

For lithium to still lead the way...

Batteries | Although lithium-ion is currently the market leading battery technology in energy storage, this status cannot be guaranteed in perpetuity. Three leading figures from the lithium-ion battery industry give Andy Colthorpe their views how the technology can continue to prosper

Whether or not lithium-ion batteries will represent the dominant force in energy storage in the distant future, the reality is that it dominates the present day of grid-connected energy storage just as it does electric vehicles and consumer electronics. The cost of commercial lithium battery packs has fallen, on average, about 10 times since 2010. Energy and power density improve all the time.

Other technologies certainly need to become more involved in the global market for the energy transition to be a success of decarbonisation and system stability – particularly long-duration storage, thermal and power-to-gas – but for now, lithium is the main event. Three industry thought leaders discuss what lithium does best – and what the industry needs to do better.

The cast

Bo Normark, an energy industry veteran with almost 40 years' experience analysing energy systems, Normark is an industrial

strategy executive for EIT InnoEnergy. EIT InnoEnergy is not only an energy innovation accelerator supported by the European Institute of Innovation and Technology of the European Union, it is also a key player in creating and leading the European Battery Alliance – driving billions of euros in strategic investment in supporting and creating the battery manufacturing value chain in Europe.

Christina Lampe-Onnerud is a corporate strategist with a PhD in inorganic chemistry, twice a winner of the World Economic Forum Technology Pioneer award, who wants to change the world of lithium-ion batteries, with highly simplified designs that can be mass produced. Her company, Cadenza Innovation has developed large prismatic 'supercell' designs for use in energy storage systems which are claimed to be cost-effective, safer and more energy dense than many competitors' solutions.

Amrit Chandan's company Aceleron is "all about the circular economy" when it comes to lithium-ion batteries, the CEO and founder of the UK-based startup says.

Chandan holds a PhD in fuel cell technology and along with co-founder Carlton Cummings is creating lithium-ion battery technologies that can be fully recycled, while also assembling packs and systems from repurposed end-of-life cells and modules that are already being marketed into developing countries as low-cost solar-storage solutions.

Will lithium continue to dominate?

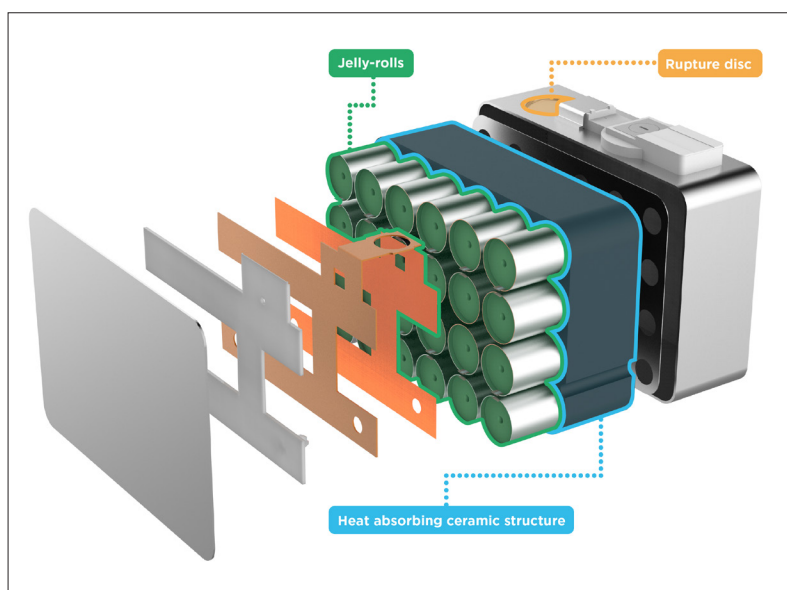
First of all, it's important to establish that lithium is not going to be the only technology relevant to energy storage or the renewable energy revolution. Bo Normark says that EITInnoEnergy has identified four main areas of energy storage technologies to focus on: lithium-ion batteries, flow batteries, ultracapacitors and hydrogen.

There's perhaps a false sense of competition out there, but flow and lithium can in fact be complementary, while these technologies can also be differentiated in their relative 'skillsets'. Firstly, Normark says, the advantage of Li-ion over flow technologies is the much quicker response time, meaning that "in the power system, you can do more with a lithium battery than the flow battery".

Scale is also an important factor; that is, the scale of manufacturing of lithium today as well as planned over the next few years.

"I always tend to say that there is an advantage in the lithium battery because basically the technology started on a 'desktop' scale, which means that a small battery per kilowatt hour costs roughly the same as a big one. So, you can choose whether you're centralised or decentralised," Normark says, although he adds the caveat that EIT InnoEnergy has invested in Voltstorage, a German company making residential flow battery systems, which he says could become "quite competitive".

