science. Alternatively, a gradual release of electrolyte additives using time-release capsules or self-healing mechanisms could be triggered by stress factors, such as heat.

Daniel Abraham, Argonne National Laboratory.

He believes scientists need to use more imagination to make advances to improve batteries and electric vehicles that are, admittedly, more than 100 years old.

But as with any breakthrough development, Imre Gyuk, in his wisdom, stressed the importance of not over-hyping developments or expecting claims to be true— that will only ever lead to disappointment.

But hype is a catalyst to make events like The Battery Show happen. Hundreds of attendees, contact details exchanged and much bonhomie exuded. But what real business will result, months down the line, is anyone's guess.

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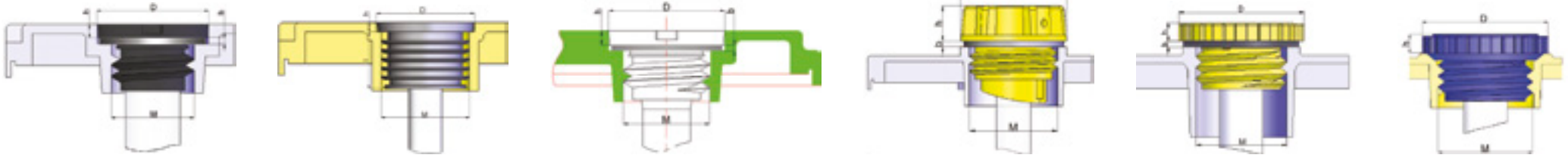
Assembly Instruction					

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The never-ending dilemma of safety testing

A few miles down the road from the Novi exhibition centre Intertek had an open house session at its Plymouth testing centre.

Intertek offers every type of test imaginable, and if it has not previously been imagined, they can custom-build test apparatus. As a company it operates laboratories for the textile, footwear, toys, petroleum and chemicals industries at 500 locations worldwide.

The site in Plymouth, Michigan, deals exclusively with commercial and electrical testing for electromechanical components, including cells and batteries with a capacity less than 6 kWh.

As with any form of battery testing, the multiple standards agencies are disparate and need harmonisation to be useful for EV battery standards. As a progressive area of research and development with new products becoming available all the time it is little wonder the standards agencies can't keep pace with the chemistries and applications.

Rich Byczek, Global Technical Lead, EV & Energy Storage, spoke on the subject of electric vehicle battery standards about dealing with 'stranded energy' in electric vehicle batteries after an accident.

Byczek's talk largely highlighted the holes in existing standards and areas that manufacturers will have to consider and engineer around in order to have a battery that not only passes safety standards, but also is safe operating in non-controlled environments.

The Electric Vehicle Standards Panel has identified several gaps in the existing ANSI standards, primarily relating to thermal runaway and stranded energy. Firstly, a lack of standards for the safe storage of large format lithium-ion batteries— that react very differently to small batteries— for warehouses, salvage yards dealers etc.

In relation to packaging, handling and transport, waste batteries are not considered in the current regulations and standards. This would include damaged, used, warranty return batteries, and their potential contact with other goods in the same shipment. Recycling standards present a large gap for lithium-ion because there are currently none.

The existing standards for overheating only focus on immediate results, not delayed overheating that can occur after a crash or abuse scenario, which could lead to problems if a battery is held in intermediate storage after an accident. A pass or fail test for over-heating does exist, but only for the time of an incident, not a delayed reaction.

Manufacturers and standards agencies must understand the hazards different size and type of battery packs, as well as chemistries and applications could present.

Stranded energy could cause problems for people working at the site of a crash, whoever takes a damaged car away for repair or disposal. Understanding how to deal with cars that are still a minority on the roads— if a roadside assistance team saw one electric car a month it would be high— has obvious problems. Let alone different vehicle types... it is easy to see why there are gaping holes in the standards when there is no 'standard EV' or even 'standard' battery.

Another problem with testing is the conditions are different to real-life use. In a controlled environment a battery might react very differently to being submerged then over-heated, or punctured or crushed in a moist environment.

Although a battery could pass a test in a controlled environment as stipulated in the standards, there's no way to simulate every potential situation a battery could be exposed to. The potential threats must be understood and mitigated for safe handling of the battery.

Byczek had a few suggestions to deal with stranded energy, first was the suitcase tester, a piece of kit to be used by vehicle recovery teams that has diagnostic and discharge capabilities. Users would need training to assess what energy is left in the battery, and discharge with the equipment.

However as there is no 'standard battery' it would be difficult for a kit to be suitable for all types of EVs. Byczek said auto-manufacturers were reluctant to harmonise, even as a safety issue, because it could be damaging to proprietary rights.

Another potential solution is to implement a device to automatically self-discharge and disconnect the system and then begin a slow discharge following a crash.

However, with both of these options, there is no guarantee a battery would be accessible after an accident, and for the auto discharge the greater the damage the less able it would be to respond.

This goes to highlight just how dangerous a battery could be following an accident, or even exposure to the elements. It also underlines the challenge of setting standards in an area with so many variables.

This problem is not going to be solved easily. Harmonisation of standards agencies would be a good start, but achieving this on a global scale will never be achieved before the technology itself once more outpaces the regulations.

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Putting it all together

Making good plates with good active material is one thing: Putting cells together and making a battery is something else. Our resident lead-acid master craftsman Mike McDonagh consider the issues around cell assembly and what can go wrong.

So far this series of articles has concentrated on lead, and the processing of lead to obtain the physical and chemical characteristics required to provide a working, commercial, lead-acid battery. The next step is to arrange the lead based components in series and contain them in an acid proof container with external connections. This now brings in a new set of materials processes with different material properties to be utilised to fabricate the battery.

In almost all lead-acid battery designs the battery plates are stacked with separators in groups which are then placed in a plastic container and a lid sealed on top, which has external terminals for connection to an electrical device.

In almost all of the lead-acid battery designs used for different applications, ranging from six volt monoblocs to single two volt cells used for emergency backup power, there are lead alloy plates and groups to be joined to achieve both capacity and voltage.

These batteries have plastic separators inside which often require forming and welding into sleeves or pockets. They are contained in plastic cases which are sealed by welding with external plastic lids. In this article, the melting properties of the metal alloys and plastics, along with the processes used, are examined, for the purpose of optimising the production throughput and product quality.

The material properties and process parameters required to ensure reliable results and optimum production rates are considered. The type of equipment used and the materials of the boxes and lids will not be considered in any detail.

It is those processes which relate to the joining of lead alloys and plastics, which critically affect the quality and integrity of the finished battery, that will be of prime concern. Likewise the process parameters and operating conditions are dependent upon the nature of the machinery and particular manufacturer's designs. It is not possible therefore to provide general guidance on operating conditions.

However, the way the materials during these processes behave and understanding the reasons for good and bad results during these processes can be addressed, as well as proposing solutions and working practices which will achieve good results. ***Table 1*** (page xxx) lists the processes and common defects arising from these.

There are five main areas which require close control:

1. Stack assembly with separation (welding process for separators);
2. Group welding of lugs with top bar and small parts components (gas welding);
3. Cast on strap with top bar and connectors (metal casting);
4. Intercell through partition welding of automotive groups, (resistance welding);
5. Box to lid heat sealing (plastic welding).

First stage – plate stacking with separation

The method of stacking the positive and negative plates with separation is dependent upon the size of the plate and the type of separator used. This can be broadly defined into four groups: **monobloc flooded, monobloc VRLA, two volt cell flooded** and **two volt cell VRLA**. The VRLA can be further segregated into AGM and GEL designs which use different separator types and different methods of stack assembly.

In all cases the plate dimensions and amount of plates determine the capacity of the battery. The number of stacks connected in series provide the nominal voltage for the battery. The plates are stacked generally with an end negative plate then separator, positive, separator, negative and so on until the required capacity is reached with another end negative plate.

However, it is not unusual to find automotive designs which do not have two end negatives on each stack. This reduces the efficiency

TABLE 1 – MATERIALS JOINING, COMMON DEFECTS

PROCESS	BATTERY APPLICATION	DEFECTS	CAUSES	REMEDIES
Gas welding	Group strap welding	Bad lug/strap adhesion	Dirty/oxidised lugs high lug/strap contact angle	Clean/apply flux Strap and lug alloy/flux lugs
	Pillar terminal welding	Insufficient weld depth	Low flame temperature Insufficient residence time	Adjust burning nozzles Re-programme/re-train
Lead alloy casting	Group strap welding	Bad lug/strap adhesion	Dirty lugs Wrong flux, no flux Wrong strap alloy High contact angle	Ensure lugs are brushed Check flux specification and flux dispenser Strap alloy should be high tin Apply flux and or lead tin solder to lugs
Lead alloy casting	Cast on strap/ lug weld	Lugs break near strap	Cast lead alloy temperature too high	Check alloy temperature in the mould using an immersion thermometer
Resistance welding	Automotive inter-cell weld	Spattering of component Weak weld Does not fill punched partition hole	Internal casting defect, anvil damage Internal casting defects, wrong current settings Incorrect squeeze time Wrong machine settings	Cut open some castings check for porosity Examine anvils for pitting or corrosion, change Cut open some castings check for porosity Check machine settings and adjust Increase if current settings are correct Check machine settings and adjust after destructive trials
Plastic crimping	Separator, sleeves and pockets	Misaligned joint seams Seams rip apart easily Separator edges outside of seams tear off	Machine settings Insufficient crimp pressure Excessive crimp pressure	Realign equipment Adjust roller pressures/tool design Reduce pressure and or temperature if using heat
Ultrasonic welding	Separator, sleeves and pockets	Misaligned joint seams Seams rip apart easily Separator edges outside of seams tear off	Machine settings Insufficient pressure or time Excessive pressure or time	Realign equipment Alter machine settings, check frequency/ output Alter machine settings, check frequency/ output
Plastic heat welding	Box and lid heat sealing	Brittle weld Poor adhesion Plastic stringing from heated tool Gaps in sealed area	Insufficient stop time on heating tool Low temperature on heating tool Low temperature on heating tool Insufficient melt down on components or heated tool defects	Adjust position and time of stop- 2 secs approx Check surface temperature of heating tool, minimum is around 195^{0}C Check the heating elements for resistance Check lid and box dimensions for high or low spots. Check the heating tool for gaps in joints. Check the heating elements for resistance

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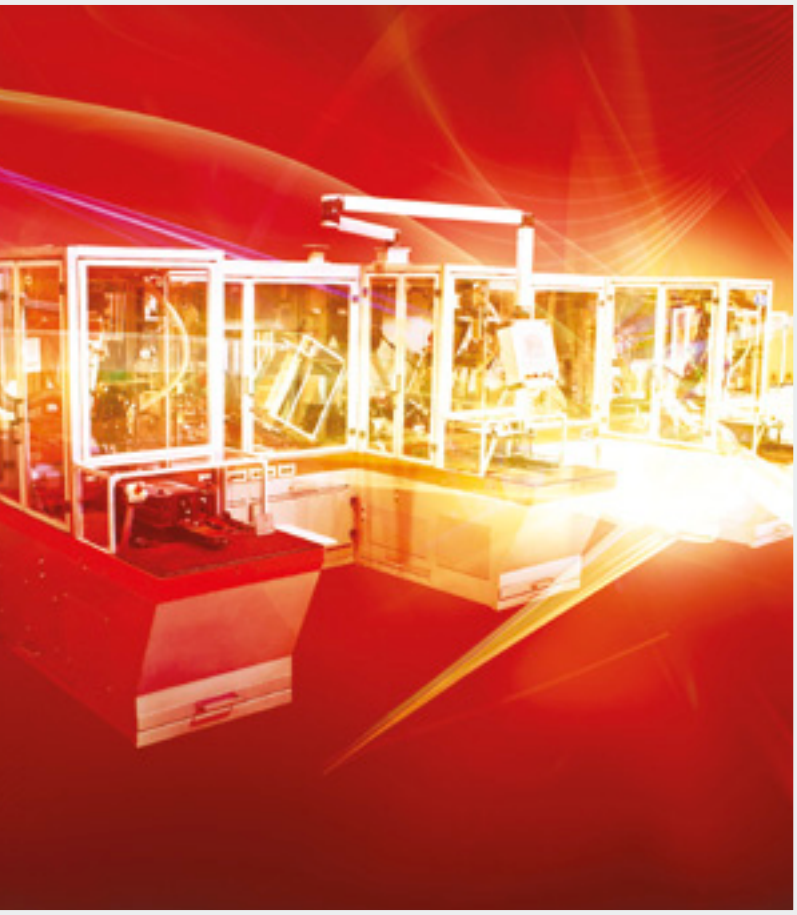

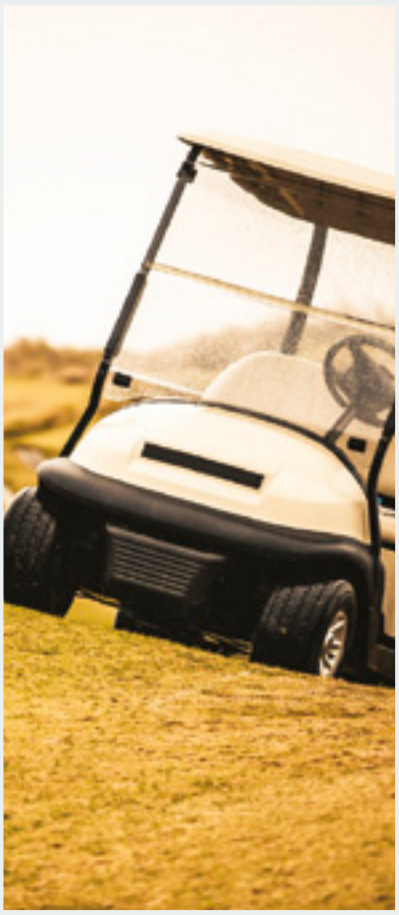

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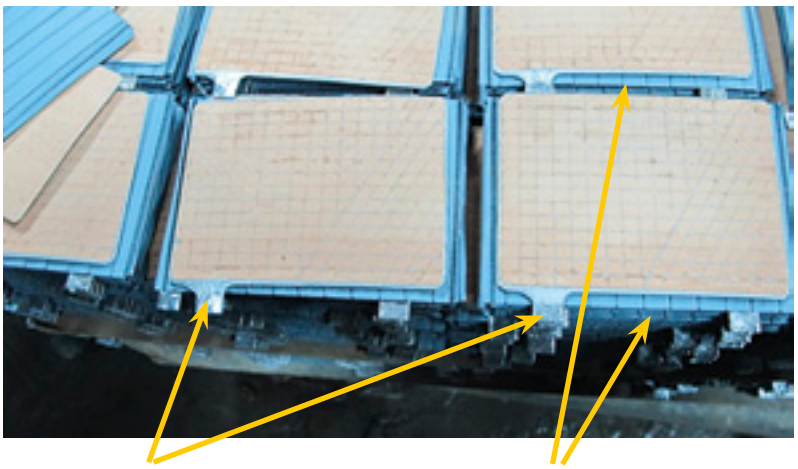


Lugs brushed to remove oxide

Polyethylene separator envelopes

Figure 1
Plate stacks with brushed lug.

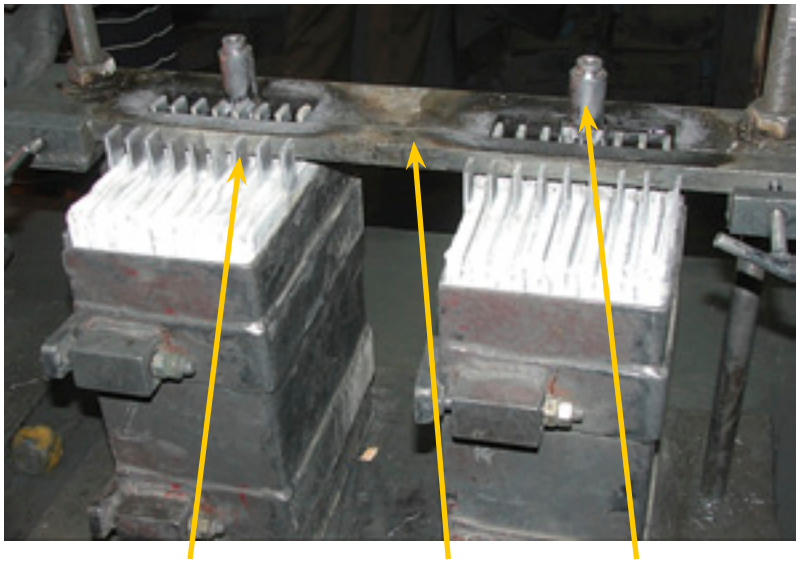
of the last positive plate but does provide significant cost savings to the manufacturer.

Monobloc flooded and Gel

The majority of automotive batteries use polyethylene for separation, sometimes as a sleeve, or most often as an envelope providing protection on the sides and bottom of the plate. The main advantages of the envelope is to increase cycle life and to allow a design without a bottom mud space. This method of wrap stacking is well known and many companies now sell wrap stacking machinery capable of achieving throughputs of around 200 batteries an hour. The basic principle of operation is to push a plate, bottom first, into the centre of a flat sheet of polyethylene separator held in place under tension. The sheet wraps around the plate and the edges are sealed by one of the methods of crimping, pressure heating or ultrasonic welding.

It can be either the negative or positive plates which are enveloped depending on which are the fewest in number. The positive and negative plates are then stacked to the required number into packs before they are joined into groups by a top end lead bar, which is formed by either group welding or cast on strap methods. See ***Figure 1***. The separators in this instance are formed into pockets by crimped rollers which apply pressure to the edges or land area of the separator. Since the separator is a loose fit and there is little pressure from expansion on the welds, this method is adequate for most automotive applications.

For gel monobloc batteries, the process is approximately the same, with the exception that the separator is a loose leaf piece rather than a sleeve or envelope. There are two reasons for this: firstly there is no possibility of short circuits due to material shedding and secondly the acid filling and gelling process is easier with the unrestricted flow provided by the open pathway of loose leaf separators.



Cleaned lugs prepared for welding

comb tool

Terminal with brass insert

Steel jigs hold the plate groups under pressure to give the correct compression.

Figure 2
VRLA group welding.

Monobloc VRLA

There are some significant differences between this process and those above. The main differences are that the separator material is made from a glass fibre fleece and it has to be compressed to around 32% of its original thickness in the battery compartment. For this reason the plates and separators are assembled in a fixed-sized jig which is designed to provide the percentage compression required for the VRLA system, (***Figure 2***). This is mostly carried out by hand, but there are companies who offer an automated, or semi-automated, system for wrapping the plates and putting them into stacks for compressing.

