**Not for the first time, and I suspect not for the last, I bring you news of an apparently game changing energy storage breakthrough that could potentially disrupt lithium-ion’s market domination.**

**Oh for fu…**

**Now then, there’s no need for that.**

**It’s not my fault the world is full of clever people who insist on coming up with exciting new developments to push the energy transition along at break neck speed.**

**I’ve got nothing against lithium-ion batteries in principle. In fact, I think they are one of THE wonders of our modern technology driven world. But, you know, precious resources, supply chain issues, occasionally dubious working practices – all that stuff that we’ve talked about on this channel before, all mean it’s probably very sensible to diversify as much as possible to ensure we can provide for the unprecedented expansion of global electricity systems in the coming decades. On top of that, developers are now beginning to make better decisions about market segmentation with more focussed solutions tailored to specific needs. One of the most significant distinctions now becoming more and more apparent is the one between the energy needed to move us around, and the energy needed to keep the lights on, otherwise known as stationary storage.**

**No not that kind of stationery storage**

**…this kind of stationary storage.**

**The latest offering in that sector reckons it uses no rare elements at all, is completely safe, and can be regenerated if it degrades, giving it a far longer lifespan than lithium-ion. So, I mean come on…we’ve got to have a look at that haven’t we?**

**Hello and welcome to Just Have a Think,**

**I’m not going to bore you with the usual diatribe about the intermittency of wind and solar and how we need to find a way to store energy when its being produced so that we can still use electrons when they’re not being produced. You’ve been listening to that rhetoric since about the year two thousand, haven’t you? So, I won’t labour the point here. It is what it is. It’s not an insurmountable limitation by any means, but it is taking quite a bit of work to upgrade and re-imagine electricity grids all over the world to enable them to continue running reliably as renewables very rapidly become the dominant power generation source in years to come.**

**So, who are these new interlopers then, and what’s their unique selling point?**

**Well, they’re a team of researchers at the Vienna University of Technology…so, yes I know that means this is going to be yet another video about a laboratory battery, not a fully commercialised mass produced end product, but honestly things are moving so quickly with energy transition technologies right now that I think it’s worth telling you about these sorts of innovations ahead of time, because I’m pretty sure it won’t be all that long before you see them in the real world.**

**Anyway, they’re calling this thing a ‘regenerative oxygen-ion battery’. My research over fifty-four years has taught me that there is quite a lot more oxygen available on this planet than there is lithium, so you can probably see why it spiked my interest.**

**The researchers have been able to create a workable system by developing CERAMIC materials that can absorb AND release what they describe as doubly negatively charged oxygen ions, by stripping off two electrons that can travel outside the cell via an electrical circuit. That means they can configure an oxygen-ion cell just like a lithium-ion cell with an anode and a cathode and an electrolyte between them.**

**Now, I dived into the research paper itself to bring you some more technical detail and I’m bound to tell you I very quicky reached the outer boundary of my intellectual competence, so I’m not even going to try to explain some of this lot!**

**For those of you with greater scientific minds than mine though, who may be keen to know which specific compounds are being employed here, I can tell you that it’s a class of materials called ’mixed conducting oxides’ of the perovskite type. We’ve talked about perovskites a couple of times on this channel. They’re all the rage in the world of solar photovoltaic research right now. They have a unique crystal structure that allows them to conduct both electricity and oxygen. That makes them very useful for things like fuel cells, which generate electricity, or devices that split water into oxygen and hydrogen. Perovskite-type oxides can also change their composition, which means developers can tweak their properties to make them better suited for different applications.**

**Scientists have been messing about with this stuff for some time and have come to realise that the properties of these materials, if handled in a certain way, lend themselves nicely to solid state batteries. By having a cathode and an anode with different levels of reducibility, or capacity for taking in oxygen, the scientists can cause the movement of ions and electrons from one side to the other and back again during charge and discharge phases. Oxygen does like to react with other stuff though, which means it can very easily escape off into the atmosphere or into water. So that avenue, shown on this diagram in light blue, has to be blocked off. But once that has been achieved you’ve got a system that looks very similar to a typical lithium-ion cell.**

**The perovskite compounds are created using abundant elements like iron , calcium, titanium, chromium and manganese. What the cells do not contain is any lithium, cobalt or nickel, which are those slightly troublesome elements we’ve all heard so much about.**