But lithium-ion batteries are evolving and improving all the time. One example is that the way EV battery charging today has



Cadenza Innovation's 'supercell' design, one of a new generation of lithium-ion battery technologies

become greatly optimised from a few years ago helps “save the batteries” and extend their lifetime. The change comes quicker than even an industry veteran like Normark could have predicted.

“If you would have asked me one year ago, I would say: ‘Yeah, of course flow batteries, they will have a role to play in the big, big batteries because there is an economy of scale.’ I’m not so sure about that today actually, because lithium iron phosphate (LFP) batteries are coming down, way down in price. It’s very difficult to compete with.”

But are lithium-ion batteries safe enough?

“Lithium-ion is the hero of the storage industry. And it can be amazingly reliable and really, really good if you package it right,” Cadenza Innovation CEO and founder Christina Lampe-Onnerud says.

There is, however, a debate still to be had about what that packaging should entail, and nowhere does this problem come into starker relief than when it comes to the question of safety. Lithium batteries are relatively safe, but incidents such as the fire and explosion at the McMicken Energy Storage Facility, which caused serious injuries to four firefighters, can have enormous ripple effects throughout the industry. Even in just the past few months there have been several fossil fuel-related incidents causing environmental disaster or deaths. But this does not make the issue of safety of lithium-ion batteries less pertinent.

Lampe-Onnerud – who herself was an investigator of safety incidents with Li-ion batteries before becoming a battery company CEO – says that there remains “misinformation in the general media” and that assertions such as lithium iron phosphate being a completely safe alternative to nickel manganese cobalt (NMC) are “convenient spin by some members of the industry” to promote sales.

“To me, that is what makes the policy-makers hesitate. That is what makes the utility companies say: ‘we’re not sure we’re ready’. If we just had a transparent discussion, we would say lithium-ion as a chemistry can use the entire first row of transition metals. They will all have a slightly different [profile] on how quickly or on what trigger causes them to go into thermal runaway, but let’s just not fool ourselves. They are all energy materials.”

Lampe-Onnerud believes that Cadenza’s answer to the problem of thermal runaway

– which means of course that impact damage or short-circuits can cause lithium-ion battery cells to catch fire – will be “one of many solutions” to the problem.

The Cadenza supercell is packaged into a larger format than most lithium cells, with a design that means that fire mitigation measures are “on the inside”, with recent third-party tests showing that thermal runaway in one Cadenza cell does not then propagate to other cells in the system. For most lithium-ion batteries to be deemed safe from propagation at the moment, they are cloaked in layers of fire mitigation equipment.

“I think the media actually has to explain what is the matter – because there’s so much spin in this industry. And so many players, colleagues in my industry that say, ‘Oh, you know, we are not at fault.’ Well, you’re clearly at fault. It’s clearly an issue.

“The reason you basically can have systems that are reasonably safe is only because you have to put a lot of safety around them. Big aeroplanes, they have traditional lithium-ion systems. The aeroplanes are safe because the batteries are put in steel chests in the stomach of the aeroplane. That’s fine, but it is not affordable.”

Lithium batteries are not yet being recycled enough

When Amrit Chandan and Carlton Cummings started up Aceleron, they got their hands on every type of lithium battery they could, from automotive to industrial to medical, consumer and more. And started taking them apart. From this, they realised that lithium batteries are “just not put together or assembled in a way that facilitates easy reuse, or recycling”, Chandan says.

“And so, Carlton and I came up with this idea of being able to package the batteries in such a way that they’re easy to take apart and put back together again so that you could repair them. Because oftentimes what happens within a battery pack is [that] it’s not the whole battery packs that will age, all the components age at different rates.

“Which means that you can have a battery pack with one or two things that are not working the way they should do and then the whole pack is considered waste.”

With current technologies not yet as effective at recovering lithium as they are the other materials, the current state of the industry is “massively, massively wasteful”, Chandan says. Lithium is itself a finite if abundant resource after all. Electric vehicles are far better for the environment than combustion engine cars and using solar power to charge EVs helps pay back a great proportion of the carbon emitted in building them.

“But then obviously, you’ve got to make sure that we extract as much use from these from these batteries as possible. It isn’t very easy to [do that] at the moment,” Chandan says.

While the plan for Aceleron is to move further and further into the value of chain of battery supply, including licensing its manufacturing techniques to OEMs as well as building the company’s own devices, the company’s initial volume sales have come from marketing solar batteries into Africa.