Two volt cells

These consist mostly of plates between 250 and 650 millimetres in height. The types are mostly

forklift truck batteries with both tubular and flat plate flooded constructions, standby power, gel and VRLA variants. The most common approach, even in today's automated world, is to assemble the groups by hand into jigs similar to those in ***Figure 2*** with the burning combs attached, but on a larger scale. The lugs and terminal connector are then joined by gas welding and adding lead alloy to form a top strap before insertion into a polypropylene or ABS or SAN cell container.

Automated assembly and cast on strap systems are becoming more prevalent, but the high capital cost and lack of flexibility, due to the change-over times for tooling, mean that the take up for this technology is generally confined to the larger manufacturers with longer production runs.

In the case of traction batteries, polyethylene separators are the most popular as they can be easily welded into a sleeve or envelope into which the plate is inserted. The most common methods are ultrasonic or heat and pressure to stick the edges of the polyethylene separators together. The space in the two volt cell is quite restricted so the seal has to withstand a tight insertion of plate and then fairly rough handling during the loading of the burning jig and insertion of the element into the box.

Two volt cells used in the standby power, emergency backup or telecoms industry, generally do not have deep discharge cycles and therefore do not suffer from paste shedding as is the case with traction cells. For this reason the separators can be loose leaf as the risk of short circuits is greatly reduced.

Top end lug and strap welding

This process is mostly carried out by gas welding methods using either natural gas or propane-based flames. The type of gas used and the design of the burners and nozzles is dependent upon the design of the strap and lug system and the physical size of the parts to be made or joined in this process. In real terms it is also a moulding process as the burning jig is designed to make a top strap of particular dimensions from the added lead which is melted into the tool on top of the plate lugs. In effect an experienced operator can create a molten pool of lead alloy, into which he adds further lead from a hand held stick of lead alloy, whilst partially melting the lugs as he progresses along the length of the tool. Behind this molten pool is left a solidified strap inside which the lugs are partially melted into the strap and ideally further attached by a low angle bond formed at the higher temperature in the molten lead alloy pool. ***Figure 3*** gives a schematic illustration of this process.

It is important to ensure that the lugs are in good condition and there is sufficient material above the tool face to allow a good contact area. Equally important is the condition of the lug. Paste residue or oxidation from long term storage, curing, or dry charge formation, which may be left on the surface, must be removed to ensure that there is a good quality weld. Further treatment of the lug surface is recommended in order to ensure that the lead alloy used as filler material to form the strap properly adheres to the lug surface. The lead alloy should form a low contact angle interface from use of flux and/or a tin lead solder dip. Also of importance are the two alloys which are to be joined, i.e. the alloy of the plate lug and the alloy of the top strap. There are **three principle considerations** for the alloys used in the plates, components and strap lead. These are:

The differences in their melting points

The lugs should ideally partially melt when the molten lead is dropped from the melted lead stick. Operator skill is required to achieve

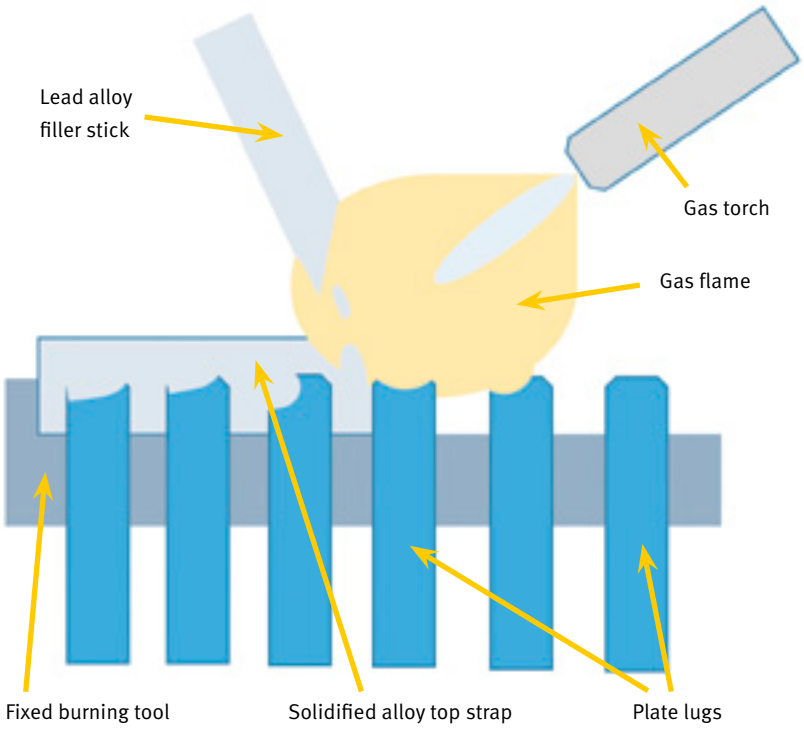


Figure 3 Schematic representation of lug to strap gas welding.

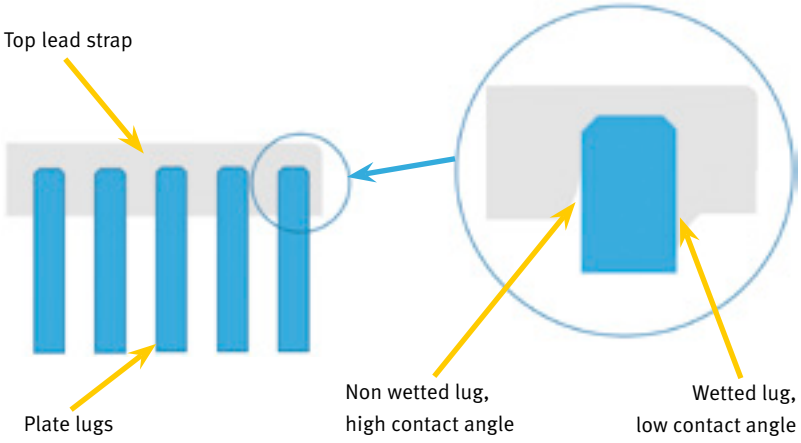


Figure 4
Effect of lug preparation on contact angle between top strap and lug.

this, but the difference between the top bar lead and the lug alloy is also important. When dropping the molten lead into the welding zone, it should partially, not completely melt the lug. The lug will be warmed by the gas flame and some operators may partially melt it this way before adding the lead. This ensures a fresh, clean surface when the molten top bar lead is dropped onto the lug. Most operators prefer that the added top bar lead has a higher melting point than the lug and component alloy. This is largely due to the speed of solidification and the ability of the operator to use the heat content of the melted alloy to partially melt the lugs and create an actual intermetallic bond between the components. However, differences in melting point of more than 20ºC should be avoided.

Their chemical differences due to alloy composition

It is possible that lead alloys which have different alloying elements can create an electrochemical cell when immersed in sulphuric acid. For this reason (and the above) those companies using lead antimony alloys should ensure that the maximum difference in Sb content is less than 5% by weight. Similarly the use of top end lead consisting of, say, a copper alloy with pure lead or lead tin, should not be used with a pure lead or lead calcium grid or an antimonial grid alloy. Experience has shown that this is of particular significance in VRLA batteries.

The contact angle formed between the molten strap alloy and the solid lug and component alloys

The wettability of one material onto another i.e. how well it sticks, is a vital component of any welding or joining process. This can be observed in the strap to lug weld by examining the underside of the weld after the group has been removed from the burning jig. If there is a high degree of wettability then there will be no gap between the lug and the underside of the strap. If there is low wettability and a high contact angle then there will be a positive meniscus with a gap leading into the strap at the lug/strap interface. This is important to ensure that there is a good area of contact and that the contact point or joint has a low resistance. ***Figure 4*** illustrates this point by showing schematically the effect of having both a low and high contact angle on the same lug. Lug cleanliness, use of flux (stearic acid) and possible dipping the lugs in a lead tin solder bath would ensure a better, low resistance contact.

Figure 5 shows a typical welded group for a traction cell. Points to note are the level of the top end strap and the degree of undercutting (component melting) at the point where the

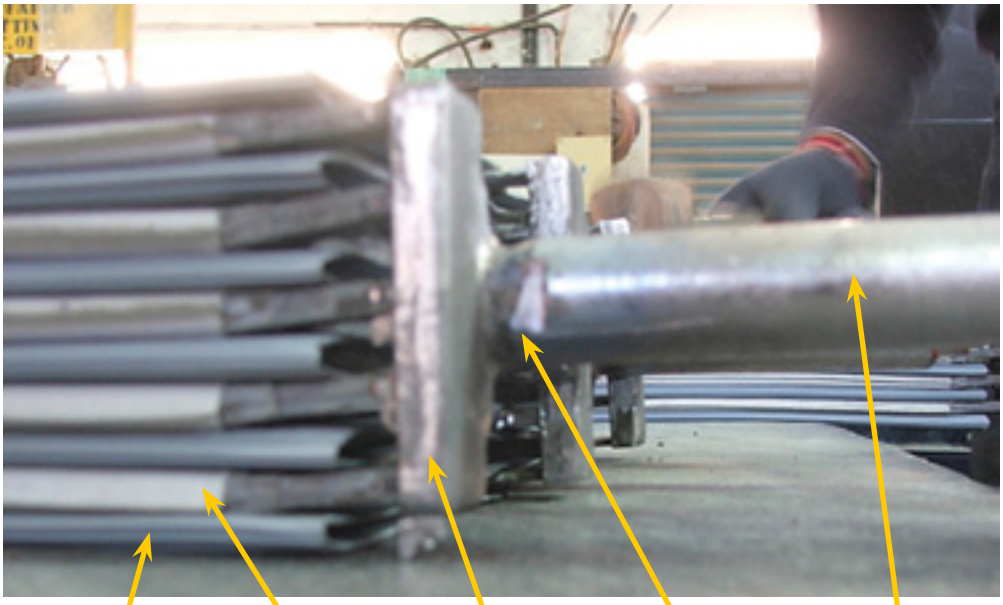


Figure 5
Gas welded traction cell element.

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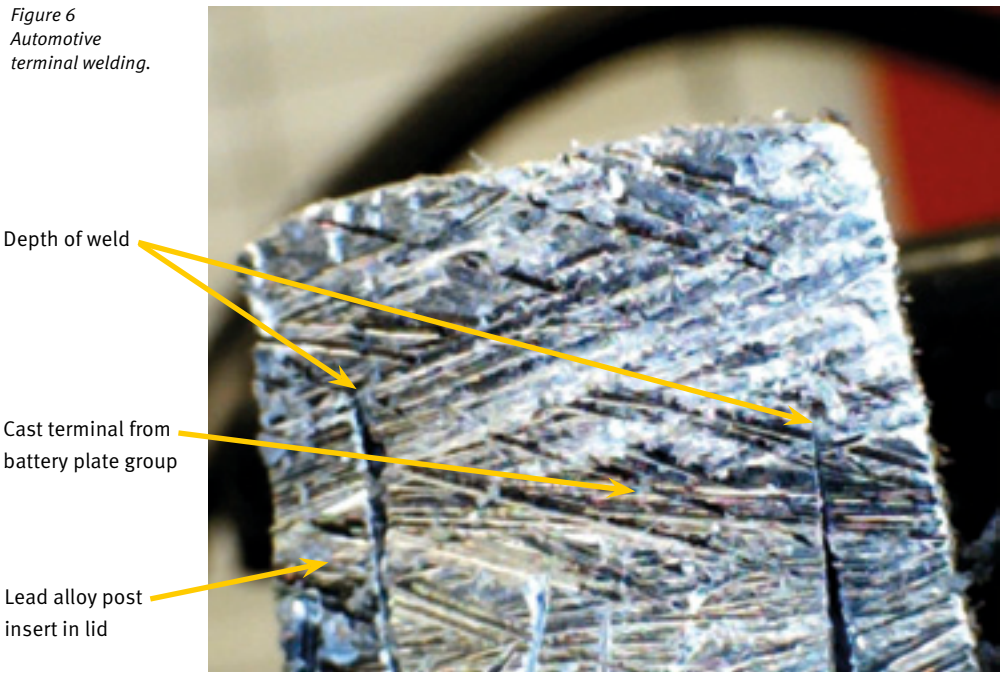
terminal is joined to the strap. This is a common problem with this component and strap welding. It is caused by excessive heat input to the area where the base of the component adjoins the top bar or strap. It requires an experienced operator to control the width of the flame as well as the residence time in that area in order to perfect the method of joining the lugs, component and top bar. Because this is a vital part of the battery production process it is advisable to take at least two cells or batteries per shift for examination.

In most automotive designs, the lid has moulded into it a lead alloy insert which is joined to the insert take-off pillars, usually by gas welding. ***Figure 6*** shows a

Figure 6 Automotive terminal welding.



typical result from a hand welding operation. It can be seen that the left hand side of the pillar has a lower depth of weld than the right hand side. This situation arose due to the operator's technique of starting the melting operation on the right side and then finishing on the right side of the post. The net result was a greater heat input to the right side and a greater depth of weld. This was a simple retraining issue. However, poor welding at this stage can be very dangerous, Acid reaching the top of the post can leak out of the post, particularly if it is moved by connecting and disconnecting car battery clamps just a couple of times. Again normal pressure testing will not show this fault and a destructive test on the first production batteries is essential.

Table 1 shows the common defects experienced from this process, the causes and possible remedies. The underside of the strap on these samples can be examined to determine the degree of wettability in a very simple way without destructive testing.

Cast on strap (COS)

This method of production has two major benefits: automation, and the removal of lead runs causing short circuits from the plate elements. The principle has some similarities with the strap/lug welding process, particularly with regard to the interface characteristics of the lug strap joint, and also with the principle of not completely melting the lugs. The main difference is that the plates groups are in fact turned upside down and that the lugs are immersed in a molten pool of lead alloy contained in a mould, which effectively casts the shape of the strap around the lugs and also casts the intercell and take-off lugs onto the plate groups. This is now the normal practice for most producers of monobloc batteries,

Figure 7 shows a typical twelve volt battery group contained in a COS rotary jig. Normally a rotary COS machine will contain **four stations**:

A jig loading station

This loads the plate groups with the lug upwards, either automatically, or by hand, depending on the machine used. The lugs are freestanding, not constrained in a jig as with the welding process. Once loaded it then turns the groups upside down in order to immerse the lugs into the strap casting mould.

A lug brushing and fluxing station which cleans and coats the lugs

The cleaning station is normally a rotary brush which removes any loose oxide from the surface. This is followed by a second, soft brush containing a flux compound which coats the clean lugs. This ensures a clean lug with a flux compound designed to ensure a low contact angle when in contact with the molten strap alloy.

The cast on strap station

This is where the lugs of the upside down groups are introduced into the COS mould before the lead alloy is pumped into the cavity and covers a portion of the lug area. Once introduced, the molten strap alloy is pumped into the mould cavity which forms both the strap and the inter-cell connector or the take-off terminals in the end two plate groups. This is the casting of the strap. The critical aspects of this part are the temperature of the molten alloy, the composition of the alloy material and the cooling rate of the mould.

For this part of the operation it is vital to ensure that the temperature of the molten alloy is not so high that the lugs are melted, or even partially melted, before the strap metal solidifies. The use of calcium alloys for the grid and high tin (more than 3%) lead alloys for the strap are common. With this combination the melting point of the strap lead is less than that of the lug and provided that the mould is rapidly cooled the strap lead should solidify before melting

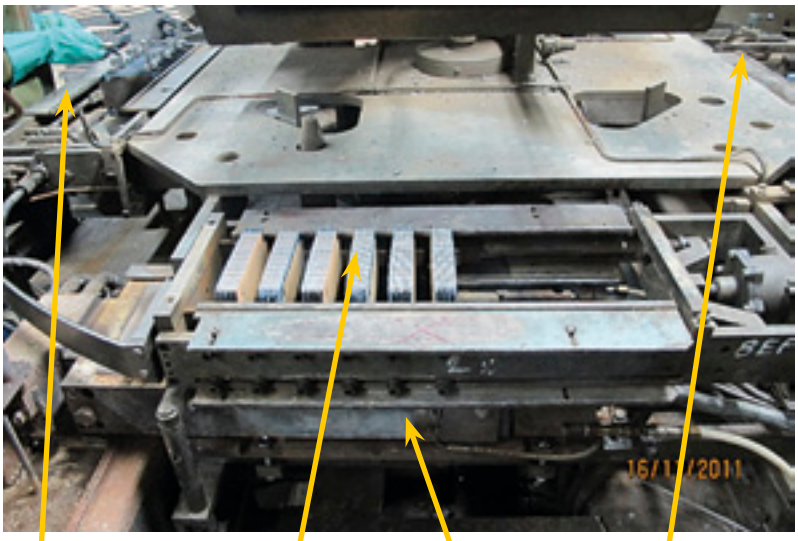


Figure 7 COS rotary assembly jig.

the lugs. The use of a high tin strap alloy will also improve the wettability of the molten metal onto the lug. With a clean lug, correct flux and a high tin lead alloy for the cast strap, there should be excellent bonding with minimum resistance.

An unloading station

This is where the groups are removed, loaded into containers, by hand or automatically, ready for the next operation. If unloaded by hand it can be useful to examine the groups by turning them upside down and checking the direction of the meniscus where the strap alloy joins the lug. Again, the strap alloy should curve downwards along the lug leaving no gap, (***see Figure 4***).

Other critical points are the separator height, the quality of the separator weld and the quality of the cast intercell connections and take off terminals.

The main advantages of this process are the lack of short circuits from lead runs, which are a feature of the strap welding process described earlier, the fast automation aspects and the reduction in the number of welded interfaces across the top of the battery. This leads to higher cold cranking performances in automotive batteries and better cycle life in semi-traction and full traction monobloc batteries. The common faults and important quality aspects along with causes and remedies are given in ***Table 1***.

