**If you’re one of those folks who’ve been kind enough to listen to my ramblings every Sunday for the last four years or so, you’ll know that I’m no expert when it comes to complex scientific matters. I am, sadly, not one of those people who can instantly tell you the atomic number of every element in the periodic table, or even which family each of those elements sits within, but I do remember my chemistry teacher lobbing small chunks of soft metal into beakers of water back in the eighties when safety gear was only vaguely optional, and being highly entertained by the vigorous reactions that ensued.**

**And, if I remember rightly, those metals were things like lithium, sodium and potassium and they were all part of the same group of highly reactive elements known as the alkali metals.**

**Today of course, we all know that lithium has gone on to become the absolute rock star of modern-day energy storage, leaving its close relations in relative obscurity.**

**But lithium is by no means an inexhaustible resource on our planet. There are only really four countries in the world that have large reserves - Argentina, Chile, Australia and China, and China is importing most of the lithium it uses anyway, so that it can hoard its own supply ready for when the rest of the world runs out. Because, you know…why wouldn’t ya?!**

**And the world may well run out if we don’t get our recycling and repurposing systems sorted out properly in the coming years. An average electric vehicle has about ten kilograms of lithium in it’s battery pack. According to PV Magazine, if EV sales continue to rise as expected, there’ll be three billion of them on the roads by twenty forty and we’ll have got through pretty much all of the existing twenty-six million tonnes of lithium available today.**

**And it’s pretty difficult to extract too, requiring large amounts of carbon heavy energy and causing lots of undesirable environmental impacts. Plus, most lithium-ion batteries require other rare elements like cobalt, which is mostly sourced from the Democratic Republic of Congo with all the environmental and human rights issues that you’ve no doubt heard about as well.**

**By contrast, Lithium’s less sexy sibling Sodium, is abundantly available all over the place. There’s more than a thousand times more sodium in the earth’s crust than there is lithium. It’s a constituent part of sodium chloride, which is of course salt. It’s actually mostly mined from soda ash, but in any case, as the sixth most abundant element on the planet, it’s pretty easy to get hold of, compared to lithium.**

**So, it makes you wonder why it wasn’t sodium rather than lithium that became the darling of electrochemical engineers around the world, and why our modern lifestyles aren’t all powered by sodium-ion batteries instead of lithium-ion.**

**Well, that’s a very good question. I’m glad you asked. And it looks like the world’s biggest battery maker, CATL of China, agrees with you because they’ve just revealed a sodium-ion battery that challenges existing lithium-ion technology for energy density and longevity and which could genuinely revolutionise the future of energy storage.**

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

**So, why didn’t CATL and all the other battery firms just use sodium in the first place I hear you ask.**

**Well, like most things I delve into in the scientific world, it turns out it wasn’t quite as straightforward as our scientific friends may have hoped for.**

**The basics of the two battery types are very similar.**

**There are two electrodes and two charge collectors, one negative and one positive, which sit on either side of an electrolytic solution with a separator membrane in the middle to block the flow of electrons inside the battery. As the system charges up, the lithium or sodium atoms release electrons which flow out from the cathode and through the electrical circuit to the anode on the other side where they’re physically captured within the anodes structure. Meanwhile, the lithium or sodium ions travel across the electrolyte to reach the same destination.**

**When the system is connected to a device, the stored electrons move back out of the battery, producing an electrical current that powers the device, before returning to their original position in the cathode, and the ions move back across the electrolyte to join them.**

**The main drawback of using sodium instead of lithium was energy density and weight. Sodium-ion batteries were achieving something like a hundred and fifty watt-hours per kilogram, compared to well over two hundred watt hours per kilogram for lithium-ion batteries. That’s a competitive disadvantage that our market driven economies simply would not tolerate at the time. Sodium ions are three times heavier too, so even though the sodium component accounted for only about five percent of the overall battery weight, it still made them heavier than their lithium-based cousins. They’re also physically larger than lithium-ions, which meant they couldn’t move freely between layers in a graphite anode in the way that lithium-ions could, so the insertion and extraction of sodium ions into and out of the electrodes put higher demands on whichever material was used.**