Starting in Kenya, and soon to expand into Rwanda, Aceleron’s second life packs are built out directly dealing with and using batteries from e-waste, with support from the Shell Foundation as well as Total, and a recent £2 million investment round closed successfully.

“We’ve taken the local partnership approach. So we partner with local entities that are already dealing with computer waste and so on – but didn’t have a strategy for actually being able to use a battery. It’s really costly actually for them to get rid of a container full of batteries because a lot of those ultimately have a lot of life left in them that can be reused.”

“Our designs allow us to be cell type agnostic and chemistry agnostic. We currently sell LFP and NMC based packs and cylindrical cells. But we can do sort of anything (any sub-chemistry).”

It’s a positive move, and the company wants to branch out into other territories



Aceleron CEO Amrit Chandan with a battery pack made from repurposed materials

Credit: Aceleron



Credit: IDEC Group

Artist render of a planned gigafactory by French industrial startup Verkor. EIT InnoEnergy is supporting the venture, which will put Li-ion manufacturing on a grand scale into southern Europe

including Central America soon. Customers already know they'd prefer to use solar with batteries than continue with diesel generators and kerosene lamps that damage their health, cause atmospheric pollution and cost them large expenses in fuel and maintenance. However, the value chain as a whole needs to take better ownership of the issue, Amrit Chandan argues.

"Often times, the attitude within the industry definitely, and this isn't even automotive, this is the solar industry, the attitude is: 'Once it's out of warranty, we don't want to see it, we don't care about it. And so it's not our problem.'

"That attitude has to change, because, again, these are finite resources, and there's limited capacity to deal with the waste in developing regions as it is."

The macro-level challenges: Security, sustainability and the climate crisis

As Amrit Chandan also points out, the global supply chain's reliance on lithium batteries coming from a small handful of places, with a heavy emphasis on China, means that there's an increasing demand for resilience within supply chains.

While gigafactories are being set up around the world, it will take some years before the majority come online, meaning that getting the maximum use out of lithium already in circulation is of paramount importance, without even getting into the potential geopolitical risks or questions of industrial competitiveness.

The sustainability of battery manufacturing sits apart from the finite nature

of lithium itself, too. EIT InnoEnergy's Bo Normark agrees that even with "the best of intentions" it hasn't always been easy for those putting lithium batteries into their products to transparently track supply chains. Again though, we can look to the automotive industry for clues of how this could change.

"It's happening now more and more in the automotive industry. If you go back a few years in time, they said clearly: 'We are not getting into the battery business. We will not look at what's happening today.'

"I mean, [now] they are deeply – and they are making alliances with the battery suppliers. They even go back to the mines and make contracts and so the intention is certainly there," Normark says, adding that automotive companies not only have the scale to address the situation but also now have no choice due to customer pressure.

The use of cobalt in batteries is perhaps the biggest sustainability question that often comes up. While newer NMC battery designs use less and less cobalt than before, and of course, LFP batteries use none at all, a lot of ethical questions over the transparency of the cobalt that is used, remains. Normark says that the "interesting twist" to this discussion is that in his opinion, staying out of the Democratic Republic of Congo (DRC), where the majority of the world's industrial cobalt is mined from, "is a bad solution".

"The ambition must be that Congo should be able to use their mineral resources in an ethical way. And we have to put pressure on them, the ones that are buying and because it's not a solution to isolate Africa. You can buy ethically mined

cobalt in Congo, and probably most of the miners are theoretically, but there is also a significant number of mines that are not dedicated at all. And the objective of course would be to bring all the mines that you want to use in Congo up to standard."

A lot of these problems – and their possible solutions – remain in the hands of private entities. After, or even during COVID-19, we will see a "technological acceleration", Cadenza CEO Christina Lampe-Onnerud believes. However, while innovators may not need policy support, policy support that mandates innovation helps everyone to progress far more quickly.

New York State, for example, has not only introduced renewable energy and energy storage deployment target policies, it has also helped directly fund research and technology development, Lampe-Onnerud points out. That "drives innovators and it drives opportunities", she says. Answering the call of a worldwide crisis can be so much more rewarding than attempting to deny or ignore it, Lampe-Onnerud says, while admitting that reports on things like methane leaks can be "extremely scary".

"It is very important that the battery industry as a whole takes this into consideration: there is a big puzzle being resolved right now, with storage, with wind, with solar. Their integration into the existing grid is critical. Let's not get so discouraged by news: we've got to engage, be price conscious, we [Cadenza Innovation] offer one solution but everybody has a responsibility to get involved, we don't have a lot of time and we have an enormous opportunity." ■