Intercell welding (resistance welding)

For monobloc batteries, once the plate groups are loaded into individual compartments in the containers, they need to be connected in series. The days of welding over the top of the container partition wall are largely over. Almost all companies now weld through holes punched into the partition wall. The method used is resistance welding. In this, the lugs attached to adjacent plate groups are squeezed together through the partition hole, using a pincer anvil, until they touch. Once contact is made, a high current is passed through which creates heat at the point of high resistance, in this case the interface between the

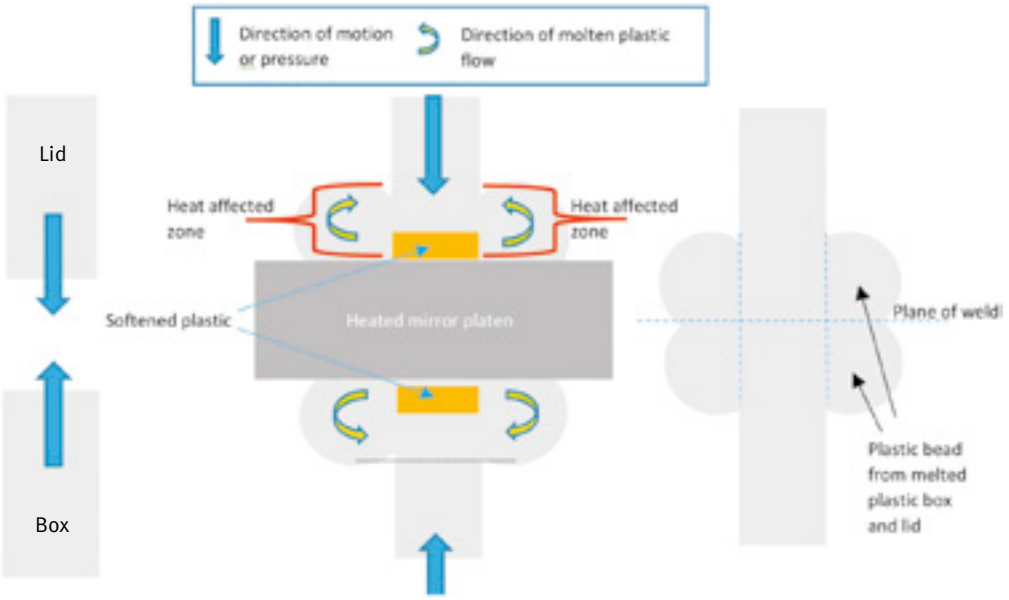
two lugs. The temperature at the interface rises until the surfaces melt. Pressure is kept on the lugs all the time whilst the welded area increases to fill the partition hole. Once the resistance has fallen to a preset value which is consistent with a good weld, the current is switched off and the pressure released.

There are several variations in the types of machine and their precise operation, but the design of the critical component, i.e. the anvil, is similar in the majority of the operations. It is a critical part of the operation as it prevents intercell acid leaks and provides the current path for the battery on charge and discharge.

There are automated quality checks which are built into many automated lines. These are based on providing a load in a shear direction by pushing attached intercell lugs in opposite directions. These checks give an indication of the weld quality but, by their nature, cannot provide a complete picture of the weld quality. It is necessary to both check the anvil head for damage and wear and perform a destructive test on the weld for one battery. The sheared surface should show evidence of a ductile fracture with no apparent holes or areas of dry contact which have not melted. It is recommended that the first battery off a production line is examined in this way. This, along with checking the anvil surface for damage or pitting, at least twice per shift, is necessary.

Heat sealing of lid to container

The last part of the assembly operation is to seal the lid of the battery onto the container. The same method is used for monoblocs and two volt cells. That is, a heated mirror platen melts the surfaces of the container and lid simultaneously, under pressure. The lid and container are removed after several seconds and the heated platen pulled back leaving the path clear to press the two molten surfaces together, again, under pressure. After a short period to allow the plastic to cool and to solidify, the weld is sufficiently strong to be pressure tested in



Box and lid sealing points, buttresses

Buttresses pressed against the heated mirror platen, melted plastic flows outwards forming a bead

Perfect welded joint

Figure 8 Heatsealing - box and lid welding process.

order to find leaks.

Although at first examination this process seems simple enough, it is perhaps the most misunderstood of all the assembly processes. Considering the consequences of acid leaks and potential litigation from the public, it is reasonable to spend some time on this process in order to ensure that the basic principles are understood.

If a producer feels confident that a pressure leak test performed at the end of the assembly process is an adequate guarantee to prevent acid leaks in service, then they are sadly mistaken. Defects which will pass through normal pressure tests can show themselves later in service, or even in handling, from packaging to order picking. This is particularly true with automotive batteries which are often lifted by their lid when filled with acid. The additional weight and sometime cooler conditions will place more stress on suspect welds which previously have not been subjected to any torsional or tensile forces. For this reason it is necessary to open the first battery after successful pressure testing, in order to examine the weld quality. It is important for **two reasons**:

The strength of the weld

The method of melting the plastic under pressure against a heated platen has two key characteristics: it provides a temperature above the melting point of the plastic and it removes dimensional differences in the mouldings to ensure that the melted surfaces all touch evenly once pressed together. However, this is not the whole story. It is necessary to understand how the melted surfaces behave under pressure and how the whole sealing process operates.

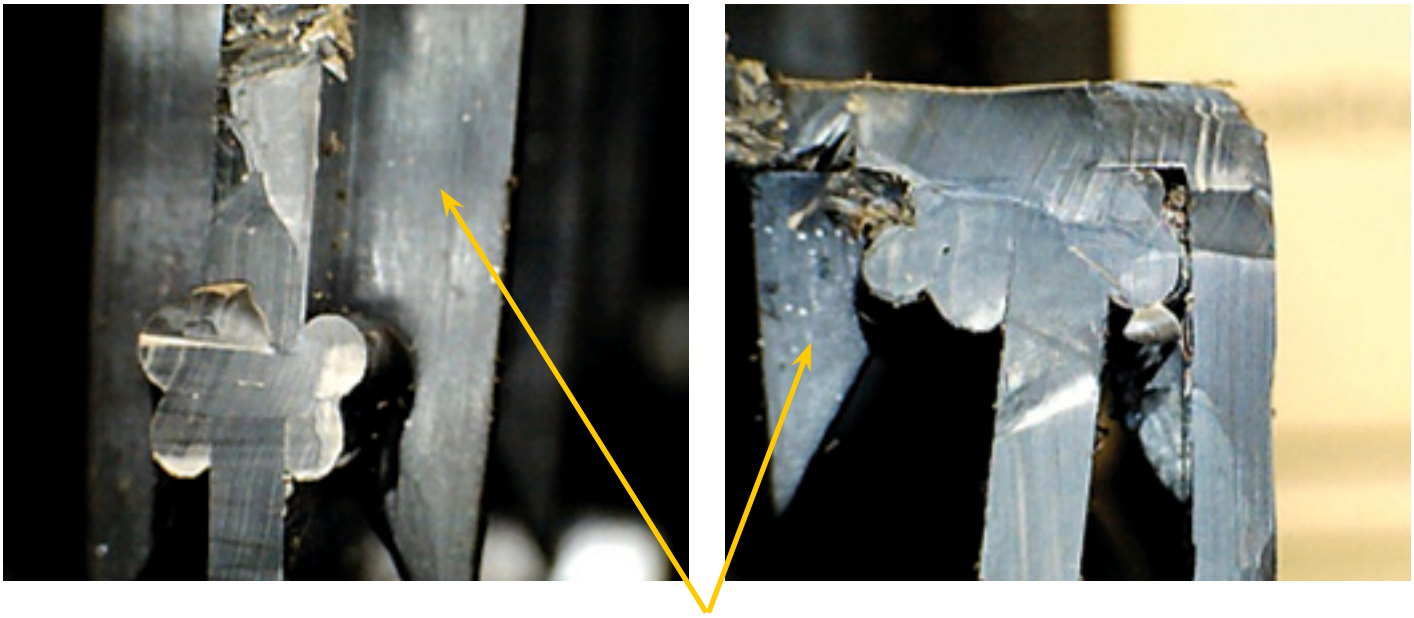
Figure 8 is a representation of the welding points in the lid and container which are melted on the heated platen and then pushed together, with the plated removed, to form the weld. In the first stage the box and lid are seated in their positions held by appropriate tooling. They are then pressed into a heated mirror platen for several seconds in order to melt the plastic surfaces. At this point whilst the container and lid are pushed into the platen, the molten plastic is pushed outwards and forms a bead on either side of the melted buttress. When the components are pulled back and the platen removed, the box and lid, after a few seconds delay, are then pressed together to form (hopefully) a bond between the melted parts of the components. Unfortunately, if the molten surfaces cool and solidify during the several seconds required to lift the components and remove the heated platen before they actually are brought together, then the joint will be weak or brittle.

It is necessary to stop the movement of the plastic components into the heated platen for a couple of seconds to increase the heat content of the melted face. This means that the molten plastic will remain molten for longer, ensuring that the surfaces of the component and not just the residual plastic bead either side of the melt are hot enough to form a homogeneous bond. If this stop to the motion is not applied, the process will keep pushing cold plastic into the molten zone and reduce the temperature and heat content of the melted plastic surface.

Simple heat sealing instructions such as ‘ensure that 1.5 millimetres are melted from both container or lid’ are wholly inadequate and potentially dangerous. Process instructions should include the use of a stop, and a time period for the stop to apply, before removing the platen and then pressing the components together. Again, minimise the delay between removing the heat and joining the components.

A. Good weld - within guide pins

B. Bad weld - right guide pin melted away



Picture A shows a well executed lid to box weld, the position held within the guide pins of the lid moulding. In **picture B** the lid has been misplaced and the right hand guide pin melted instead of the lid buttress. The resultant weld is actually between the molten plastic bead and the lid and is very fragile. This passed the standard pressure test but later after lifting by the lid produced intercell acid leaks.

The position of the welded edges

It is often found that when setting up a lid and container for heat sealing that the alignment is not perfect, or that the tooling is a multiple tool which serves several lid sizes and designs. Under these conditions it is possible that a weld is obtained which passes the pressure test, but is in fact a time bomb waiting to go off in service. ***Figure 9*** shows a typical heat sealing fault arising from tooling misalignment. The actual misalignment (due to being a multiple tool) was slight, but the effects, catastrophic. It led to in-service failures, car acid damage and many compensation claims. In this ***Figure*** you can see an adequate weld which is contained within the designed pin guides. However, there is still a faint gap in the wall material where the two surfaces meet. The second picture shows a bad weld which resulted from the right hand guide pin being melted due to tool misalignment. The container partition wall is held in place by the melted bead of the container and lid, not the actual components. Closer examination shows an open joint along the melt line which is almost touching. This is taken from a warranty return which passed the heat seal test but failed early in service, most probably due to lifting from the lid handle.

Figure 9 Examples of plastic box and lid welding.

To check the weld quality it is necessary to destructively test. To do this, cut off the lid with about 5 cm of the container remaining attached all around the lid. First examine the weld visually to ensure that the weld is even and that the welded points are in the right place. Then cut the box vertically into strips around the lid in key parts, particularly edges and corners. Break these strips off the lid using a pair of pliers. If it snaps off with little resistance you have a problem. If it is difficult and the exposed broken weld on a coloured component is white, then you probably have a good weld. If not, check your tooling set up and your process times and temperatures.

This article has concentrated on the practical aspects of joining together the disparate materials used in battery manufacture. It has also tried to highlight the key areas which can create problems in service but may not be easily detected by standard test methods. It is strongly recommended therefore, that manufacturers critically examine these key parts of their processes and put in place invasive or destructive tests which will show these defects in sufficient time to prevent whole production runs from being affected. This, training operators to look for these defects, and be critical of their own work, can save the manufacturer from high warranty costs, as well as the damage from public liability litigation.

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SOURCE OF INNOVATION

Notes from a small island

Optimism about the huge potential of energy storage in the UK is tempered by the hard reality of vested interests and government inaction. The Editor explores the opportunities and challenges ahead.

The island of Gigha, off the west coast of Scotland.

Britain is a small island. It may have been a small island which once ruled the waves, but now it is just a small island. And, what's more, it's a small island with an energy problem.

The British government is currently undertaking Electricity Market Reform (EMR), a colossal project which will ultimately subsidise just about every form of power generation, be it wind, wave, nuclear, coal, gas, solar, biomass, tidal or cow fart capture and storage. The last one may be erroneous.

Some argue there is a glaring emission from EMR. Well, actually, two glaring emissions. In September, the opposition Labour party caused uproar from the 'Big Six' utilities (British Gas, EDF, E.ON, RWE npower, Scottish Power and Scottish & Southern Energy) when it proposed to freeze energy bills for 20 months and split their vertically-integrated generation and supply businesses into separate entities.

Assuming Labour wins the election, and that may not be too much of an assumption given poll ratings, this leaves just one glaring emission, energy storage. There is no specific provision in the new regime to develop energy storage and currently the Department of Energy & Climate Change (DECC) gives the industry only a few crumbs from its enormous subsidy table.

As BEST went to press, DECC is finalising financing to develop the 3 or 4 winning projects of its £17m (US$27m) Energy Storage Development Competition, which flies so low under the radar few in the mainstream energy industry, let alone the wider public, are aware of it.

One of the projects likely to receive funding is for energy storage on a small island, Gigha, off the west coast of Scotland. REDT (Renewable Energy Dynamics Technology)— operated by Sir John Samuel, who developed the regenesis vanadium redox flow battery (VRFB) at generation utility National Power (now owned by RWE)— is set to build a 1.2 MWh project to store surplus wind energy for use in the local electricity network.

For the time being, a 1.2 MWh VRFB demonstration project may be as good as it gets in Britain in terms of DECC funding. DECC has no clear roadmap to develop electricity storage beyond these pilot projects and certainly no plans to dole out the kind of incentives for storage as seen in California, Germany, Korea and Japan.

For DECC, electricity storage is something of a forbidden fruit. Stung by the take-up of solar power at absurdly over-generous terms in 2010— which ultimately saw the UK government embarrassingly lose a case in the High Court when

Energy Storage Technology Demonstration Competitions – Summary of Phase One Winners

Lead bidder	Title & outline of proposed energy storage demonstration project
Aston University	**HB2G – Hybrid Batteries to Grid:** A hybrid scheme with a mixture of second life ex-transportation batteries with new battery technology to fulfil energy storage needs of both power and energy at lower cost while at the same time contributing to the development of commercial opportunities from automotive battery re-use.
B9 Energy O&M Ltd	**Making SENSE (Smart Energy Storage):** A 1MW / 6MWh commercial-scale Isothermal Compressed Air Energy Storage system (ICAES) to address challenges in the Northern Ireland electricity network.
Energy Cache Inc	**Gravitational Potential Energy Storage via Aerial Lift of Aggregate Material:** Design, construction, and testing of a 250kW, two hour capacity, commercial-scale demonstrator installation of a system to address bulk energy storage needs and rapid response capability.
Enrichment Technology Company Ltd	**Decentralised Energy Storage Solutions for Local Grid Applications:** A flywheel-based energy storage system capable of providing maximum power of 1.2MW and maximum energy capacity of 200kWh to address national and local grid requirements.
EValu8-Transport Innovations Ltd	**EVEREST (Electric Vehicle Embedded Renewable Energy Storage and Transmission):** Modular storage solutions to defer electricity network upgrade costs when installing Plug-in EV rapid chargers, provide an integration hub for intermittent renewable generation, and reinforcement of the electricity distribution network. The proposed energy storage device will in part use 'second life' EV batteries as its primary storage medium.
Highview Enterprises Ltd	**Isle of Grain Liquid Air Energy Storage Demonstration Project:** A commercial scale – up to 6MW and 30MWh – demonstration plant to demonstrate Highview's proprietary liquid air energy storage system and to demonstrate how the system efficiency can be optimised using low-grade waste heat and cold sources.
Hydrogenics Europe NV	**P2G BioMet – Power-to-Gas via Biological Methanation:** A 1MW power-to-gas facility to demonstrate the conversion of surplus electricity into methane for storage and distribution via the existing natural gas grid.
Moixa Technology Ltd	**MASLOW – Distributed energy storage for essential consumer and grid-scale network needs:** 1MWh of storage across 750 domestic sites. The MASLOW system provides night storage for electricity through Meter Attached Storage, to power low voltage LED lighting and DC electronics during peak periods. The system stores energy from local solar or regional wind resources to provide back-up power.
PassivSystems Ltd	**PassivBellows:** Electrical and thermal storage at grid-scale in multiple domestic premises to meet consumer and grid-scale needs.
REDT UK Ltd	**Vanadium Redox Flow Battery (VRFB):** A 1.2MWh flow battery storage system on the Isle of Gigha to store surplus wind energy for use in the local electricity network when required.
Viridor Waste Management Ltd	**Liquid Nitrogen Cryogenic Energy Storage Demonstration Project:** A liquid nitrogen based energy storage and generation system (up to 5MW and around 20MWh) using waste heat from a landfill gas engine to increase system efficiency.
Yuasa Battery Europe Ltd	**Grid Reinforcing Operation of Uninterruptible Power Supplies:** A 2-3MW, 4MWh energy storage system based on using industrial lithium-ion batteries in existing uninterruptible power supply equipment and infrastructure.

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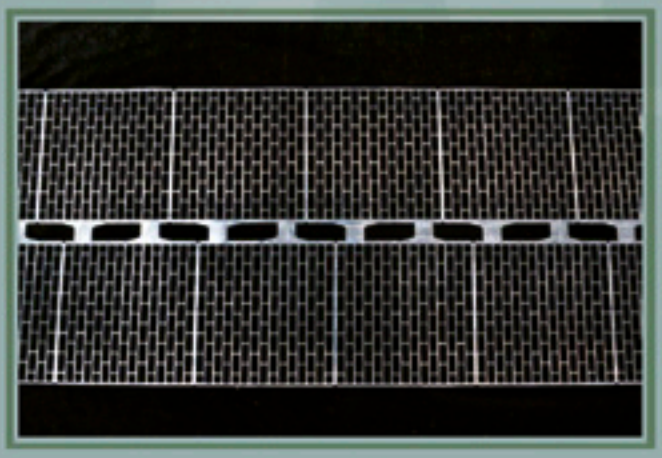
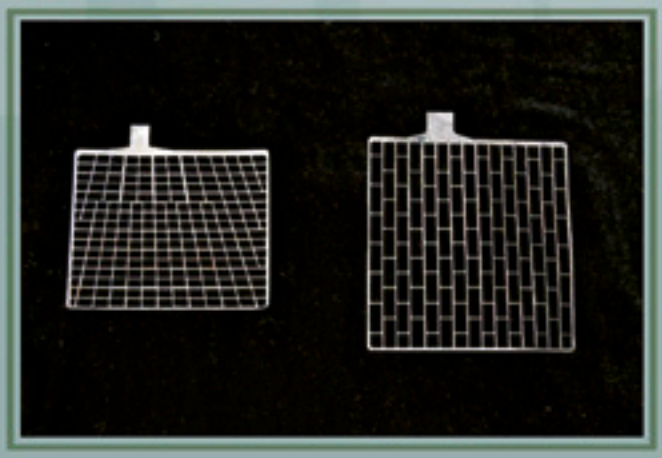
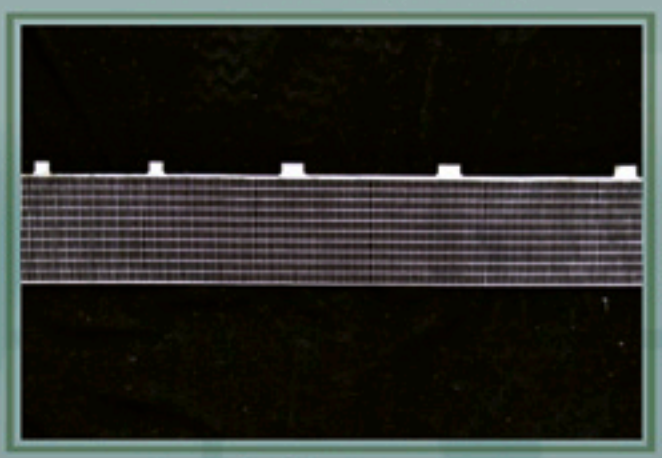


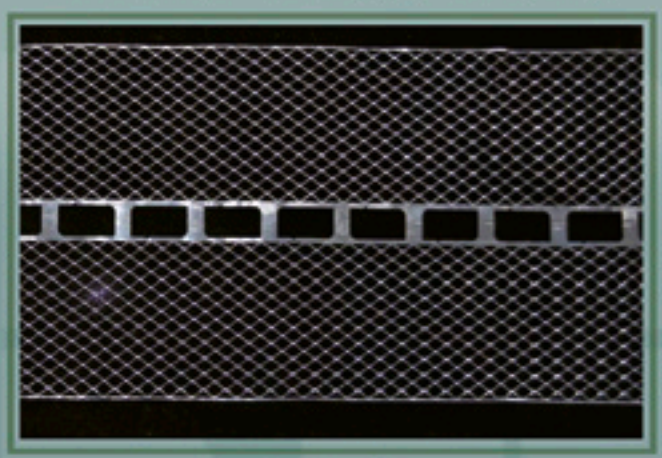
Continuous Punched Grid (double side)



Punched Grid (Left– Car Battery, Right–Industry Battery)



Punched Grid (Spiral Wound Battery)



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it prematurely pulled the plug on the highest tariffs— DECC is wary of burdening consumers with extra subsidy costs.