**But, as the largest battery producer in the world, CATL have always been at the forefront of research and development. With more than five thousand people in a dedicated R&D team and state of the art computer simulation technology, they’re constantly searching for more sustainable ways of producing these essential products, mindful of the finite nature of the resources available. They’re already making lithium iron phosphate batteries for all the Tesla cars sold in China for example. Those batteries also have a lower energy density than standard lithium-ion batteries, but importantly, they don’t contain any cobalt. And just this week, Tesla has announced that it’ll be switching over to lithium iron phosphate batteries for all of its standard production vehicles worldwide, so it’s not difficult to imagine that CATL are taking incremental steps towards replacing lithium-based batteries altogether.**

**Back in July twenty-twenty one they launched the first generation of their sodium-ion battery technology, with an energy density of a hundred and sixty watt hours per kilogram and a zero to eighty percent charge time of just fifteen minutes. The major point of difference with this newer technology was in the materials used for the electrodes. The cathode material is something called Prussian White which, according to the science bods is a fully reduced and sodiated form of Prussian Blue with a high working capacity, high theoretical capacity and low toxicity, which circumvents the need for a reactive sodium-loaded anode in cell assembly. Now if you now precisely what all that means then you’re a smarter human than me, and if you’re not sure what all that means but you’d like to find out, then I’ll leave a link in the description section below to the page where you can access this explanatory paper. Suffice to say, Prussian White is a very cheap, easily produced, non-toxic material with good discharge rates and an ability to maintain a capacity as high as ninety five percent after ten thousand cycles, which makes it a very attractive option for a battery cathode.**

**Over on the anode side, which in lithium-ion batteries is generally made of graphite, CATL has developed a hard carbon material with a uniquely porous structure that they say enables the abundant storage and fast movement of those larger sodium-ions, giving it an overall performance and cycle life equivalent to graphite.** **And, because sodium-ions don’t tend to form an alloy with aluminium, CATL have been able to use an aluminium foil as the current collector on the anode side instead of the more commonly used copper. Not only does that make each battery about eight percent cheaper, it also makes them ten percent lighter.**

**Plus, the properties of sodium salt makes it possible to use a less concentrated electrolyte solution. Which saves even more money.**

**CATL say they can manufacture their new sodium batteries using exactly the same machinery and processes that they use for their lithium-ion production, so no expensive new set-up required either. And just as a cherry on top of the happy little CATL cake, it tuns out that sodium ion batteries have much better thermal stability than lithium-ion, so there’s an improvement in safety ratings too.**

**So, I think it’s fair to say that our friends at CATL were really quite pleased with themselves. But they certainly didn’t rest on their laurels.**

**In January twenty-twenty the company applied for a patent on a second-generation sodium-ion battery which they claim will surpass two-hundred-watt hours per kilogram, which is even better than lithium iron phosphate technology and getting up towards the levels of performance currently achieved by standard nickel-based lithium cobalt batteries**

**Full production is scheduled to come online as early as twenty-twenty three, with CATL looking to supply not only Tesla and other auto makers, but also low-cost stationary energy storage facilities for electricity grids around the world, helping to smooth the path for the rapid implementation of renewable energy.**

**As with all these apparently revolutionary new announcements in the world of battery storage systems, it’s important not to get too carried away with slick marketing presentations, and instead focus solely on the real-world performance and commerciality of the product. There’ve been loads of grand promises made by various industry newcomers in the past, all claiming to be the next market disruptor. But very few of those designs have come to fruition. Having said that, CATL are a pretty serious outfit who do tend do to do exactly what they say they’ll do, so if I was a betting man, I’d say we may well be seeing electric vehicles powered by sodium-ion batteries within the next few years.**

**You may disagree with me on that one of course. If you do, or if you think sodium-ion batteries are the best thing since sliced bread then jump down the comments section below and leave you thoughts there.**

**That’s it for this week though.**

**As always, a huge thank you to the channel’s amazing Patreon supporters who help me keep these videos completely independent and ad-free. And a quick shout out to the folks who’ve joined since last time with pledges of ten dollars or more a month.**

**They are**

**Benjamin Simon**

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**Kenneth Spry**

**And**

**Brian Moss**

**And of course, a big 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**