**In twenty-twenty-three, the Chinese car manufacturer BYD**

**launched a phenomenally good value little battery electric town car called the Seagull. Now, Chinese car companies are churning out good value battery electric vehicles, or BEVs, every week at the moment, aren’t they, so what’s so special about this pocket hatchback. Well, apart from the surprisingly high quality and astonishingly low price, the Seagull is NOT powered by the lithium-ion batteries that you’ll find in all of its BEV competitors. The chemistry inside the batteries of this little power house is SODIUM-ion.**

**You will no doubt have heard all sorts of media buzz around this apparently exciting new battery technology in recent months, and we’ve done a couple of videos about it here on the Just Have a Think channel too. So, you might be forgiven for thinking it’s yet another example of how our friends in the East are continuing to steal a march on Western battery and vehicle manufacturers. But maybe not, because sodium is much more commonly available in the global supply chain, and as a consequence, sodium-ion battery manufacturing facilities are now springing up in regions outside of China, including here in Europe and over in the United States. We looked at several of them in a video earlier this year, but now there’s another one to add to the list. They’re called Natron Energy, and they say they’ve developed a unique chemical configuration to store and release energy from sodium that gives them a competitive edge over the rest of the pack.**

**So, the obvious question is, what have they found that the others haven’t?**

**Before we get stuck in though, make sure you stick around to the end of the video to find out how you can get your exclusive Just Have a Think discount on tickets for the upcoming Everything Electric LIVE event in Harrogate.**

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

**We’ll get to our friends at Natron Energy a little bit later in the video, but it’s worth recapping why battery developers are looking for alternatives to lithium-ion in the first place. One good reason is material availability. Sodium is the sixth most abundant element on Earth, and its availability in an already well-established global supply chain means fewer potential bottlenecks and price spikes that often come from an over-reliance on raw materials that are only available in limited geographical locations. Just like lithium, sodium is an alkali metal, and just like lithium it has a single electron in its outer shell, which makes it highly reactive. That means the basic configuration of a sodium-ion battery is more or less the same as lithium-ion. Charging the battery causes electrons to be liberated from lithium or sodium atoms, and the positively charged ions that are left behind are attracted by electrochemical potential difference, or voltage, from a cathode to an anode where they’re stored until the battery is in use. In a typical lithium-ion battery that storage function is performed fairly well by the layered hexagonal lattice structure of graphite.**

**I say ‘fairly-well’ because although the lithium ions sit nicely inside the hexagon part of the structure, they’re actually a bit larger than the distance between layers, so there’s a very slight expansion and contraction in the graphite material on each charge and discharge, which contributes to eventual battery degradation.**

**Sodium ions have an even larger radius than their lithium counterparts though, so they just don’t work at all in a graphite anode. They’re also about three times heavier than lithium ions, which isn’t ideal either.**

**So, mainly for those two reasons, lithium-ion chemistry has effectively been the course of least resistance for battery developers for many decades now.**

**But lithium-ion batteries were originally only conceived for use in small electronic devices like the famous Sony Walkman.**

**Things have changed a bit since then though, haven’t they? Lithium-ion batteries now provide the power for just about every conceivable application, from tiny medical devices like pacemakers, right through to megawatt hours of utility scale energy storage. A typical modern electric car contains about ten kilograms of lithium in its batteries, and most of them also include cobalt and nickel. Lithium iron phosphate batteries have done away with the latter two elements, but there is still that geographical limitation on lithium that we saw earlier. The world isn’t running out of lithium though, as some scare mongers would have you believe, and in fact, as the battery recycling industry ramps up, we will reach a level of so-called circularity that could see more than ninety-five percent of battery materials being re-used in that way. But it doesn’t hurt to spread your liabilities a bit, does it? And price stability is still a very strong motivator for product development. Sodium-ion batteries have a couple of other significant advantages over lithium-ion too.**

**Firstly, unlike lithium-ion batteries, sodium-ion batteries can be discharged right down to zero volts without causing any damage. That makes them cheaper and safer to transport. They can also use aluminium instead of copper for the anode charge collector, which shaves a bit of weight and cost off the overall cell pack.**

**So, if you could find a good working alternative to graphite for your sodium battery anode, then you could be in business. Which is why there’s been an awful lot of research work going on in recent years to achieve that goal.**

**The world’s largest battery maker, CATL in China, and the Swedish battery maker Northvolt, have both tackled the problem by using a hard carbon material in their anodes. Hard carbon has a much looser structure than graphite, which means it can accommodate the larger sodium ions without any significant degradation. To achieve the potential difference across the cell, CATL and Northvolt both use a material called 5:44 Prussian White in their cathodes.**

**So, what’s that then?**

**Well, we took a brief look at this stuff in our previous Sodium-Ion video. Essentially, it’s a variation of Prussian Blue. You probably know Prussian Blue much better as a vibrant pigment in artists paint and dyes, but as a chemical it has a high iron content and offers very good stability and low toxicity, all of which are very attractive qualities for battery chemists. Prussian White is a fully sodiated analogue of Prussian Blue, which in plain English means it's had sodium ions inserted into its structure where they intercalate themselves within the existing framework of the compound.**

**And that brings us nicely to the folks at Natron Energy in the good old US of A. I suppose you might reasonably view them as a start-up company, but in reality, they’ve been developing their sodium-ion battery technology since twenty-twelve.**