The author can well understand this— particularly as it is planning to give a circa 35-year index-linked feed-in tariff to new nuclear power stations – but such is the reticence one begins to question their motives.

As Sir John Samuel well knows from his experience with National Power, utilities view energy storage with great suspicion, and with DECC happy to spend potentially billions of consumers' cash on capacity payments on new CCGTs which may have relatively low load factors, one can well understand that too.

Renewables, too, seem not particularly keen. Again this is not too surprising, as wind, solar et al get paid for exporting electricity to the grid, as well as generating power via feed-in tariffs.

As time goes on, these incentives diminish and ultimately disappear. Rather than being a sink for all this renewable power, the grid will have to find a use for it.

DNOs – Where the big money is

This is where distribution network operators (DNOs) come into the picture. Anthony Price, director of the UK Energy Storage Network (ESN) believes there is massive potential for existing and well-proven energy storage technology, i.e. lithium/sodium/lead-acid batteries, to be deployed by DNOs to avoid investment in new transformers and other infrastructure.

Above and below: Samsung SDI containerised lithium-ion energy storage systems, as to be used by S&C Electric at a trial in Leighton Buzzard, UK.

"The really big opportunity is to use electricity storage in distribution grid companies to optimise the increasing volume of intermittent generation and generation sources on the distribution network," says Price. "If we can run the distribution network on average load instead of peak, it would save the rewiring of Britain. That's where the really big money is, and the market we want to unlock."

Under the current regulatory system, however, such storage will not be sufficiently rewarded. In common with most of its European Union neighbours, the UK views energy storage assets as generation assets.

As DNOs cannot hold a generation licence, they cannot effectively install energy storage systems on a widespread basis without a major change in regulation.

While the benefits of load smoothing and load following already make economic sense in niches like island applications, for energy storage systems to realise their true value potential, the output must be sold into market, which requires a supply licence, which is again off-limits to DNOs.

The ESN has been lobbying DECC for several years to change the regulation, but it has so far largely fallen on deaf ears, says Andrew Jones, EMEA managing director of S&C Electric.

"We have been telling them what the barriers are, and DECC now recognises the barriers are real and that they need to make changes to licensing. However, before they make changes they want to see action in the field to see if the business case stacks up under UK requirements.

So S&C Electric is doing just that. In 2014 it will switch on a £13.2m ($21.4m), the 6 MW/10 MWh 'Smarter Network Storage' battery technology project at a primary substation in the English town of Leighton Buzzard. The project, funded under regulator Ofgem's Low Carbon Networks Fund, is Europe's largest energy storage trial.

Using Samsung SDI's lithium manganese chemistry and integrated by Germany's Younicos, the system will provide frequency regulation as well as load shifting. Most importantly, thinks Jones, it has the potential to save over £6m (US$9.5m) on network reinforcement investment in transformers, cable and overhead lines.

"On a like for like basis, the energy storage system weighs in at around £2m (US$3.2m) more than investing in a new transformer 40 miles away plus the cost of linking it to the Leighton Buzzard substation. But the additional ancillary services could be worth a total £8m (US$12.8m) saving in asset deferment."

Jones sees the project as proof-of-concept, a working energy storage system that allows a DNO to reinforce its grid. "It will help us ascertain the real value of storage to the network," he says. "At the moment there simply hasn't been enough research done in the UK to inform the debate."

If the scheme is a success, the pressure will undoubtedly be on DECC to 'show more ankle' to the

energy storage industry. Jones believes it will adopt ESN's target of 2000 MW by 2020.

"How that will actually translate for the market, we don't know," he says. "But we are not asking for subsidies, we don't believe they are needed because if the necessary regulatory measures are taken the business case stands up without them."

There's no money left, says UK Government

In the short term, however, the industry will continue to feel DECC's cold shoulder. The official line is that there is no money left, as Ian Lucas, DECC's Head of Engineering explains.

"We are in a world where we are trying to deliver a renewable revolution in a very economically constrained climate," he says. "We've put a lot of subsidy into the sector already and we have to be mindful of the affordability.

"We have no plans to subsidise energy storage now. We don't think we have fully understood what the right mix of the potential options is." Furthermore, the department sees little need for electricity storage this decade.

"The reality is the (energy storage) problem isn't here today, to achieve our 2020 (renewable energy) targets the density of existing technology required is not massive." Lucas acknowledges, however, that the volume of wind power in distribution networks require deep thought, and DECC is beginning to wrestle with the impact of renewable energy on DNOs.

"Our analysis of EMR has thrown up a serious issue of what happens to the end-to-end grid," he says. "By 2025 to 2030, this will be a material issue given the density of renewables.

"We are building up a work stream to explore this to inform future policy mechanisms. We have been engaging with National Grid and DNOs to tackle this work."

Quarry Battery: The clue is not in the title

Even if DECC believes it is as yet unnecessary, one British firm is going ahead with an energy storage project with neither a change in regulation nor subsidy.

Quarry Battery is undertaking a bold scheme to construct a privately-financed 600 MWh, £100m pumped storage hydropower facility in North Wales. It has also identified five further sites for what it believes will be economic pumped hydro storage schemes.

Quarry Battery believes the increasing volume of wind power in the UK will push down night-time electricity prices but sees daytime prices rise as the reserve margin of baseload generation falls. Electro-chemical energy storage technologies could take advantage of this widening margin, the so-called day/night arbitrage, in the future, but it all comes back to regulation, says managing director Dave Holmes.

"At the moment storage falls between two stools," he says. "At the moment there is no point in making a business case for something that can't happen. If I was able to change regulation, I would define energy storage as a separate class from generation or grid asset."

Developers of other energy storage technologies like thermal are also embittered by DECC's inaction. If the UK government fails to give energy storage a strong enough push, it will fail, says Toby Peters, chief operating office of Highview Power Storage.

Peters argues for a well-developed plan for energy storage instead of DECC's current quarter-assed approach. This plan would take the form of a roadmap for energy storage to 2020 and beyond, and see the building of a shop-window for UK technology so that its innovations can be sold.

This means subsidy and

Highview's 300kW cryogenic energy storage pilot plant in Slough, UK.

support under the UK capacity mechanism to keep the lights on. "The government has to look at market mechanisms," says Peters. "Energy storage is the only part of the energy technology mix which is not being supported post-demonstration.

"As it stands, energy storage in the UK is not going to pass through the 'Valley of Death'. ***Do we want to use technology built in UK or imported? Do we want to be ready beyond 2020 or panic in 2021 and turn on more diesel generators?***

"If energy storage is not supported under EMR's capacity mechanism, we will be asking the next generation to pay twice."

Peters is pessimistic. "Energy storage in UK is not going to happen this side of 2020. One of the challenges is as more diesel and gas generation is contracted under the capacity mechanism, for storage to happen you have to tell these people to somehow throw it away."

Despite the mountain to climb, the industry believes it is onto a winner with electricity storage, particularly for DNOs. DECC's Ian Lucas sees a sees a small chink of light for electro-chemical storage even without subsidies and immediate regulatory changes.

"Before I joined DECC, I used to help people build small and medium-sized renewable projects," he says.

"I've been on the receiving end of a DNO wanting to charge £1.5 million to connect a single wind turbine. Some of the energy storage scenarios must be of some economic value now. As we incentivise embedded generation, the energy storage community should think about where that value already exists."

Yet it is doubtful this will be enough. It cannot be stressed enough that for electricity storage to really develop, regulation needs to change so that relatively passive DNOs can become more like active DSOs (Distribution System Operators).

The final word goes to ESN's Anthony Price. "We need to recognise the total system value of putting storage on the system, and it needs a steer from governments to prevent dominant vested interests to serve themselves.

"Imagine little Achilles being dipped in the River Styx and, rather than Paris waiting to hurt him where he was most vulnerable, it is the powers that be in Westminster lurking in the shadows ready to deliver the fatal blow."

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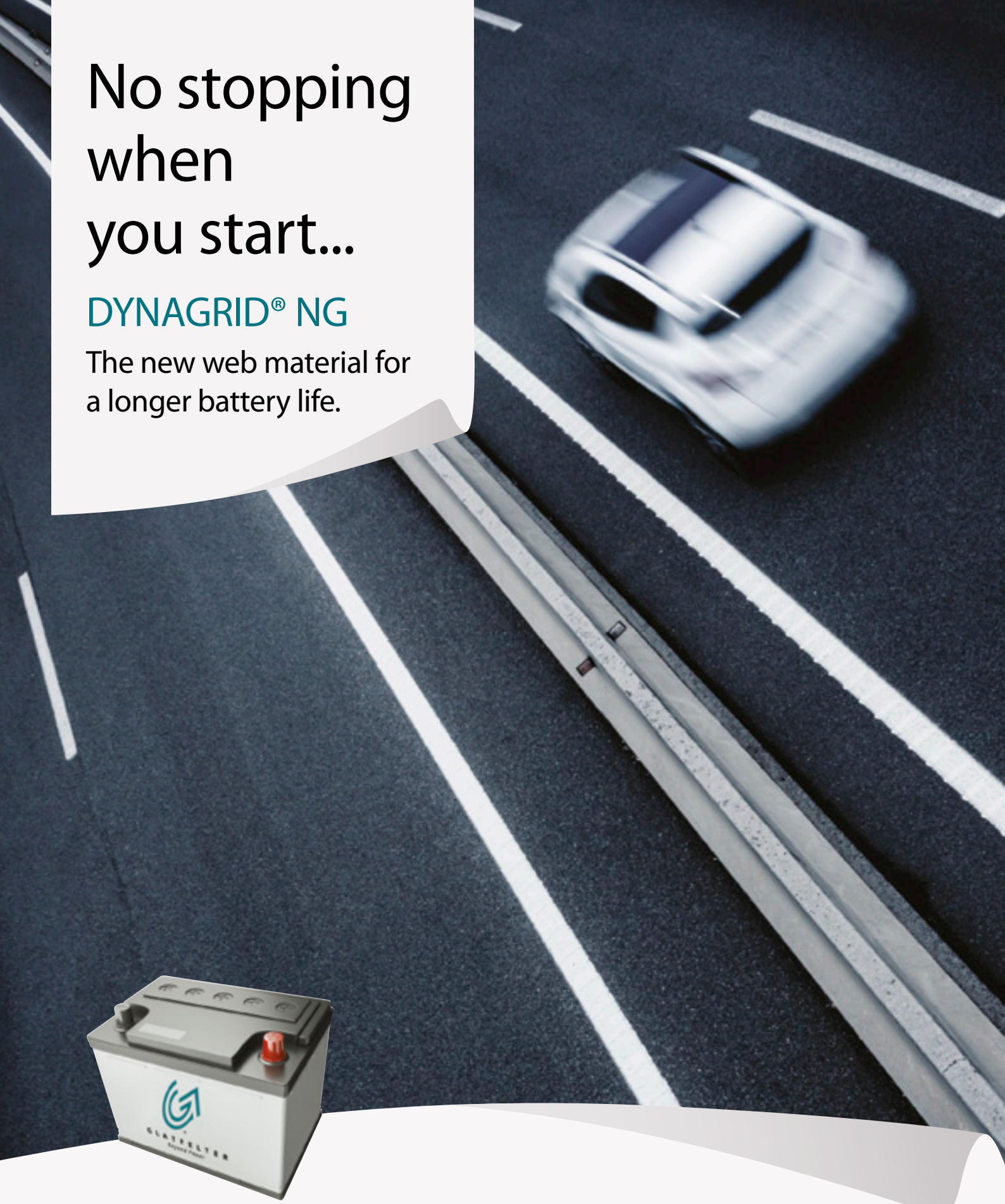

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Electricity storage: Win friends and influence people, then make the sales

The UK is taking baby steps in using large-scale energy storage through government-backed trials. But what's there to prove? 'We know it makes sense,' writes Gerry Woolf.

BEST does not normally take a parochial view of issues affecting the world of batteries and energy storage technologies. But in recent months, energy and energy pricing has become a hot topic in the UK.

It has culminated into a highly political issue as this writer was putting the finishing touches to this article. The leader of 'Her Majesty's Opposition', one Ed Miliband, has threatened to freeze energy bills for 20 months if the Labour party is elected in May 2015, the date of the next general election.

And that promise could well be a vote winner. UK power utilities, of course, are up in arms over the announcement. It will mean less generation, less investment and possibly blackouts. ***They would say that, wouldn't they?***

None of this can be good for electrical energy storage. The generation utilities, if not the network operators, are still in denial over the fact that electrical energy can be stored in quantity. But 2013 could be a turning point, according to Andrew Jones of S&C Europe, an offshoot of the major US player in the storage arena.

Indeed it would be unusual not to find an electrical energy storage project in the US without S&C being involved. The Chicago-based firm is rooted in the arcane world of switchgear, but in the early 1990s and with support from the US DOE, it pioneered large-scale backup power for business and the result was S&C Purewave UPS products. The rest is history.

S&C's strategy in the UK is the same as the company has taken in the USA, via trade associations such as the US Electricity Storage Association (ESA), of which it is a leading member. That is to lobby at the highest level and change the rules to allow storage to make commercial sense, as well technical and strategic sense.

In the summer the ESA proclaimed a major victory when the Federal Energy Regulatory Commission (FERC) had expanded a small piece of legislation - Order 755 - to the non-ISO (Independent System Operator) regions of the USA should track the installation,

Andrew Jones of S&C Europe.

operations and maintenance costs for energy storage— in layman's terms, the business case can be made.

FERC has already made it possible for operators of storage based frequency regulation technology, primarily flywheels, to reap a reward. But it has taken the best part of five years in direct lobbying, and more than a decade's worth of discussion among storage proponents, to get to this position.

In the UK the lobbying process is still at a very early stage through the auspices of the Energy Storage Network (ESN). Its objectives mirror what ESA has lobbied for in the USA.

The UK electricity storage proponent push comes at a time when the British government is scrabbling about trying to encourage investors to invest in rebuilding the country's fast disappearing power generation capability— about £110bn ($175bn) will need to be spent over the next decade. ***But will any of it be spent on electrical energy storage?***

The ESN is not hopeful— not while there is absolutely no recognition of the cost and revenue profile of energy storage versus traditional peaking plants; ESN says that to just use storage as a reserve or standby plant destroys two-thirds of its value, and makes such a project virtually non-financeable.

In Britain, piecemeal token funding is the way forward in so many areas of research and development. Power generation and supply is no different.

The Office for Gas and Electricity Markets (Ofgem) created the so-called Low Carbon Network Fund to support projects sponsored by the Distribution Network Operators (DNOs) to try out new technology, operating and commercial arrangements.

The aim of the projects is to help all DNOs understand how they can provide security of supply at value for money as Britain moves to a low carbon economy. But the scope of the supported activity is enormous— everything from electric vehicles, heat pumps, micro and local generation and demand side management, not forgetting the smart metering roll-out provided to network companies. Too many ideas are being investigated with too little money.

It is no wonder then that Jones was beaming when this writer met with him earlier this year when S&C Electric Europe, Samsung SDI and Younicos announced they had signed a joint agreement to deploy Europe's largest intelligent network storage project, at a UK Power Networks substation.

The scheme should save £6-8m (US$11-14m) on traditional network reinforcement methods. By providing frequency regulation as well as load shifting, the project will also stabilise the grid much more effectively than traditional thermal generators, providing more space on the grid for clean, but intermittent renewable energies.

The fully automated 6MW/10MWh Smarter Network Storage (SNS) battery technology project will be installed at Leighton Buzzard primary substation in order to assess the role of energy storage in cost-effectively delivering the UK's Carbon Plan. The technology can provide a range of benefits to the wider electricity system, including absorbing energy, then releasing it to meet demand, to help support capacity constraints and to balance the influx of intermittent and inflexible low carbon technologies onto the grid.

But it's hardly "big bucks"— £13.2 million spread over four years between four major players. And there's precious little else.

S&C is installing three 25KW hour lithium-ion batteries for Scottish and Southern Energy in Slough for an eco homes project using S&C's PureWave Community Energy Storage (CES) product— the first batteries to appear at street level in the UK.

Meanwhile, in April and under the same UK Government programme, GE won a contract with the UK's Western Power to provide 100 kWh systems of its Durathon sodium nickel battery systems at five of its high voltage substations in Milton Keynes, located 45 miles northwest of London.

Jones said: "The major grid challenges from the UK's decarbonisation can be met through energy storage's inherent ability to reinforce the network. But currently there are limited large-scale energy storage projects here, leaving a confidence gap. This practical demonstration promises to show the strengths and limitations of storage and unlock its potential as a key technology for the transition to low carbon energy."

S&C's PureWave Community Energy Storage (CES) product.

