**One of the most common requests I get here at Just Have a Think is to go back and find out what happened to all those shiny, optimistic technologies that I’ve covered in my videos over the last six years or so. You know… like, which ones look like they might actually play an important role in the green energy transition over the next couple of decades, and which ones have fallen by the wayside.**

**So, a couple of times a month during twenty-twenty four I’ll be selecting one of those previously featured innovations to bring you the latest news on its progress.**

**And we’re kicking off the series right here, today, with a battery chemistry that, at first sight, looks like a simple, cheap, abundant and safe replacement for lithium-ion, but which, like most new technologies, has turned out to be much more complicated in the real world. I am of course talking about SODIUM-ion technology.**

**So, has this soft, highly reactive metal demonstrated enough advantages over its periodic table neighbour to disrupt an already rapidly growing market, or has it all just been one big PR stunt by our friends over in China?**

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

**We first checked out sodium-ion chemistry in this video way back in March twenty-twenty-two.**

**Here’s what we established back then :**

**There’s more than a thousand times more sodium in earth’s crust than there is lithium. Sodium is apparently the sixth most abundant element on the planet. It is of course a constituent part of salt, which is abundantly available from many sources, not least of which is the ocean. That makes sodium an extremely appealing prospect because it means that, in theory, almost every country in the world could build its own sodium-ion battery infrastructure and become far more energy independent than is currently the case.**

**The basic functionality of a sodium-ion cell is essentially the same as lithium-ion. During charging, ions are extracted from the cathode and move through the electrolyte to the anode, where they’re stored. The energy to make this happen is provided by the flow of electrons in the external circuit. As the battery gets discharged, the ions flow back to the cathode, releasing stored energy in the form of electrons that travel back through the external circuit to do some useful work.**

**Broadly speaking, that structural and functional similarity means that sodium-ion batteries can be manufactured using existing lithium-ion battery production infrastructure. Which is quite handy from a capital investment point of view.**

**As a rather fortuitous result of some complicated science involving electrochemical properties and operating voltages, BOTH of the charge collectors in a sodium-ion battery can be made of aluminium. You can’t do that in a lithium-ion cell because the lower electrical potential of the GRAPHITE ANODE tends to react with aluminium, causing it to corrode and dissolve. Which you don’t want. So, the ANODE charge collectors in lithium-ion cells are typically made from copper, which is heavier and more expensive, and which also comes with some well publicised supply chain challenges. Unlike lithium-ion cells, sodium-ion cells can be discharged right down to zero volts with no damage or degradation. That means they can be shipped around the world much more safely and cheaply, which is a very significant advantage in today’s globally connected markets.**

**It's not all upside for sodium-ion though, of course. The biggest challenge is its relatively low energy density. Lithium ions and sodium ions can both move extremely quickly through an appropriate electrolytic fluid, which means energy can be delivered more or less instantaneously. But lithium-ions are small enough to nestle neatly within the tight lattice-like structure of the graphite anode, in a process called intercalation.**

**Sodium ions have a significantly larger radius and are three times heavier than lithium-ions, which means they’re too big for intercalation in graphite. That challenge has largely been addressed using a material called ‘hard-carbon’, which has a far looser structure that can store sodium-ions without any significant degradation, but it does mean that sodium-ion batteries don’t currently pack the same punch as the best lithium-ion chemistries, which is something we’ll have a look at in more detail in a moment.**

**Those differences in electrochemical properties, that I mentioned earlier, mean that a different electrolyte and a different cathode material have also had to be developed for sodium-ion batteries. The detail of that painstaking research work is outside the scope of this presentation, but I did delve into in my original video, which you can jump back to by clicking up there somewhere.**

**When I made that video, back in early twenty-twenty-two, COVID-19 and the invasion of Ukraine had caused lithium prices to spike up to some pretty crazy levels on global commodity markets, which was making sodium look like an extremely compelling alternative at the time. Lithium prices have tumbled back down to record low levels now though, according to Bloomberg NEF, so, sodium has lost a little bit of its cost advantage.**

**And then there’s something called life cycle analysis, or LCA. Long term viewers of the channel may remember an interview I did a couple of years back with a guy called Dr Robert Pell who runs a company called Minviro that specialises in these vital industry studies. In twenty-twenty-three they published this paper comparing the LCA numbers for several sodium-ion chemistries versus the most common lithium-ion competitors, using lithium iron phosphate cell chemistry as the default baseline. The analysis showed that on a full lifecycle basis, sodium-ion isn’t yet quite the magical panacea that some make it out to be. Only one form of sodium chemistry actually performed better than lithium iron phosphate. That’s this one here, second from the top. It uses the hard carbon anode that I mentioned earlier and a so-called ‘layered transition metal oxide’ cathode. Unlike other chemistries, these cells contain no cobalt, which is a big plus. Their biggest impact actually comes from their liquid electrolyte, which for the sciency types in the audience, is ‘Sodium Hexafluorophosphate.‘ or NaPF6. After that comes the cell production process itself and then the manufacturing process for the cathode.**