**The current configuration does also use Lanthanum though, which is not exactly rare but not really what you could call abundant either. Researchers are already experimenting with ways to replace Lanthanum with a cheaper and more environmentally friendly option. According to Tobias Huber, one of the paper’s authors**

**“In this respect, the use of ceramic materials is a great advantage because they can be adapted very well. You can replace certain elements that are difficult to obtain with others relatively easily.”**

**And the use of ceramics also improves the safety factor of the battery cells because ceramics are not flammable.**

**It’s not all roses in the garden though. There are a couple of wrinkles that I should point out.**

**Firstly, these things don’t run at room temperature, they have to be heated to somewhere between two hundred and four hundred degrees Celsius, so you won’t be seeing them in mobile phones, electronic devices or electric vehicles in the future. They are aimed squarely at the stationary energy storage sector, where those thermal engineering parameters are perfectly feasible. Of course, any potential customer will want to understand the cost benefit analysis of energy required to maintain working temperature versus energy delivered by the system. That’s hard to say of course, because it depends on your initial energy source. If you’ve got a bunch of wind turbines or solar panels just outside your facility then it’ll probably be a non-issue, but other set ups may not be quite so conducive.**

**The second caveat is that the chemistry doesn’t allow for quite as high energy densities as the lithium-ion battery. The paper provides us with something called a Ragone plot, comparing the expected performance of oxygen-ion batteries with other electrochemical energy storage technologies. Down the bottom here you’ve got capacitors, which pack a nice punch but only for a tiny burst of time. Then you’ve got supercapacitors that are an attempt at achieving the best of both worlds between instant deliverability of capacitors and the higher energy density of batteries. At the other end of the scale, up here, you’ve got fuel cells, which have a really good energy density upwards of a thousand watt-hours per kilogram. Lithium-ion sits just below that along with flow batteries, and things like sodium-sulphur technology.**

**The oxygen-ion chemistry comes in around here, with an energy density only about a third that of a typical lithium-ion cell.**

**But energy density is not so critical in stationary storage, because you’re not trying to move a physical object like a car from A to B, you’re simply moving electrons to help stabilise grid frequency and move supply availability from one period of the day to another. So, the limiting factor is not weight, bit simply the amount of space you have available to install your facility.**

**Perhaps the most important advantage of this new battery technology though, is its potential longevity. According to Alexander Schmid, another of the paper’s authors**

**"In many batteries, you have the problem that at some point the charge carriers can no longer move. Then they can no longer be used to generate electricity, the capacity of the battery decreases. After many charging cycles, that can become a serious problem."**

**By contrast, in the oxygen-ion cell, if any of that pesky reactive oxygen does get lost as a result of unwanted side reactions, then that loss can simply be compensated for by taking oxygen from the ambient air. That means the batteries can be regenerated time and time again, giving them an extremely long operational lifetime.**

**The question is how the lifecycle costs stack up against each other once you include the energy cost of maintaining operating temperature and the upfront costs of manufacturing the ceramics and packaging.**

**That analysis still needs to happen, but a patent application for the new battery idea has apparently already been filed in cooperation with commercial partners in Spain, and a demonstration prototype is in the works as we speak.**

**So, although it’ll probably be some years before we see rows of these things sitting in warehouses next to power distribution centres, oxygen-ion does represent yet another option for grid operators to choose from, and when you look at the long and ever-extending list of energy storage technologies already available, most of which we’ve covered in videos on this channel, you start to see the level of flexibility that grid operators now have available to them in tailoring their energy storage solutions depending on power output, site dimensions, location and geographical limitations. That means less and less reliance on lithium-ion technology which has performed valiantly, but which was never originally conceived of or designed, for utility scale energy storage.**

**So, what do you reckon? Are you one of those chemistry wizards who knows all about his kind of research, or perhaps you work in the energy storage industry, and you have views on how these things might be integrated.**

**Whatever your point of view, why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though. Thanks, as always to our amazing Patreon supporters, who keep me going and enable me to keep ads and sponsorship messages out of all my videos. And I must just give a quick shout out to the folks who’ve joined recently with pledges of ten dollars or more a month. They are…**

**Jonathan Langdon**

**Kristin Wohlschlagel**

**Rick Erb**

**Steven Smith**

**Jay Wilson**

**Christiaan S.**

**Colin McPherson**

**Amala**

**Jos Van Egmond**

 **and**

**Chris Roop**

**And of course, a huge thank you to everyone else who’s joined since last time too.**

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**As always, thanks very much for watching! Have a great week, and remember to just have a think. See you next week.**