But distribution grid operators should not have to wait till 2016 when the Low Carbon Networks programme ends to learn of the value of storage in the UK. As long ago as 2007 UK Power Networks obtained a 200 kWh Energy Storage System for installation at Hemsby, Norfolk which received support from the UK Engineering and Physical Sciences Research Council (EPSRC) and the Innovation Funding Incentive (IFI).

Having installed the device in April 2011, the system has been running and a first early learning report was published a little under a year ago with a final report due imminently. There is little doubt the system does exactly what it says on the tin: the first modes of operation implemented on the device have demonstrated that the energy storage device is performing as expected both as a Static Synchronous Compensator (STATCOM) device and real power exchange (charge/discharge) modes.

Accordingly, UK Power Networks was able to reduce voltage fluctuations and manage demand. The overall round-trip efficiency of the ESS is quoted by ABB (the main contractors) to be more than 90% and the operators have been assessing the overall efficiency of the total installation, which would be impacted by several components: the lithium-ion batteries, the power conversion system and the 1 MVA step-up transformer. ***But was it a money-***

maker? Equivocal is the short answer. The operators claim that on-going annual operating costs have the potential to be optimised for future installations. They took a decision, for the purposes of transparency and ease of reporting, to meter both import and export rather than treating and settling any round-trip losses as technical losses associated with the plant.

200 kWh Energy Storage System installed at Hemsby, Norfolk. UK.

UK Power Networks had limited interest from energy suppliers, which to an extent was to be understandable for an installation of this size as it was not sufficiently large enough to offer them services, but was large enough to represent an imbalance risk if not forecast with an accurate demand and generation profile. As such, the project has had to proceed on the basis of business and generation tariffs for 'traditional' network users.

The energy import charges are higher than the revenue that can be generated from exporting a similar amount of energy back onto the network, when considering the specific tariffs being used in this project.

But the operators say this interaction starts to look 'substantially different' in the case where larger installations are being discussed with a supplier, and in which ancillary services are being offered or agreed to help the supplier at the same time as agreeing a settlement mechanism for round-trip losses incurred, whilst the device is supporting the distribution network. In simple terms, give it the same benefits that FERC has granted to US operators and it could be a winner.

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DC grids: Going back to the future

Ruth Williams visited Bath, in southwest England, to see how a computer network run from a DC micro-grid has become the starting point for an international study for using battery storage to maximise renewable energy.

Although AC won the 'war of the currents' of the 1880s, DC is perfectly suited to low voltage electrical devices including computers and LED lighting, as well as many energy efficient appliances. If localised DC networks or self-contained micro-grids became commonplace, this could create a large market for lead-acid storage batteries, as well as other chemistries.

Since December 2010, a research team from England's University of Bath has been operating a DC micro-grid in its library. Called Project Edison, evoking the first DC systems used in the 19th century, the University has installed a bank of 50 computers in its library.

The computers run on DC that comes from a three-phase AC to DC system feeding into the computer string. The AC-DC convertor is attached to a bank of 16 lead-acid batteries.

The DC 50 computers installed are 50% more energy efficient than the predecessors because of energy efficient technology and the DC-power network.

The DC computers run on 24V as opposed to 230V AC. DC computers are not new but they are rare, the majority of the 50 bought by the University had to be imported from China.

The batteries provide 12 hours of power; four hours had been designed for but the low power consumption of the computers meant 12 hours is available.

The existing computers were due for renewal and were replaced with energy efficient machines when the network was installed.

One of the benefits of a DC network is energy efficiency, however the efficiency savings for the University came more from updating the computers than the network alone. Compared with the old computers the energy saving is around 50%, but compared with modern, energy efficient computers, the DC network makes an energy saving of about 10%.

Dr Miles Redfern, Senior Lecturer in Electronics and Electrical Engineering at the University of Bath, says the real savings are made with the reduction of electrical noise. AC power usage creates waveform distortions that cause a lot of electrical noise, which utility providers fine big customers heavily for.

To counterbalance, the University spends a great deal of money to filter the electrical noise out. DC power emits a waveform that is virtually flat, which creates no distortion so does not need filtering. Additionally, because there is no AC-DC power conversion, fans are not required. This not only reduces acoustic noise, but also lessens the need for cooling.

The system has attracted attention from local distribution network operator Western Power Distribution to apply the network model to 30 homes, ten schools and an office in the nearby city of Bristol to assess the benefits of utilising DC power in a home, including how battery storage could help customers save energy.

"Many people have talked about doing this, but we have it up and running, we can see the benefits and the problems," says Redfern.

"There are problems, we are finding them and how to solve them. One of the biggest challenges is how to design a DC distribution system: we are using technology from the 1930s."

The original plan included photovoltaic panels on the library roof to generate DC power for the micro-grid, however the University's

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Vice Chancellor vetoed their inclusion for aesthetic reasons. If renewables were used, the batteries could store power when generation is high for use when there is little or no sunlight.

So is the project complete without demonstrating the use of integrated PV?

"Not entirely," says Redfern. "The panels were a fundamental part of the project. DC can support multiple renewables generation, we could put windmills on there for instance and they would work together with the DC power.

"For integrating renewable energy into the system, DC is ideal. The money has run out to retrofit it, from an engineering point of view we can make it work but aesthetics may be detracted and the finances are questionable."

As it stands, the system could make time of use savings for users on a variable electricity tariff by using energy from the batteries during peak-time, and recharging them during low-peak hours.

Even without using renewable energy, the savings for a company with a lot of computing equipment start to add up. Redfern says one of the benefits the batteries offers is backup power: "The battery system provides UPS capabilities– last year the university had two blackouts and the library power was shut off for a time; the level with the DC network experienced no interruption."

Having worked out the teething problems, the University became involved with the UK's Low Carbon Network Fund and Western Power Distribution working on SoLa Bristol to apply the principles to households, offices and schools.

The participating organisations are equipped with PV panels providing power for electronics and computing equipment. For households where the peak usage does not match peak energy production, lead-acid battery energy storage is included.

Professor Furong Li of the Electronics and Electrical Engineering department at the University of Bath explained the project is focused on local systems for small-scale usage. Describing her role as 'philosophising on future energy requirements', Li has has three objectives.

"Firstly, designing a better DC network to understand what arrangement works best to capture most energy from PV and how that can benefit customers," she says.

"Secondly, improving energy management to manage both local and remote generation to match with local demand. Thirdly, a variable tariff was developed to provide the right message to say when the energy market is low and when the system has a pressure."

The SoLa project is also exploring shared ownership of storage batteries. "In this project we explored if energy storage can be jointly owned by the network and the consumer. So if the network is exceeding its limits the batteries can be used to ease network pressure."

This idea of locally generated power contributing to national energy security is part of the beauty of such a system, and what Li and Redfern believe will benefit managing future energy supplies.

The next step in the DC micro-grid journey will take the team to India to work with specialists from the Indian Institute of Technology (IIT) to assess how DC micro-grids with energy storage could be used to reinforce national energy security.

The collaboration, which also involves research teams from Durham and Cardiff universities, will assess power systems including local micro-grids, security assessment, power system analysis, tariff design and future scenarios.

The three-year project begins in January 2014 with the two research teams meeting to better understand each other's challenges. Li says: "We will run a test study to trial systems used in UK and India, which will help when we look to the future to see how the current practices of the two nations

Left to right Dr Miles Redfern, Professor Furong Li of the Department of Electronic and Electrical Engineering, and Knowledge Transfer Partnership Fellow Surendra Kaushik, who has been involved in both Project Edison in the library and Project SoLa Bristol.

might be useful and what we can learn from each other."

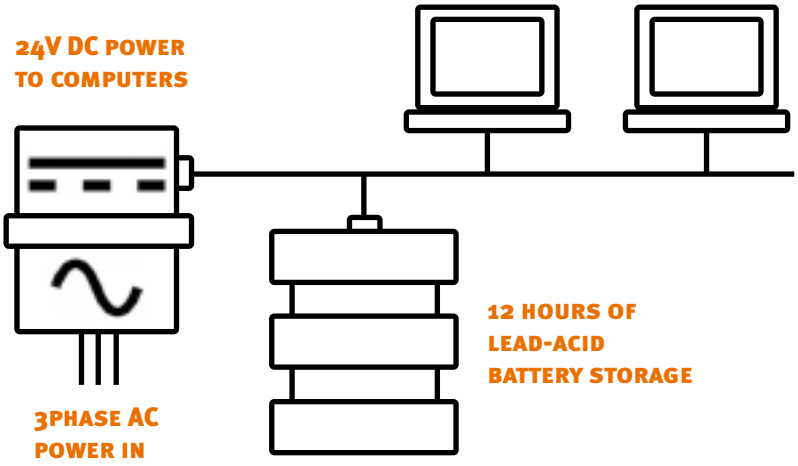
The next stage involves understanding how a system dominated by renewable energy generation will work in practice and what potential problems could arise.

Ensuring energy security in a country like India that has tenuous supply and extremely high demand on its capacity will need demand management and energy storage.

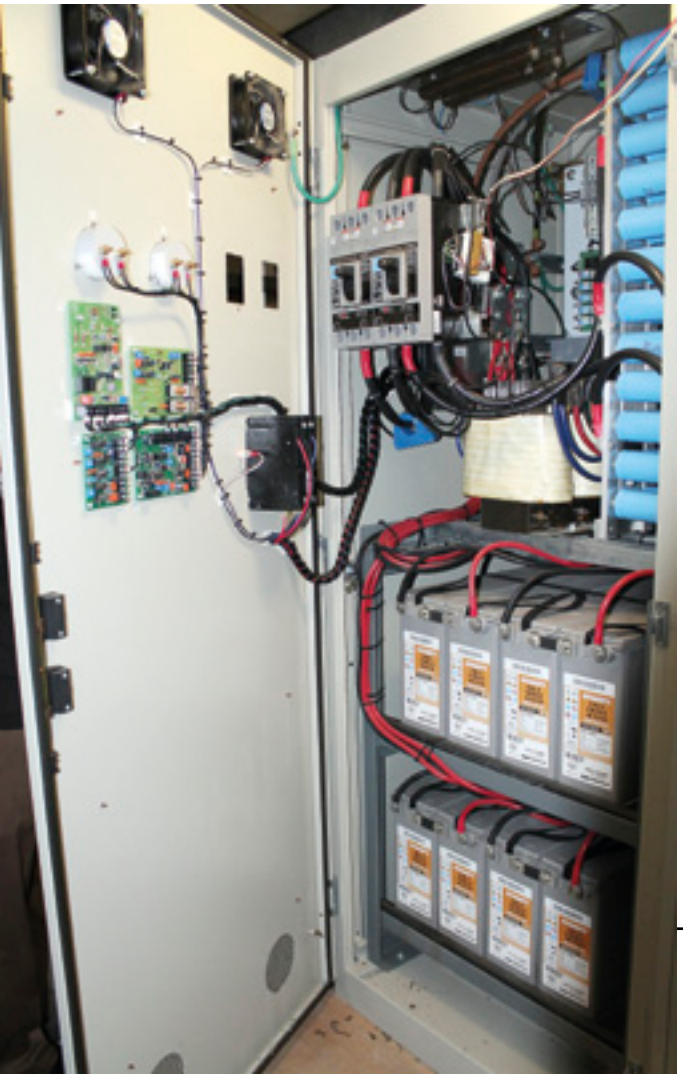
While it might seem a far cry from the UK with its well-established national grid and redundancy in both generation capacity and power lines, it is becoming more relevant every year. In the UK, nine power plants totalling 12GW of capacity have been shut down in two years due to environmental obligations.

A further six GW of coal-fired power stations and three GW of oil-fired plants are due to be closed by 2015 which will further reduce a peak demand reserve margin which has fallen to just 5%.

Alternating current enters the system for conversion to direct current that can then be used in the computer string. Battery storage provides UPS capabilities for the system.



The one-tonne cabinet sits on the floor above the library's computer bank. Three-phase AC is fed into the convertor as seen at the top of the cabinet and the lead-acid batteries for UPS are below.



The partnership is mutually beneficial, explains Professor Li. "The UK is still considered a leader in system generation, so we want to see if UK practice can be used in the Indian system— particularly with a lot of renewable generation.

"That will lend itself to the UK's energy problems of the future. At the moment we have lots of controllable generators, such as gas and coal powered plants, but in the future we could have a situation similar to India with lots more renewables and our consumption rising with the population and the electrification of transport."

Li and Redfern suggest the need to become more creative about what we can expect from demand and supply of energy. Redfern says: "At the moment we have unmanaged demand so we have to manage the generation to meet the demand. If we have unmanageable supply from renewables the only way we can balance is by managing demand; and with energy storage."

The use of energy storage, Li explains, will be very important because India does not have a strong interconnected system and power interruptions are frequent, storage on a small-scale could be creatively used. The batteries could be used to return power to the grid when generation does not meet demand. As with the Bristol SoLa project, shared ownership would be mutually beneficial.

"With the development of local DC networks with PVs and other local renewable generation, it would really help to mitigate the security issue, and also rural India has no access to mains energy supply, so storage of electricity will become more important," she says.

As a major up and coming consumer of software and IT equipment, India is an ideal platform to expand the library-style DC network. A small-scale network has the bonus of requiring less infrastructure than AC, Li added: "Energy storage is modular and easy to install, you don't need planning permission so things can happen a lot quicker with energy storage than building pylons across the country."

So what form of storage is under consideration? Redfern says the team has an agnostic approach: "We are not committed to any chemistry, lithium-ion is expensive, sodium-sulphur creates large amounts of heat, lead-acid is abundant and cheap but lead is perceived as dirty. Battery engineering is the big subject of

the future but we are letting other people do that job."

Making storage work at small-scale and for national grid level presents the biggest challenge for the team. "With a local DC network we only need to understand local conditions," says Li.

"But if you consider the community and national security you need to analyse all the situations and requirements. That is the biggest challenge in this project, to see how local will interact with national in terms of energy and security and how it needs to adapt."

The Engineering and Physical Sciences Research Council (EPSRC) is funding the UK universities' involvement and on the Indian side funding is coming from the Department of Science and Technology. The funding amounts to just over £1m ($1.6m) from the UK and just under £1m from India.

This is peanuts when spread between three universities over three years, so how far will it actually get them? "We are doing so many other research projects, such as the library DC network, SoLa Bristol and work between the UK and China on smart grids, we have base knowledge to grow from," says Li. By combining expertise a lot of previously acquired knowledge can be exploited and applied to the two settings.

The library project remains hugely relevant because the India UK project is focussed on making smart DC grids work on behalf of bolstering national energy security. "We have done a lot of groundwork, so we are confident that with the expertise from both countries we can design a DC network that's better for local use and strategise how, and should, it be utilised from local to national use."

Both Professor Li and Redfern are eager about the prospect of the huge challenge ahead, and it is a monumental undertaking with a lot for each country to learn. ***A future electrical grid peppered with renewable generation— bolstered by micro-grids and energy storage— could be a realistic prospect for many regions, will India and the UK be the trailblazers?***

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The story of India's 'green' telecom towers continues

Our south Asia correspondent Dipak Sen Chaudhuri reports on how India's drive towards renewable energy in rural and semi-rural communities looks set to boost usage of lithium-ion for energy storage applications.

The story that we have been following since the Summer issue (BEST No. 41) is picking up pace. In July it was announced that Reliance Jio Infocomm Limited (RJIL), a group company of corporate India's first family, the Ambanis, had placed a €35m (US$47m) order with France's Saft for lithium-ion battery packs.

The packs will be used as the exclusive back-up battery for all mobile broadband base stations for RJIL's upcoming 4G operations. Little extra detail about the 'specialised' packs is available, but it looks to be a 'moment of truth' for the Indian battery industry.

In an immediate scramble, other telecom operators are fast-tracking their alternative storage technology plans, mostly lithium-ion. At least one such operator has decided to test the technology in 7 000-10 000 base transceiver station towers, across the country in some of the most power-starved locations.

In a queer turn of events however, India's power shortage has unexpectedly started showing a reverse trend. Improved power generation, reduction of transmission losses, a less oppressive summer and early monsoon have all contributed to an easing of the power deficit.

This has spelled a major 'seasonal demand' problem for suppliers of batteries and home UPS systems, commonly known as inverters. In recent years this segment has been a major revenue earner and a handsome contributor to profits, but almost all manufacturers of batteries and inverters have had to take a major hit in their top-line as well as bottom-line.

Nevertheless, not for a moment should it be thought the sudden improvement in grid power supply will change the need for back-up power in the telecoms sector. Telecoms installations are increasingly in rural and semi-rural locations where grid power, even if available, will continue to be unreliable.

An interesting development that is taking place in the telecoms sector originates in what has already reported in the last issue, namely the regulatory authorities directive to tower operators to 'hybridise' their power requirement by having a combination of renewable and grid power as the available source of energy.

The tower operating companies (TOWERCOs) are virtually being asked to be power generation companies! They have expectedly expressed their difficulties in venturing into areas beyond their core-competence and also the enormous financial outlays required for the same.

In India, both manufacturers and users of renewable sources enjoy a fat government subsidy, the TOWERCOs have requested the government of India to extend this support to them. However, the total money required for this— hybridizing 20% of all urban towers and 50% of all rural towers— is huge and beyond the budgets of the concerned departments of the government.

It is in this background India is now seeing the arrival of renewable

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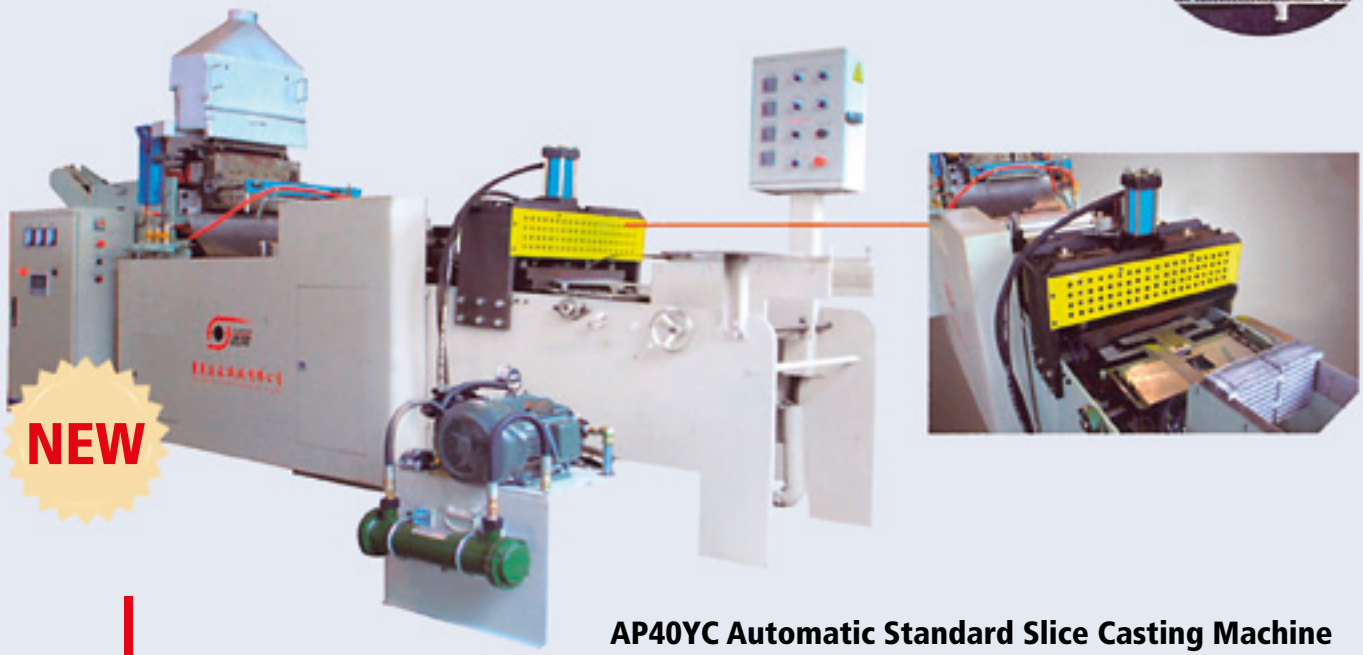
The company, established in 1966, is located in Wanzhou District, Changjiang.