**This next chart shows how the impact of each of the cell chemistry options diminishes over the lifecycle of the cell. The axis on the right is logarithmic, which means the differences in impact between each chemistry right at the very beginning of their lives are actually much wider than they look on the graph. This vertical rainbow stripe in the middle here represents the optimum working life cycle of each chemistry, colour coded to match the lines. ALL cell types have a rapidly diminishing impact line over time though, which let’s not forget is very different to the environmental impact of burning fossil fuels, which is catastrophically terrible from start to finish.**

# The bottom line, say the Minviro researchers, is that the so-called “sustainability” of modern batteries is a very complicated assessment that goes far beyond simple metrics like abundance and accessibility, and new developers will do well to factor these kinds of assessments into their investment strategies on a voluntary, pre-emptive basis, before their countries’ governments force them to do it via stricter regulations.

**Despite those caveats though, a veritable gold rush is still going at full tilt in the sodium-ion battery sector. So, who are the movers and shakers to look out for in twenty-twenty-four?**

**Well, let’s start in China…obviously.**

**The world’s largest electric car manufacturer, BYD, recently announced the construction of a dedicated sodium-ion battery manufacturing plant in eastern China with a reported investment of one-point-four billion dollars and an annual production capacity of thirty gigawatt-hours – enough to supply well over a million vehicles per year in the popular microcar sector beloved by middle class urban Chinese commuters.**

**Over in Europe, in November last year, the Swedish company Northvolt launched a sodium-ion battery developed specifically for stationary energy storage systems, which may well be the sector where sodium-ion proves to be the most useful. After all, if you can use lower energy density sodium-ion cells in applications where nothing has to be physically moved, then that frees up the supply of lithium for more power-hungry applications like road vehicles, which seems to make a lot of sense.**

**Northvolt say their cell has been validated for an energy density of more than a hundred and sixty watt-hours per kilogram, which puts it somewhere close to lithium iron phosphate levels of performance. It’s based on the hard carbon anodes that we talked about earlier, and something called Prussian White for the cathode, which the eagle-eyed among you may have spotted a moment ago on the performance charts from Minviro. This stuff is rapidly becoming the favoured option for sodium-ion cathodes because it ticks a lot of performance and longevity boxes. The technical explanation goes like this.**

**“Prussian White 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.”**

**Which in plain English means it 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 does make it a very attractive option for a battery cathode.**

**Northvolt’s cells, like most new sodium-ion cells, are free from lithium, nickel, cobalt and graphite, which is certainly a very encouraging development from a global resource management point of view. Northvolt say the low cost and safety at high temperatures make this technology especially attractive for stationary energy storage solutions in developing markets like India, the Middle East and Africa.**

**Here in the UK, we have Faradion, who last year announced a partnership with Infraprime Logistics Technologies to provide sodium-ion batteries for commercial vehicles in the Indian electric vehicle market on the back a national commitment by Narendra Modi’s to invest one point four trillion US dollars by twenty-twenty-five with the aim of reaching thirty percent electric vehicle adoption by twenty-thirty.**

**Over in the states, a start-up called Unigrid Battery, founded by two graduates from the University of California, San Diego, has secured substantial orders for its Powerwall style product based on sodium-ion chemistry and a tin-based anode material, which they reckon can provide higher energy density and reliability as part of the herculean global challenge of achieving grid stability and resilience during the mass roll out of intermittent renewables like wind and solar.**

**Hot on their heels is another US firm called Acculon Energy who are aiming their sodium-ion technology at both mobile and stationary energy applications and who are planning a production facility with two gigawatt hours of capacity to be up and running by mid twenty-twenty-four.**

**There will no doubt be others that I haven’t mentioned here, so apologies if I’ve failed to plug a company that you’ve just bet the farm on, and you know…if you have done that then…good luck!**

**So, is sodium-ion on the cusp of displacing lithium-ion as the go to chemistry for billions of battery cells all over the world?**

**No.**

**According to this recent research paper the overall size of the global battery market is projected to be around four hundred and twenty billion US dollars per year by twenty thirty, by which time sodium-ion batteries are predicted to have captured only about four-point-four billion or so, which is about one percent.**

**But it is another string to sustainable energy’s metaphorical bow isn’t it? And if it can be embraced as a complimentary technology to free up lithium-ion to be used in sectors where it’s best suited, like road transport, then sodium-ion could represent a very useful addition indeed.**

**No doubt you’ve got your own news and views on Sodium-ion technology. Maybe you HAVE invested in an exciting start up company and you want the world to know about it, or perhaps you’ve worked on the development of sodium cell technology and you can share some insights with us all.**

**Whatever your thoughts, why not jump down to the comments section below and share them with us there.**

**That’s it for this week though. Thanks, as always, to our Patreon supporters, who enable me to keep ads and sponsorship messages out of all my videos. And I must just give an extra special thank you to the folks who joined recently with pledges of ten dollars or more a month,**

**They are**

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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.**