**What sets Natron Energy’s technology apart from CATL and Northvolt is the fact that it uses Prussian Blue for BOTH the positive AND the negative electrode in the battery cell. Now my limited layman’s understanding of batteries is that you need two different materials for cathode and anode, and there has to be a potential electrical difference between them so that you can induce a movement of ions from one to the other. So how can Natron be using the same stuff on either side of the cell?**

**Well, the research team very helpfully published this white paper recently to outline their thinking. The paper explains that the atoms in Prussian Blue particles are arranged in large, cubic cages that contain empty spaces, or pores that are larger than sodium ions. That allows for very fast intercalation, or storage, of those ions without deformation, and very fast release when required. Natron Energy claim its battery can be fully recharged from zero to one hundred percent in under 15 minutes.**

**To achieve the movement of ions across the electrolyte, the research team at Natron have basically messed about with the chemical make-up of the Prussian Blue in each electrode.**

**The CATHODE-grade Prussian blue is based on a blend of iron and manganese, which gives it a HIGH operating potential. Over on the anode side, the Prussian blue is based on PURE manganese, which means IT operates at low potential. And, hey presto, there’s your voltage, or potential difference across the cell. The Natron paper also points out that both iron and manganese are cheap and abundantly available materials. In fact, iron oxide and manganese oxide are both readily available as waste products from other industrial processes, which means there’s no need to start opening up a bunch of new mines to obtain the raw material.**

**As a bit of icing on the chemical cake, as well as improving longevity, eliminating the stresses and strains of expansion and contraction in the electrodes also means much less heat is generated in the cell. That means you don’t need the additional cooling systems that are typical of a lithium-ion set up, and it also means you can ramp up the fast charging of a sodium-ion battery without the risk of lithium metal plating and dendrite formation that can occasionally result in thermal runaway and fires.**

**The main downside of sodium-ion though, is energy density.**

**But then again, that’s only really an issue if you’re trying to move something, like a car or a truck, isn’t it? If the batteries are used for stationary energy storage, then energy as a function of weight isn’t of particular concern. And that is indeed where the folks at Natron Energy are targeting their product.**

**They say their Sodium-ion battery technology is more suitable and more efficient than lithium-ion batteries when used for fast-discharge, fast-recharge applications like the uninterruptable power supply, or UPS systems in data centres, or for peak load shaving and utility grid stability systems, or in industrial power applications.**

**That doesn’t preclude them altogether from the electric vehicle revolution though, because they’re also an ideal candidate for stationary energy storage at EV recharging stations.**

**So, where is Natron Energy on the old ladder of Technology Readiness Level, or TRL then? Well, it looks like they’re well on their way.**

**Back in twenty-twenty the company received a nineteen-point-nine-million-dollar award from the US Department of Energy to turbocharge their research work. That brought in further investment from the likes of Chevron, Khosla Ventures and Prelude, and most recently the company secured a further thirty-five million dollars of funding from ABB Technology Ventures, NanoDimension Capital and Volta Energy Technologies.**

**In April twenty-twenty-four, Natron Energy opened up a factory in Holland, Michigan, representing the first commercial scale sodium-ion battery production facility anywhere in North America with an anticipated annual production of six hundred megawatts worth of batteries aimed primarily at servicing the explosive growth in the data centre UPS market that I mentioned earlier.**

**The medium-term goal is to open gigawatt-scale facilities in various US states to expand the range outwards to include the telecoms industry, EV fast charging stations and industrial off-road vehicles.**

**So, no shortage of ambition there then, eh? And in my humble opinion, for what it’s worth, this is a great example of upping your game to confront the challenge of the energy transition and compete with the market leaders over in China, instead of whining about how unfair the world is.**

**That’s just my view though of course. Yours may well be very different, and if you’re keen to share that view, or any other bits of news or insight about sodium-ion batteries, then as always the place to leave your thoughts is in the comments section below.**

**That’s it for this week folks,**

**but before I go, I must just let you know that we‘re already hurtling towards the second Everything Electric show of the year! How time flies! The next event is being held at the well-established and much-loved Yorkshire Event Centre up in Harrogate from Friday 24th to Sunday 26th May. You never know, we might actually be having some decent weather by then, and the site has lots of outdoor space for a wider range of new electric vehicles to be on show and of course with the usual attractions for families and space for the kids to run around and have a bit of fun. I’ll be hosting another six discussion panels too, so it’d be great to se you if you can make it. The discount code for Just Have a Think viewers is still valid, and I think it’s being displayed on the screen right now along with the website where you can grab your tickets. There’ll also be a link to that website on the end screen of this video and in the description section below. Harrogate is a popular one folks so if you are thinking of coming along, I would recommend grabbing your tickets early. Hopefully see you there.**

**I must also say a massive thank you to the amazing people who support the channel via Patreon and who help keep the content completely independent, and of course a big ‘thank-you’ to you for watching up until now. If you liked this video and want to keep up to date on new content, then don’t forget to hit the subscribe button and the notification bell. That way you don’t miss out, and you‘ll be massively helping to keep the channel going, for which you get my eternal gratitude.**

**So, have a great week, and remember to just have a think.**

**See you next week.**