As the biggest manufacturer of lead-acid battery production equipment, its products have won many ministerial level technical progress awards, such as the National Key Product Award. The machines have been sold to over 2 000 domestic customers and exported to more than 30 countries and regions such as USA, Germany, Vietnam, India, Burma, Italy, Poland, North Korea, Turkey, Malaysia, Bangladesh, etc.

Yuanfeng's principle goal is technical innovation with management innovation as its basis. The company aims to provide better, newer and more advanced lead-acid battery production equipment for the whole lead-acid battery industry and satisfy customers requirements from around the world.

Casting Rolling Production Line



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energy supply chain opportunities (RESCOs). These are large facilities of renewable energy generation located in the rural and semi-rural heartlands, which would have sufficient capacity to supply power to three, four or even five of the towers and also providing the villagers in the vicinity with community lighting— domestic as well street-lights, recharging solar lanterns and perhaps also power up their major source of entertainment— the community television!

The concept is hugely appealing to the tower companies as they no longer have to bother about power generation including managing pilferages, which extend from solar panels to batteries, and are quite prepared to commit to be 'anchor users' of such projects to ensure financial viability of the RESCOs.

On the other hand as the local communities would benefit and depend on the sustained availability of these renewable sources, the villagers would ensure their safe operation free from pilferages.

This seems to be a win-win situation for both tower companies as well as the proponents of green energy. The storage technology continues to be central to the success of this model, except the requirements slightly change. They would have to be compatible with 'renewable energy generation' and immediately the whole question goes towards superior charge acceptance of high power generation. It does seem lithium-ion all the way.....

ABC: One little Indian

As the 15th Asian Battery Conference came to a glittering end, it was time for a reality check, so far as storage battery technology in India is concerned. Indians were present in large numbers— perhaps in terms of participants they were as many Indians you could find as Chinese.

However, only one out of a total of 40 papers presented in the conference was by an Indian. It was perhaps unfortunate that this Indian gentleman reviewing the Indian battery industry was representing a Bangladesh battery manufacturer!

Yet, this has been a good conference for India. As many as eleven Indian organisations were amongst the exhibitors— China had 26. These included battery manufacturers, component manufacturers and alloy producers, to name a few.

Maximum interest was noted, at least in terms of footfall, in manufacturers who have stepped out of the routine and developed components quite unique and different from current practice.

This includes a separator manufacturer— Raman FibreScience— and a tubular plate gauntlet manufacturer, KE-Technical Textiles, who had caught the attention of the prospective buyers with their own technology. There will be more on these and other such companies in the coming months, as they are worth watching.

Generally the exhibitors were pleased at the interest they created and in a few cases the preliminary responses they got. Even if only a percentage of these responses get converted to sustained business, they believe, the conference will have been a big success for the Indian businessmen.

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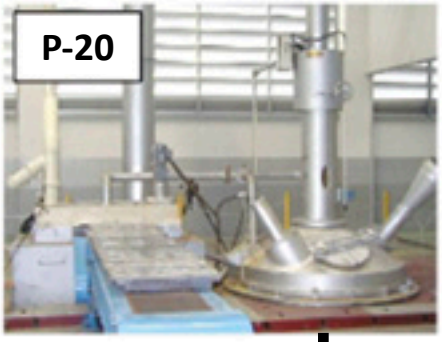
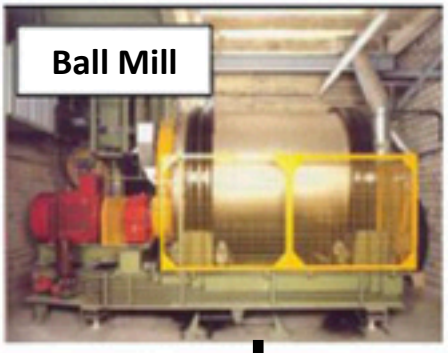
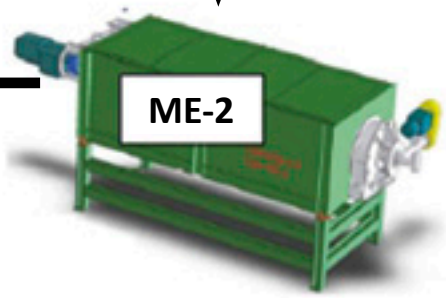




Raw Oxide

Battery Oxide
Barton or Ball Mill Oxide



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Turkey looks to Asia as Europe flatlines

As the European market continues to idle, Turkish battery machine manufacturers are relying on customers in the East to ensure their futures in the lead-acid battery industry. Ruth Williams reports on the shift from west to east.

Every month market figures are available giving a different view on the continued demise or recovery of the Eurozone. The growth that does exist is slow, while Asia continues to boom for both automotive and battery markets. With news that AABC is relocating to Asia for 2014, it is clear that many in the industry see the future for battery production lying away from Europe.

Although Turkey, Maghreb Arab and near Middle East regions have not been impervious to the global financial crisis, they have not sunk as low as Europe.

Turkey shares a border with several of the near Middle East countries and has a close proximity to North African countries that are gaining industrial momentum. Following the Arab Spring that began in Tunisia in December 2010 many nations are becoming democratised and industrialised.

Countries in North Africa and the near Middle East are in a transition period following the social uprisings. While some of these countries have on-going troubles, several nations embraced change to mark the beginning of a new era of stability both politically and for the economy.

The Arab Spring dampened economies in the near Middle East, but forecasts for 2013-14 indicate that the non-oil economy alone is set to grow by 4.3% this year.

While in Africa, countries have seen growth of 4.5% in 2013, according to figures from the African Development Bank. For 2014, growth is predicted to be 5.2%. As a region, North Africa is anticipating 4.3% economic growth for 2014. One of the infrastructural challenges for industrial growth is implementing energy security.

In battery terms, these regions are seeing considerably more growth in their respective markets than Europe— a trend that is expected to continue into the next year, according to figures from Eurobat, based on collated data from its members.

The figures from Eurobat's Industrial Battery Committee for 2012 show motive power batteries make up 57% of the total lead-acid battery market and standby power accounts for the other 43% in the Europe - Middle East - Africa (EMEA) region. The motive power market in the Middle East and North Africa region is growing considerably but the market size is much smaller than Europe for 2V cells.

The lead-acid battery stand-by market was worth €840m (US$1143m) in 2012 across the EMEA region. For the Middle East the value was €53m, which is 7% up on the previous year, compared with 2% growth for the EMEA region. Africa has a double-digit increase on the previous year, with a value of €51m showing that the Middle East and Africa are experiencing far greater growth than Europe for battery consumption.

Turkey has long been called the gateway from east to west and its manufacturers have the best of both worlds. Picture Turkey's prime geographical position: it borders Greece, Bulgaria, Georgia, Armenia, Azerbaijan, Iran, Iraq and Syria, as well as having ports on both the Black Sea and the Mediterranean Sea. This opens trade up to many regions, including the near Middle East region that has little by way of domestic battery production.

This position works to the favour of Batek Engineering, maker of grid casting, plate making, battery

assembly, and battery and cell formation machines. Celal Saricam, Managing Director says: "We have a strategic advantage of being able to reach European and Asian customers alike.

"The logistic advantages are there for both Asian and European manufacturers; customers get all the European qualities of competence, engineering and technical qualifications. Our position means they are getting much better terms and quicker lead times than other manufacturers can afford. We are the most eastern European country and close to Asia, so we have a logistic advantage in terms of service and shipment."

Turkey has a trade agreement with the EU, called the Customs Union, which has been in effect since 1995 to allow goods to travel between the two without customs restrictions. The EU is Turkey's number one import and export partner with machinery and transport equipment being the major sectors. Turkey's other major export markets for these goods are Iraq, Russia, USA, UAE and Iran.

As readers will know, Zesar is a plate production and battery assembly machine maker based in Istanbul that also views the proximity to Europe as an advantage.

Zesar's General Manager, Mohsin Ali, says: "In Europe, there is a decreasing number of manufacturers due to rising costs, so customers have to look beyond to Asia. However, Turkey is very close and European customers do not have to pay import taxes because of the shared economic community. This makes Turkey important for European traders."

As the industry in Europe has struggled, companies have had to move their attention to other markets. "The share of our business in Europe is gradually decreasing each year. We have gone from having 50% of our business in Europe to just 10%. The market has shifted to Asia," says Saricam.

The impact of the Eurozone crisis has been felt by all industries. Saricam says while the problems in the European battery industry had a lesser impact on Batek, the economic downturn still reverberated.

"The downturn is affecting not only European manufacturers but also those supplying Europe as well as Asia and the Middle East." He explained that because Asian companies make up much of Batek's customer base, any slow down in sales for those companies will affect Batek's sales.

Despite these problems, there is growth for Turkish battery manufacturers both domestically and for exports. Inci Akü is a lead-acid battery maker which increased its total sales revenue in 2012 by 40% over the previous year. It broke production and sales records to increase its total sales revenue from overseas sales to be 60% of the company's revenue.

Domestic sales increased by 40% compared to the previous year. Inci Akü exports to over 70 countries from its production locations in Manisa in western Turkey, Ukraine and Germany.

Like the machine makers, the battery producer weathered the Eurozone crisis by focussing its direction to other regions. In a statement at the beginning of 2013 Göksel Paker, Chairman of the Board and CEO, said of the company's response to the financial problems: "We have acted with planned and long term perspectives in terms of

Turkey shares a border with eight countries, which allows for prime trade opportunities.

diversifying our foreign markets, increasing our market shares and realising our investments that would enhance our competitiveness. Thereby while we got over the hardest period of crises with success, we also gained significant advantages compared to our competitors."

Turkey's geographical position offers a natural advantage once more for companies to strengthen exports to Asia and Northern Africa where the markets are growing.

Ali says: "The position of Turkey makes it open for anyone who doesn't have domestic manufacturers— such as Iran or Syria. Generally speaking those places are open for anyone, we know they have a lot of problems with new countries, that's why it is not easy to trade with them, but Turkey has very good relations with them. This makes Turkey a peculiar country, because we can export to those countries very easily."

But selling into the Middle East comes with its own problems. According to Ali, it is a less successful region for Zesar. "There are not so many battery manufacturers in the Middle East and the ones who are there either go for very low-cost Chinese products or they go for expensive US or European-made brand products," he says.

Ali admits Zesar is not at either end of the scale: "For the type of machines we make we are not low quality like many Chinese or Far East products; but at the same time we are not as sophisticated as European or US products. We are somewhere in the middle— which puts us in a bad position to sell to the Middle East.

"It makes our lives difficult because some people want the price of Chinese products but the quality of European products. That is just not possible," he added.

Africa is another growing export region for Zesar; Ali said it is one of the most important export markets. "In African countries there's a demand for industry, so our customer base is increasing. So far we are active in Sudan, Algeria, Morocco and in contact with some other countries that we expect to expand to soon."

An ever-growing battery manufacturer in North Africa is Assad Battery, which has plants in Tunisia and Algeria with a total production capacity of 1.26 million lead-acid starter and industrial batteries.

Assad has a 59% market share of battery sales in Tunisia, leaving a minority for overseas manufacturers to sell into. It has a strong presence in other North African countries: a 26% market share in Libya for 2012 and 14.8% in Algeria shows its strength in these regions.

Slim Ayadi, Product Development Manager of Assad says this is far from an exclusive territory: "We export across the Middle East, Africa and Europe. For example, 1.3% of replacement car batteries sold in France in 2012 was an Assad battery." Indeed, 80% of the company's output is SLI batteries.

Assad gains 68% of its total revenue from exports; of this distribution 60% is in North African countries, 35% in Europe, and 5% in Middle East and Africa. Since 1989 it has had an international trading group called Assad International which allowed it to trade with customers in the EU, Africa and the Middle East including France, Germany, Italy, UK, Spain, Algeria, Libya, Morocco, Senegal, Egypt, Syria, Saudi Arabia, Iraq and Iran. It also has a joint venture with Enersys to manufacture and export industrial batteries to the European and North African markets.

Inci Akü sees the potential of growing into North Africa. It is considering building an assembly plant in Egypt to serve Arab and African countries. As a central production site Egypt would have the advantage of trade agreements between Arab and African nations, covering about 30 countries, which will give a great competitive price advantage.

While Asia is set to continue growing, South America is tipped to be the next major region of growth. Saricam says Batek is concentrating on gaining a foothold in this market: "We will put our efforts for the future to having a solid market share in South America. We are doing market research and studies to be able to penetrate this market."

Batek intends to replicate its success in Asia with South America. Despite having no geographical advantage for supplying the continent, Saricam says it is essential for future success: "It is one of the growing markets of our industry so we have to be there. Any company that wants growth has to be in the growing markets."

This change in strategy is related to the European downturn, to continue to grow, companies will have to diversify the markets they operate in instead of depending upon just one.

Despite the changes in markets, Batek has no fear of the future of lead-acid batteries for the automotive industry: "I'm sure the lead-acid battery will maintain its advantage in terms of price and cost in the automotive industry for the next 10 – 15 years. I don't think the industry will change the energy storage technology from one day to another, it will take quite a long time."

As the Middle East and African regions move more and more towards industrialisation— and with it cars needing replacement batteries— the market is opening up for machine makers, component suppliers and battery makers. Turkey is poised to serve this tinderbox of battery activity that could soon leave Europe in its wake.

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Carbons open the door for a surge in supercapacitors

John Miller explains how new carbon improvments are allowing supercaps to invade the space of conventional devices— which will have profound effects on performance and price.

The autumn 2010 issue of BEST reported on the development of an electric double layer capacitor (sometimes referred to by the product names "Supercapacitor" and "Ultracapacitor") with an ability to filter AC power and thereby function like a conventional aluminum electrolytic capacitor. The particular capacitor referred to in that article was a developmental device having vertically-oriented graphene nanosheet electrodes with a very special structure. Though fairly novel at the time, activity has since become increasingly focused on such very high power electric double layer capacitors with potential for filtering applications.

But why is this significant?

Electric double layer capacitors are known for their high reliability. If they were able to perform filtering, the likelihood is that they would soon replace wholesale all aluminum electrolytic capacitors now used in filtering applications: a product not known for its reliability. An additional and highly significant consideration is that the capacitance density of electric double layer capacitors is generally orders-of-magnitude higher than other capacitor types.

Electric double layer capacitors would, quite simply, be able to pack the same level of performance into devices of much smaller physical size. And with the dual advantages of high reliability and smaller size, market pull should be strong for

such products in many present and some newly emerging applications. Further, remember that one of today's rapidly growing applications involves converting stored energy (for instance from batteries) into AC power plus the reverse process, AC to DC conversion. Aluminum electrolytic capacitors are, at present, a key component in power inverter circuits used to help effect such transformations. If these new electrochemical capacitors that filter can indeed meet industry performance requirements and maintain volume and reliability advantages, they may help to accelerate growth of energy storage technology, important for society in the many energy conservation implementations that range from transportation to electric micro-grids.

Noting that high-power performance and high-frequency operation are essentially one and the same, then what is really needed in a capacitor intended for filtering applications is an ability to be efficiently charged and discharged in very short times. For example, filtering 60 Hz power available from an ordinary wall outlet in the US requires 120 Hz operation, i.e., reducing the voltage ripple on full-wave-rectified AC power to produce smooth DC voltage. This, of course, requires charging and discharging the capacitor every 0.0083 seconds, the period of one cycle at a frequency of 120 Hz. Since clearly it takes an exceptional electric double layer capacitor to do that, substantial activity around the world has lately been directed toward such research and development.

The figure below is a so-called Ragone plot that compares several

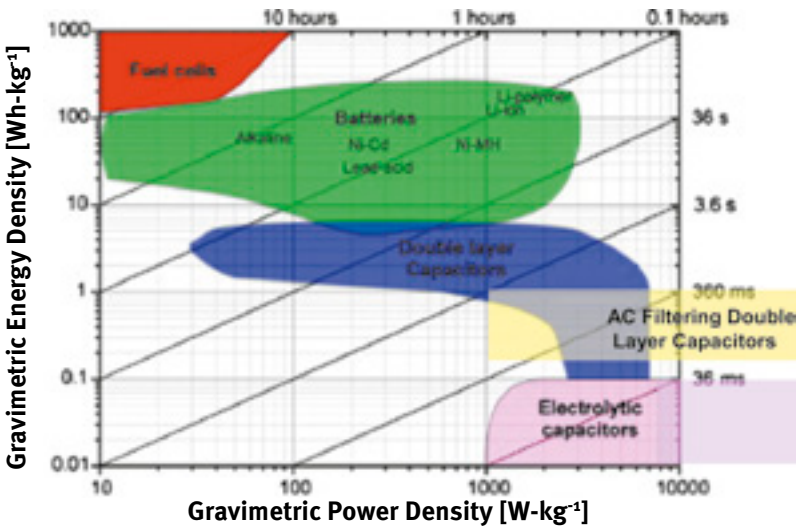

Figure 1
Ragone Plot.

technologies on the basis of their gravimetric energy and power density. Diagonal lines show discharge times. This comparison is single dimensional in that it ignores cycle life, cycle efficiency, operating temperature range, safety issues, failure modes, etc., which are also important in most applications. Nevertheless, a Ragone plot can be used to show the region where such electric double layer capacitors with filtering capability might reside. Batteries of various types sit in the large green area below and to the right of the red fuel cell region. Discharge times span a range from one hour to 1/10 hour to 1/100 hour (36 s), showing the range of performance offered by the different battery technologies.

The blue area below the battery region is the electric double layer capacitor region. While this technology has lower specific energy than batteries, it extends farther to the right, offering higher specific power. Diagonal lines show it to be able to discharge in less than one second.

The pink region represents electrolytic capacitors, which is below the electric double layer capacitor region and it extends far to the right, efficiently being able to charge and discharge in much less than 0.0083 seconds.

Yellow defines the region for the new electric double layer capacitor having AC filtering performance— it is above the aluminum electrolytic capacitor region and extends equally far to the right.

An important parameter not shown in a Ragone comparison is cycle life. For example, both an alkaline flashlight battery and an electrolytic capacitor are shown—the battery is able to deliver only a single discharge while the capacitor must deliver more than ten billion cycles during ten years of operation in a 120-Hz filter circuit.

The question, of course, is how can an electric double layer capacitor be made to operate at the ultra-high power levels of an aluminum electrolytic capacitor? For this there are two requirements. The first is that all sources of series resistances must be reduced to absolute minimum values. This means resistances having both ionic and electronic origins. The second requirement is that distributed charge storage must be totally eliminated, i.e., the electrochemical capacitor must be made to perform like a series-RC circuit (have a single time-constant). To reduce resistance sources requires the use of metal current collectors, ohmic connection between the charge storage material and the metal current collectors, use of a thin and open separator (or possibly no separator), use of an electrolyte with high conductivity, and so on.

While these advanced, high-operating-frequency capacitors still rely upon electric double layer charge storage at the interface between a solid and an electrolyte, they employ a very special carbon in their electrodes to minimise distributed charge storage effects. High-surface-area activated carbon is used in conventional electric double layer capacitors, which usually do exhibit distributed charge storage behavior. One-, two, and three-dimension external-surface-area carbons each having nanometer-size features have been investigated and reported in the literature to be able to eliminate distributed charge storage. The one-dimensional carbons typically are single and multi-wall carbon nanotubes, with numerous reports on efforts using them to approach the frequency response of an aluminum electrolytic capacitor.

The two-dimensional carbons typically are graphene as discussed in the autumn 2010 Capacitor Tech-Talk column in BEST. Graphene can be as thin as a single atomic layer, similar to a piece of paper with front and back surfaces exposed, which store charge on both of these faces as well as along the edges. The three-dimensional external-surface-area carbons are typically carbon blacks or other spherical nanomaterials including carbon nano-onions. The micrograph below shows examples of all three types of nano-materials, nanotubes

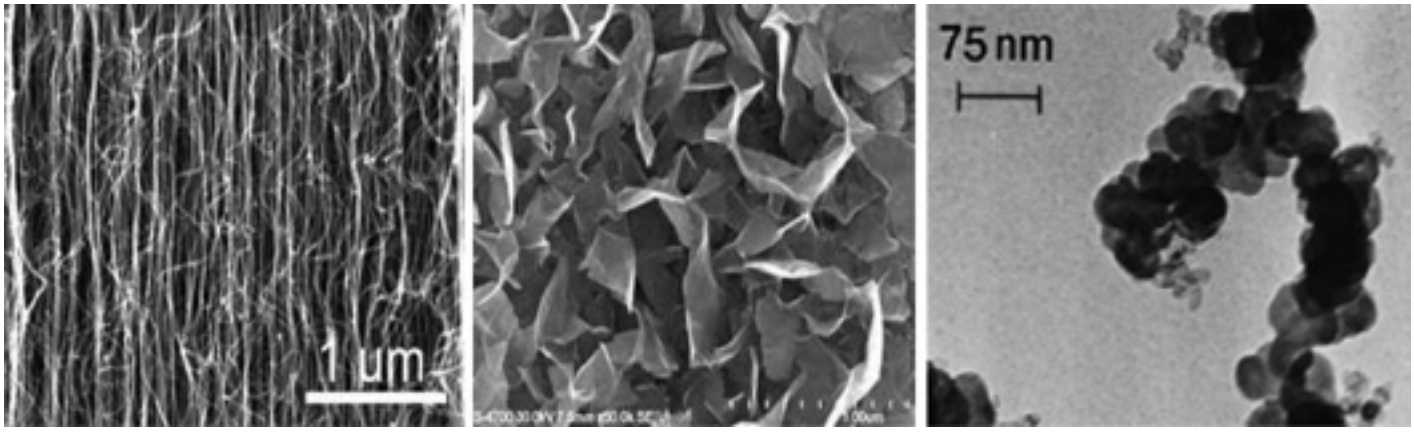

Figure 2 External surface area carbon.

on the left, graphene in the middle, and carbon black on the right. They all have external-surface-area primarily and each has been used and reportedly shown to offer high-operating-frequency performance.

In contrast with the many popular essentially-DC applications where commercial electric double layer capacitors are used today, for filtering applications one of the most important performance metrics is called the 'dissipation factor', which is a measure for the amount of energy lost during one charge/discharge cycle.

Should there be even only a very small amount of energy lost during charging and discharging while operating at 120 cycles per second, this will lead to a corresponding temperature rise and the emergence of thermal management concerns related to keeping the operating temperature below some maximum value. The ideal dissipation factor is zero, of course, which means the phase angle between the charging/discharging current and the charging/discharging voltage is exactly 90°.

This phase angle is measured at the filtering frequency. In practice a phase angle value of 90° is never realised— filtering capacitors generally closely approach this value but they never do reach it. Phase angle is critically important for capacitors used in filtering applications and constitutes a metric by which such capacitors should be compared. Performance comparisons among different capacitor technologies, irrespective of the capacitance values, can be directly made using this metric. It is a most important parameter to use when comparing different filtering capacitors, or the different ways of implementing high-operating-frequency electric double layer capacitors.

Several examples of two-dimensional external surface area carbons are shown in the micrographs above. Here vertically oriented graphene structures are grown from a nickel substrate to which they are directly connected, so that there is very little resistance between the graphene and the current collector. As shown, the graphene structures are spaced sufficiently far apart to obviate porous electrode behavior that generally is observed with high-surface-area activated carbons due to their micro-porosity.

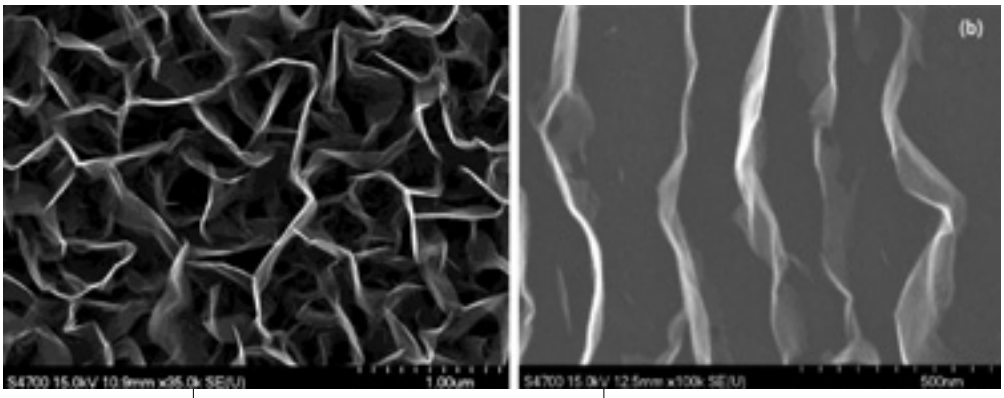

Figure 3
Graphene structure micrograph.

Many approaches have been used to synthesise special carbon nano-materials—the examples shown here used plasma-assisted chemical vapor deposition to convert methane gas into the nano-structured graphene solid. Process-control knobs provide opportunities to create specific graphene structures and external electric fields can be applied to align the structures as shown (right micrograph in ***Figure 2***).

Graphene nanosheet electrodes can be used to make electric double layer capacitors using the popular sandwich design. This involves placing two of the vertically-oriented graphene structures on nickel substrates opposite each other with a microporous separator between, then wetting the separator and graphene surfaces with electrolyte. Despite its conventionality, this design works extraordinarily well in that it can yield performance of nearly a 90° phase angle at 120 Hz. However, owing to the substantial thickness of the current collectors and the separator compared with the thickness of the graphene charge storage material, the active material occupies only a very small fraction of the total device volume. Thus, a conventional design is poorly suited for high-operating-frequency electric double layer capacitor devices.

In the interests of higher volumetric efficiency one can in fact use a planar design, the approach shown in ***Figure 4***. We start with a substrate that is an insulator, for example alumina. First a thin nickel metalisation of the surface is performed and then the vertically oriented graphene nanosheets are grown on top of the nickel. The surface can then be turned into two electrodes by creating a gap—physically removing both the graphene and the nickel down to the insulating substrate, as depicted in the figure. For instance, a laser can be used to ablate away the material and create this gap. Finally, when these two electrodes are overcoated with an electrolyte, an electric double layer capacitor cell is created. Note that no separator is used in this design. On a volume basis, this planar design has higher efficiency than the conventional sandwich design, which does require a separator and uses two thick current collectors.

The advantage of a planar electric double layer capacitor is shown in ***Figure 5***, which compares device capacitance density versus voltage for this capacitor design (solid line) with that available from standard commercial aluminum electrolytic capacitors (triangles). Parameters used to make the planar double layer capacitor projections include: 2.5 V cell operating voltage, 50 µm total cell thickness, capacitance per area of 500 µF/cm2, and all cell-gap-area losses ignored. As is clearly evident from this figure, the planar electric double layer capacitor offers significant volumetric advantages over aluminum electrolytic capacitor technology, each offering comparable frequency performance.

At 50 V, capacitors using this approach are more than an order of magnitude smaller in size than present commercial aluminum electrolytic capacitors with the same capacitance value. At low voltages, e.g., 10 V, there is at least a hundred-fold size advantage for the planar electric double layer capacitor. And at high voltages, e.g., 300 V, these electric double layer capacitors offer less but still at least a five-fold size advantage over aluminum electrolytic capacitor technology.

Value is often derived from using smaller-size circuit components, particularly in non-stationary applications like transportation or portable electronics. Electric double layer capacitors with filtering performance are expected to have very high value.

Even a comparison like this based only on size makes the electric double layer capacitor quite attractive as a substitute for aluminum electrolytic capacitors. A compelling case is made when reliability is included. The failure mode for an electric double layer capacitor is usually an "open circuit" while for an aluminum electrolytic capacitor it is often a "short circuit". The critical relevance of this to overall reliability is obvious. Assuming that the planar design calculations can be realised in product form, then both size and reliability factors will provide strong motivation to replace aluminum electrolytic capacitor technology with electric double layer capacitor technology.

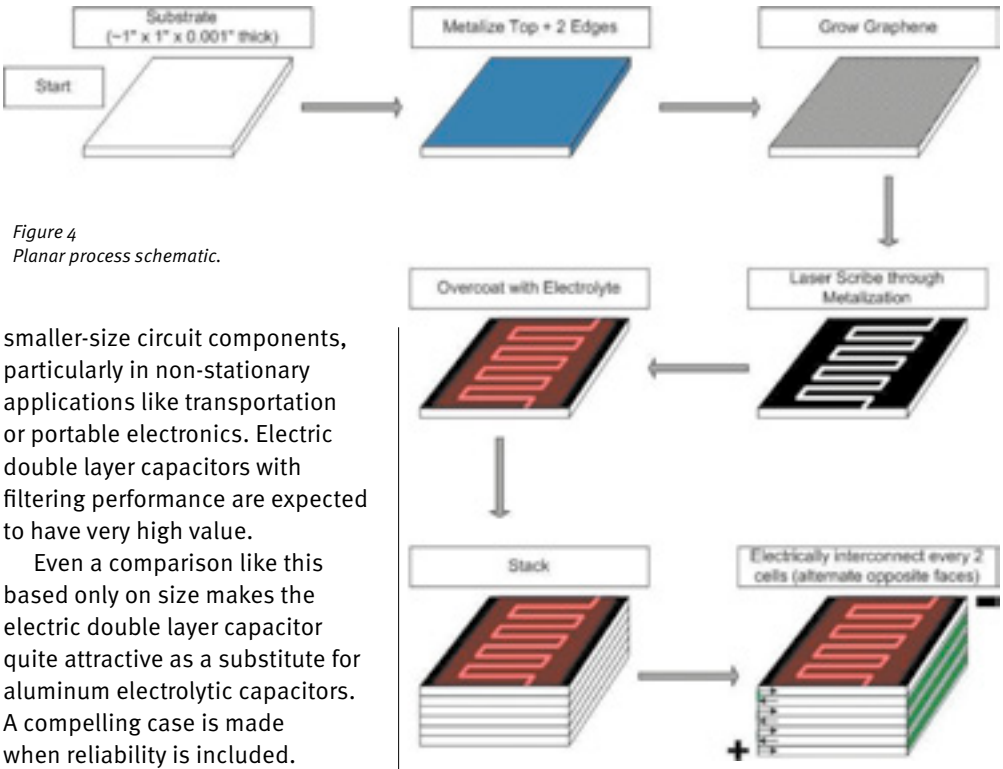

Figure 4
Planar process schematic.

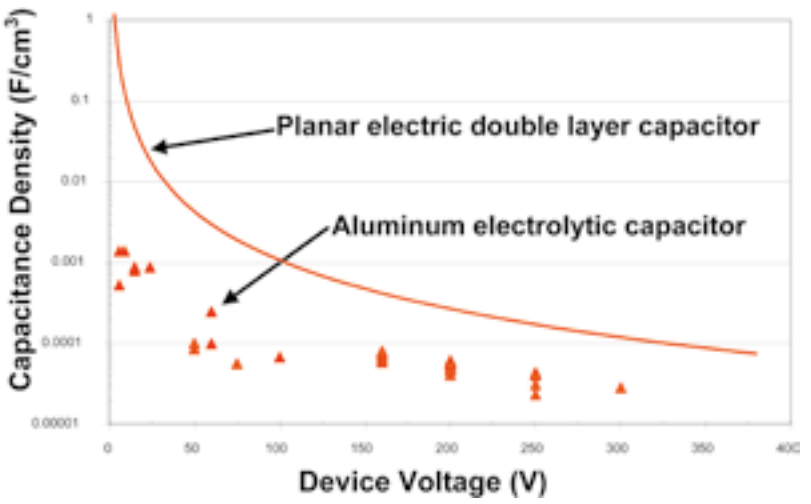

Figure 5
Capacitance density comparison.

Over and above graphene, there have also been reports in the literature of using carbon black, a three-dimensional form of external surface area carbon, to create high-operating-frequency electric double layer capacitors. This material has been shown to offer a phase angle near 90° at 120 Hz, with vertically-aligned carbon nanotubes likewise demonstrating similar performance. Very simple approaches have been devised to convert thin graphene-oxide layers into conductive external-surface-area graphene charge storage material, one involving the use of a low-power CD-writing laser to locally heat and reduce the oxide. Such two-dimensional charge storage material has been shown to offer quite interesting high-frequency performance.

The two major criteria needed to achieve AC filtering performance previously discussed, however, remain relevant. Very low resistance is needed along with a single-time-constant electrical response.

A recent exfoliated-graphite electrode electric double layer capacitor paper reported reducing the series resistance to a very low value such that the phase angle at 20 000 Hz was 45°. However, the phase angle remained near this same approximate value down to 0.1 Hz— it did not approach 90° as needed for filtering. These results confirm the need to have absolutely no distributed charge storage along with a very low series resistance in a filtering electric double layer capacitor.

Returning to the Ragone plot, the emphasis here has been to tap the higher-energy-density characteristic of an electric double layer capacitor, yet greatly increase its power performance (move to the right) so that the device can filter like an electrolytic capacitor. There has been a misconception that simply reducing capacitance values of a standard electric double layer capacitor will increase its operating frequency. Yes, the RC-time-constant is reduced when C is reduced, but operating frequency is not substantially increased due to the effects just mentioned— distributed charge storage from a porous electrode material. One needs to have a single-time-constant response, generally provided by special external surface area nonomaterials, so that the electrode can be efficiently charged and discharged without worrisome redistribution of charge and its associated losses.

For electric double layer capacitor technology to succeed in filtering applications as an alternative to electrolytic capacitor technology, it will certainly require advanced electrode designs using special external-surface-area carbons that have by now established themselves as a viable option, whether in the form of carbon nanotubes, carbon blacks, or graphene structures.

The large number of research and development groups active today in this area suggests that we will indeed be seeing electric double layer capacitor products in the future that compete head-on with aluminum electrolytic capacitors. Importantly, these new capacitors should provide higher reliability and have a more compact size.

12 – 14 November 2013

Automotive 48V Power Supply Systems

Frankfurt, Germany

The sole focus of this conference is 48 volt systems for mild hybrids and stop/start cars. Presentations from OEMs, automakers, and R&D centres will include future battery strategies for 48V systems, electromagnetic compatibility for power supply and the power demands on a system.

Info:
www.48v-vehicles.com

13 – 14 November 2013

NiBS Battery Conference 2013

Oswestry, Shropshire, UK

UK standby power company NiBS (Northern Industrial Battery Services) hosts a conference and exhibition featuring technical papers discussing the latest industry trends and current product issues presented by industry experts, including Advanced Battery Care.

Info:
ww2.nibsltd.com/conference

18 - 20 November 2013

IRES 2013

Berlin, Germany

The 8th International Renewable Energy Storage Conference and Exhibition (IRES 2013) is a platform for sharing knowledge and exchanging ideas on the future of energy supply. Conference session topics include storage demand; PV home storage systems; flow batteries; high temperature thermal energy storage; and large-scale systems.

Info:
www.energystorageconference.org

2 - 3 December 2013

Fenibat 2013 1st National and International Lead-Acid Batteries Fair

Londrina, Brazil

The lead-acid battery industry is booming in South America, so what better excuse to visit Brazil? At this two-day conference and trade show you can meet with members of the Brazilian and South American lead-acid battery industry and view new products, services and technologies from Brazilian and international manufacturers.

Info:
www.fenibat.com

12 – 15 November 2013

Advanced Energy Technology Congress

San Diego, California, US

Three events co-located over four days: *Next Generation Batteries* looks at battery materials, system design and integration, and manufacturing and commercial applications. *Lithium Battery Power* dissects technology and materials development through device packaging and integration to applications and safety in a full spectrum of lithium-ion batteries applications. *Battery Safety* addresses concerns in battery safety in different sizes, systems and applications.

Info:
www.knowledgefoundation.com/viewevents.php?event_id=305&act=evt

17 – 20 November 2013

EVS27: The World Electric Vehicle Symposium and Exposition

Barcelona, Spain

Featuring lectures and a poster exhibition for delegates to present and discuss their EV-related work. The ride and drive area allows visitors to test-drive battery, hybrid and fuel cell electric vehicles on the streets of Barcelona. Within the topics discussed are batteries, fuel cells, propulsion systems (motors and power electronics) and BMS.

Info:
www.evs27.org/en/home

20 – 21 November 2013

Graphene Live! USA 2013

Santa Clara, California, US

Graphene promises to be the wonder material of the 21st century, with supercapacitors and batteries as well as electronics being developed using it. The conference will cover all the promising applications of graphene, including graphene composites, supercapacitors and batteries, functional inks, logic and memory, touch screens, sensors and bio-electronics and beyond. Graphene Live is co-located with Printed Electronics.

Info:
www.idtechex.com/graphene-live-usa/conference.asp

2 - 4 December 2013

Automotive Battery Safety Summit

Wiesbaden, Germany

Focus is on the most important safety strategies of battery systems to meet the regulatory requirements and standardisations at Europe's only lithium-ion safety conference. Attendees can learn about the latest developments regarding battery pack design to enhance functionality, durability and reliability on every battery level; learn how to test high voltage batteries with robust design verification testing to prevent internal shorts.

Info:
www.battery-safetysummit.com

14 – 16 January 2014

4th Annual Electric Energy Storage Event

San Diego, California, US

This event looks at the capital benefits of grid-scale storage on a domestic and international perspective. It includes three days of presentations and case studies from electric energy storage experts as well as interactive workshops. The conference covers energy storage in relation to renewable energy source, regulatory/policy/ federal resource planning, business development, R&D, new technologies, distribution technology, and smart grids.

Info:
www.marcusevansassets.com

5 – 7 May 2014

Battcon 2014

Boca Raton, Florida, US

The Battcon International Stationary Battery Conference features a non-commercial conference for users, manufacturers and developers of all types of stationary batteries. All chemistries and applications feature on the comprehensive schedule. Alongside the conference is a two-day trade show, and of course, golf sessions.

Info:
www.battcon.com

8 – 9 May 2014

Australian Energy Storage Conference & Exhibition

Melbourne, Australia

Australia's first on- and off-grid energy storage event is being held in Melbourne and will feature a two-day exhibition and conference showcasing technological advances, market trends and financial analysis of the energy storage market in Australia.

Info:
www.australianenergystorage.com.au

19 - 23 May 2014

AABC Asia

Kyoto, Japan

The first Asian AABC brings the conference and exhibition closer to the carmakers and suppliers of the xEV market and battery technology innovators.Top energy storage technologists from Asian carmakers and their suppliers will assess the Asian electrified vehicles market and the battery technology that will power it.

Info:
www.advancedautobat.com/conferences/

3 - 7 February 2014

AABC 2014

Atlanta, Georgia, US

The tried and tested format of Anderman's conference returns with a couple of additions. The EC Capacitor Technology and Application and Large Lithium-ion Battery Technology and Application symposia will each feature poster sessions including short oral presentations from six of the presenters. The Advanced Automotive Battery Technology and Application and Market symposium will follow the previous set up.

Info:
www.advancedautobat.com/conferences/

EVS27: This series has been running since 1969 now comes to the streets of Barcelona.

9th INTERNATIONAL CONFERENCE ON LEAD-ACID BATTERIES

LABAT'2014

10-13 June 2014 , Albena, Bulgaria

ORGANIZED BY:

Lead-Acid Batteries Department
Institute of Electrochemistry and Energy Systems
Bulgarian Academy of Sciences

LABD SINCE 1967

Traditionally very informative event where:

- Leading research scientists and technologists from all over the world present their latest experimental results and research achievements in the field of lead-acid batteries
- New trends for future development of lead-acid battery technology are outlined in the course of interesting discussions and spontaneous exchange of exchange of ideas on topical issue
- Manufacturers and suppliers to the lead-acid battery industry present new products, machines, equipment and services
- Professional networks expand naturally in a friendly atmosphere among the calm and the beauty of this wonderful seaside resort

DEADLINES TO REMEMBER:

Pre-registration, Short Abstract submission and reservation of exhibition space **30.10.2013**

Early bird registration and submission of Extended Abstracts **15.03.2014**

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14·ELBC
Edinburgh • 9-12 September 2014

ADVANCE NOTICE

14th European Lead Battery Conference and Exhibition

Edinburgh | Scotland | September 2014

The International Lead Association is pleased to announce that the 14th European Lead Battery Conference (14ELBC) and Exhibition will be held at the Edinburgh International Conference Centre, Scotland on 9-12 September 2014.

14ELBC will provide an ideal opportunity for anybody involved with the global lead battery industry to review and discuss the most recent technical advances associated with lead-acid batteries, especially in the areas of emerging new automotive and renewable energy systems.

Technical presentations at the Conference will bring delegates right up-to-date with the latest research and development information from around the globe, and will be of keen interest to both manufacturers and users of lead-acid batteries, as well as to the scientific community. An extensive Exhibition – expected to involve over 100 exhibitors - by suppliers to the industry of equipment, materials and technology, will also take place.

Since the first meeting in Paris in 1988, the European Lead Battery Conferences have developed a reputation for high quality presentations on the design, manufacture, performance and use of lead-acid batteries. Over 600 delegates and 100 exhibitors attended 13ELBC in Paris in 2012, and similar numbers are confidently expected in Edinburgh.

14ELBC Conference Secretariat:

Maura McDermott
International Lead Association,
Bravington House, 2 Bravingtons Walk, London N1 9AF United Kingdom
Tel: +44 (0) 20 7833 8090 | Fax : +44 (0) 20 7833 1611 | E-mail: 14elbc@ila-lead.org

ila
International Lead Association

130 advertisersindex

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Arbin	sales@arbin.com	arbin.com	120
Ateliers Roche	meshmaker@roche-meshmaker.com	roche-meshmaker.com	24
Batek Makina	info@batekeng.com	batekeng.com	31
Batterie Fullungs Systeme	info@bfsgmbh.de	batteryfillingsystems.com	39
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Beijing ARD Machinery	ardsale@ykard.com	ykard.com	94
Bernard Dumas	bdumas@bernard-dumas.fr	bernard-dumas.fr	19
BM Rosendahl	r.jonach@bm-rosendahl.com	bm-rosendahl.com	79
Buhler	grinding.dispersion@buhlergroup.com	buhlergroup.com	25
CAM	cam@cam-srl.com	cam-srl.com	62
CBE	eng@cbeequipment.com	cbeequipment.com	51
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Cellusuede Products	sales@cellusuede.com	cellusuede.com	72
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Froetek	info@froetek.de	froetek.com	58
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International Lead Association	14elbc@ila-lead.org	ila-lead.org	129

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Kallstrom	office@kallstrom.com	kallstrom.com	23
KE Technical Textiles Pvt. Ltd.	info@ketex.com	ketex.com	41
Kraft Powercon	info@powercon.biz	kraftpowercon.com	110
Kustan	geku@kustan.de	kustan.de	57
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LABAT'2014	dpavlov@labatscience.com	labatscience.com	128
Lap GmbH Laser Applikationen	m.mandt-merck@lap-laser.com	lap-laser.com	21
Leader Tech United	sales@ltucompany.com	ltucompany.com	109
Mac Engineering	maceng@mac-eng.com	mac-eng.com	BC
Maccor	sales@maccor.com	maccor.com	43
Maxwell Technologies		maxwell.com	54
Oak Press Solutions	sales@oakpresses.com	oak-battery.com	15
Officina Meccanica Romanese	omr@omroff.it	omroff.it	47
OM Impianti	info@omi-nbe.com	omi-nbe.com	104/105
PC di Pompeo Catelli	info@pompeocatelli.com	pompeocatelli.com	69
Penox Engineering	engineering@penox.de	penoxgroup.com	114/115
Polyworld Sendirian	info@polyworld-my.com	polyworld-my.com	108
S&C Electric Company		sandc.com	101
SE.R.I. S.p.A	info@serihg.com	serihg.com	53
Shandong Sacred Sun	weizengliang@sacredsun.cn	sacredsun.com	70
Shenyang Jugu Equipment Manufacturing Co	info@jugucn.com	jugucn.com	102
Sorfin	sorfin@sorfin.com	sorfin.com	61
Sovema	stella.fermo@sovema.it	sovema.it	34/35
STS Instruments	info@stsinstruments.com	stsinstruments.com	20
Timcal	info@ch.timcal.com	timcal.com	22
Water Gremlin	smende@watergrem.com	watergrem.com	4
Wirtz	sales@wirtzusa.com	wirtzusa.com	8/9
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Yacht Battery Company		yacht-battery.com	16
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Zhongguan	sales@zgcccn.com	zgcccn.com	83

Where lethal voltages and rhetoric pass harmlessly to earth

A question of credibility

While the *Scribe* was away in Singapore, it was announced Britain's Royal Mail is about to be privatised. The Queen, in case you're wondering, doesn't own the business, it's state-owned and Westminster is desperate for cash.

In this 'austerity' era, Mr Cameron can barely afford to fire the odd cruise missile, so a couple of billion sterling raised from the Royal Mail is what Harold Macmillan, British Prime Minister between 1957-63, would undoubtedly called a classic example of "selling off the family silver."

Standard-priced mail deliveries all over the UK will soon be a thing of the past and the general effect will inevitably be a poorer, more costly service. That's the experience in Germany, the Netherlands and in many other countries that have gone down this route.

But what's that got to do with the readers and advertisers of BEST? Crappier and more expensive mail doesn't help us do our job any better. The ESPL postage bill now is pretty enormous.

With the advent of the tablet and who knows what else, print media could be history in a decade [Though they said that ten years ago! – Ed.]. That's why were doubling our efforts in electronic media. No trees, no dogs biting postmen and faster delivery. But at least we actually take the trouble to mail hard copies of BEST and Chinese BEST to readers and advertisers.

And you can ask us for evidence of postage from our mailing house, UK Postings Ltd. We'll happily provide it. You can learn how many copies we send all over the world, and to which countries. **More importantly, we're registered with the US Postal Service in order to distribute as a publication in that part of the world.** It is a US legal requirement to display that information; see our masthead on page 5.

This is more than can be said for one so-called industry publication. ***Does it go anywhere by mail at all? Or only hotel waste disposal?*** Questions need to be asked. It's your advertising budget, after all.

While the great and the good were gathered at the Shangri-La in Singapore, fellow gentlemen of the press gathered in Frankfurt for the International Motor Show (IMS). It's one of the best— the ESPL team has a weakness for all that comes from Cupertino in terms of IT and the output of German auto industry.

Unsurprisingly, there's a plethora of hybrids announced; a pure electric racing car for the Formula E F1 competition and a handful of city electrics. Lithium is the energy storage source of choice.

The Frankfurt show had more than 1600 journos in attendance and your *Scribe* is glad he wasn't one of them. These are nightmare events to convey all the features and benefits of so many vehicles in so short a time.

Only the glamorous autos get serious attention, while PRs invade your inbox, voicemail and sleep to inform you of their company's offerings. Second only to the IMS nightmare is the Consumer Electronics Show in Las Vegas. ***Imagine comparing and contrasting the latest crop of smartphones?***

While the dream cars have lithium batteries under their hoods, the cars for lesser mortals are still pretty much wedded to lead-acid for now. What worries me— on your behalf— is their increasing electrical load.

Even the bottom-of-the-range models feature Internet connectivity— you can be sure these cars will depreciate faster than Dell shares.

You can't make cheap cars much more comfortable because padding for noise reduction and big behinds adds weight and cost. But gizmos are easy— electronics are literally cheap as chips— their real cost is measured in amp-hours.

With all these electronics, these automobiles are pushing the need to up the DC bus to 48V. And that's what lead-acid people need to worry about: the chemistry tipping point.

Throw in more stop-start and micro-hybridisation and a 48V DC electrical system may well turn out cheaper to manufacture than a 48V lithium-ion energy storage only system or a lithium/lead combination. It is coming. ***When?*** The *Scribe* doesn't know. But soon. Something to keep you up at night.

Many expats in Singapore asked the *Scribe* if the UK was out of the worst of the slump. They had been reading headlines in the Murdoch-owned press. ***A new housing boom, a warm summer and things are getting better - wasn't that a Tony Blair line?!***

Well, no. The people that really get things sorted are engineers, not politicians. Free wi-fi at the somewhat pricey Shangri-La hotel helped the *Scribe* keep abreast of the salvage operation of the cruise liner Costa Concordia, which ended up on the rocks, nearly two years ago. On 13 January 2012, she was wrecked off the coast of Isola del Giglio in Italy mainly thanks to an incompetent captain. You could substitute the word captain for bankers: vis-a-vis Lehman brothers, RBS and HBOS.

In what has been described as the biggest salvage operation in history, the 114,137 tonne vessel was righted in 19 hours using a technique developed by US navy engineers in 1942 known as parbuckling. A pity the economies of the western world can't be fixed so quickly. So share in the moment of applied scientific smugness.

The nerds won. Again.

Lasers

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Battery diagnosis and monitoring

Global Energy Innovations

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Battery Testing

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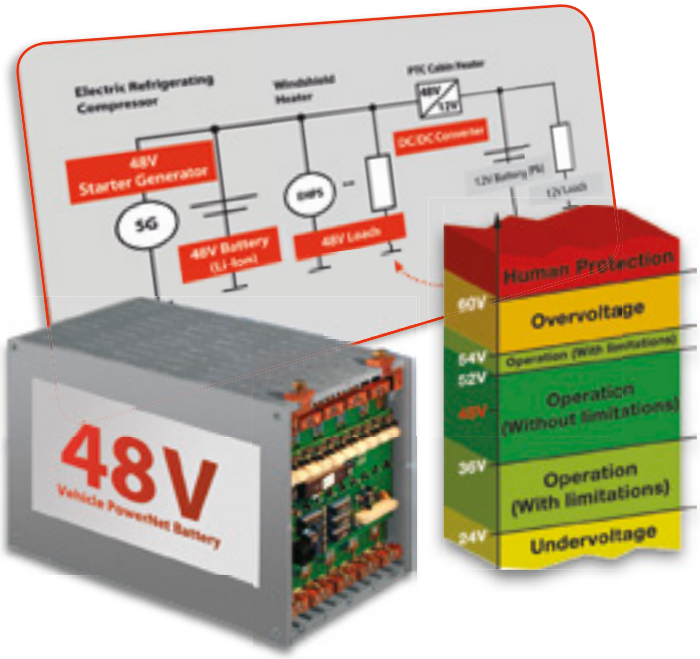
Gentlemen, Start/Stop Your Engines

Start/Stop and 48V Battery Testing



Meeting global CO_2 emission reduction targets of cars in 2015/2016 and after 2020 will require a new generation of batteries.

In a stop/start application, the battery experiences many different charging and discharging scenarios from a battery in a conventional vehicle; 48V actually questions the methodology used in urban efficiency tests.

Understanding the complex interaction of all elements in a dual-voltage powernet vehicle requires simulation of all possible phases in a stop/start system in an HiL.

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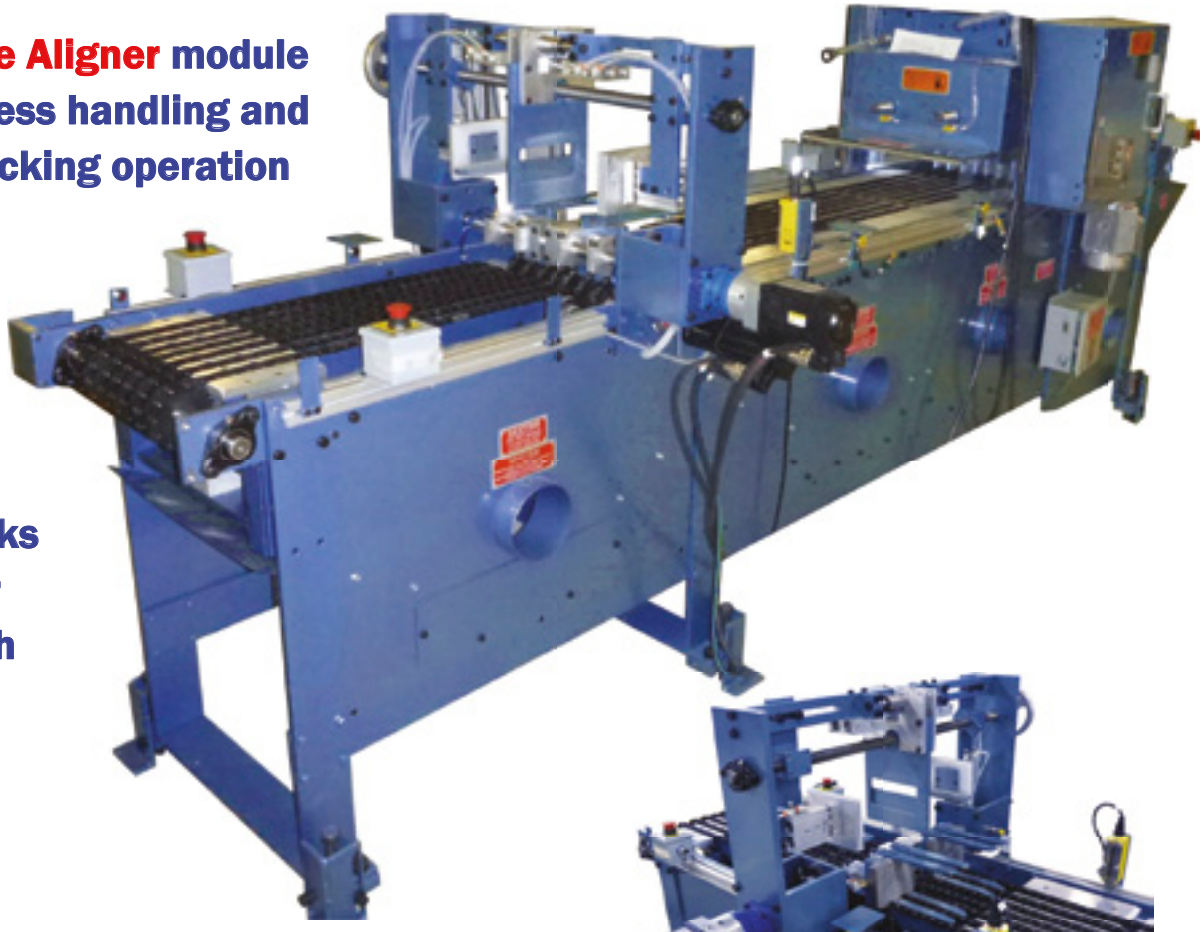

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