**If you’ve been watching in recent weeks, you’ll know I’ve been reviewing the progress of some of the most promising new energy technologies that we’ve featured here at Just Have a Think over the last six years.**

**But the other day, as I was delving through the archives to find the next apparently game changing breakthrough to bring you up to date on, I passed by this video from twenty-twenty-two featuring dear old John B Goodenough, God rest his soul – the so-called Godfather of lithium-ion - and it reminded me that, while all these potential market interlopers have been shouting from the rooftops about their innovations, the folks who manufacture lithium-ion batteries haven’t exactly been sitting on their hands waiting for the rest of the world to overtake them. They’ve been busy bees as well. So, as well as reviewing how the competition’s getting on in twenty-twenty-four, I thought it might not be a bad idea to assess the status of the market leading technology as well. And what I discovered was pretty astonishing!**

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

**Before we dive into the data on lithium-ion, just a quick clarification about the upcoming Everything Electric show in London. I’ve been slightly inundated with messages from folks asking me which specific discussion panels I’m going to hosting, and who the panellists are, and all that sort of stuff. So, if you’re interested to get those details, stick around to the end of the video and I’ll give you the full run down then.**

**Meanwhile, back in the world of energy storage technology, new information about the current and future costs of lithium-ion batteries has just been released, and they make the price drop of wind and solar over the last couple of decades look like a gentle snow plough down a nursery slope!**

**I’ll come back to those mind-blowing numbers a bit later in the video, but first of all, let’s have a quick look at the current state of modern lithium-ion technology. As a brief reminder, energy density measures the amount of electricity in Watt-hours contained in a battery relative to its weight in kilograms. Power measures a battery’s ability to output electrical current and it’s typically rated in kilowatts. Batteries for mobile phones, for example, have high energy density so that the battery can be as small as possible, but low power because they’re not running much. In fact, it turns out that power and energy density are often inversely proportional. The most common battery chemistries today are Lithium Nickel Manganese Cobalt Oxide, or NMC, and Lithium Nickel Cobalt Aluminium, or NCA. They both have high energy density, and you’ll find them in the top-end products like high performance EVs and Tesla’s Powerwall. The only slight wrinkle, as I’m sure you know, is that some of those additives come from some not so wonderful sources, with even less wonderful working practices and welfare policies. Organisations like Amnesty International are still, quite rightly, campaigning vigorously to get human rights abuses eradicated from supply chains, and to be fair to the vast majority of major global tech businesses, they have recognised the issue and taken some pretty strident steps to achieve that same goal.**

**But what if you could develop a battery that doesn’t need any of those questionable materials, but which still packs enough punch to propel a private road vehicle from A to B at a reasonable speed and with reasonable range and longevity? That’d surely solve a bunch of problems in one fell swoop, right? And that’s pretty much the thinking behind lithium iron phosphate, or LFP chemistry. LFP batteries typically have a high power rating, but they can’t really compete with NMC or NCA chemistry when it comes to energy density. Iron does improve safety and reduce heat output though, which means LFP batteries don’t generally need the same level of cooling as the higher end chemistries. So that saves quite a lot of cost. Iron itself is also extremely cheap and abundant, as you can see from this brilliant infographic produced by the artistic geniuses over at the Visual Capitalist website. And by the way, just for fun, let’s see if we can find where lithium sits in the grand scheme of things… ah there it is down there in the barely noticeable section.**

**As an added bonus, LFP batteries tend to have longer lifespans than most other lithium-ion batteries. So, there’s a growing trend towards the use of LFP chemistry in the types of vehicle that most folks are likely to use to take the kids to school, go to the supermarket and get to work and back on a daily basis. Which is why the latest cost figures that I mentioned earlier in the video make for such interesting reading.**

**This chart from Our World in Data shows that in the thirty years between nineteen-ninety-one and twenty-twenty-one, the price of batteries declined by ninety-seven percent. That’s already a pretty remarkable statistic. But now, the world’s largest battery maker, CATL reckons it will reduce the cost of its LFP battery cells by a further fifty percent by mid twenty-twenty-four, to just over fifty-six US dollars per kilowatt hour. That means a typical sixty kilowatt-hour LFP battery pack that was costing auto-manufacturers almost seven thousand US dollars in twenty-twenty-three, will set them back less than three thousand four hundred dollars just twelve months later, saving those car makers more then three thousand dollars on the cost price of each vehicle.**

**But what about the availability of lithium itself? Well, the TLDR version, as summarised by data analyst Hannah Ritchie in this recent article, is that the world does have enough lithium for electric vehicles decades into the future, BUT the world is currently not producing enough of it to keep up with demand. So, we’ll need to get a wiggle on, or maybe we’ll need to lean more heavily on other technologies like sodium-ion after all. And what all the other critical minerals needed for the energy transition? Well, Hannah Ritchie’s actually written a whole book about our future world, including a section on resources availability in which she makes this point…**

**“Those that say low-carbon energy will use too many materials should take a look at how much we currently mine for fossil fuels. The world extracts around fifteen BILLION tonnes of coal, oil and gas every year. The International Energy Agency projects that the world will need around twenty-eight to forty MILLION tonnes of minerals for low carbon technologies in twenty-forty, at the height of the energy transition. [ ] Put simply: moving to low-carbon technologies will mean less mining not more.”**

**And our friends at Visual Capitalist can help with THAT visualization as well. If we Zoom back out from our focus on the one hundred and six thousand tonnes of lithium that we currently extract each year, and go past even the gargantuan two point six billion tonnes of iron ore extraction, we have to make a whole new graphic to fit in the amount of oil, coal and gas that the world currently consumes every single year, none of which is recyclable, in stark contrast to the metals and minerals on the first page, all of which can be recycled and refurbished into new products.**

**Hannah Ritchie’s book references this twenty-twenty-three research paper, which estimates requirements for fifteen of the most critical, structural, and bulk materials needed to build new electricity-generating infrastructure between 2020 and 2050 in 75 different IPCC mitigation scenarios aimed at limiting atmospheric warming to two degrees Celsius or less. Their summary chart shows that even in the extremely unlikely one-point-five-degree scenario, global reserves massively exceed requirements, even for copper, which is the current scaremongering story being touted by our friends in the fossil fuel propaganda community.**

**No serious industry analyst is suggesting it’ll be an easy path though. Getting at those reserves will require massive amounts of new infrastructure and transport networks, all of which will have a carbon footprint that will need to be extremely carefully managed. And of course, lithium-ion batteries and electric vehicles and all the other lovely so-called sustainable innovations that YouTubers like me go on about all the time won’t solve the climate emergency. Anyone who tells you that we can simply switch to electric vehicles to claw our way out of our predicament is either ill-informed or disingenuous. I’ve made dozens of videos about the other fundamental changes that will be essential to our children and grandchildren’s safety and prosperity. Not least of which is a radical reduction of the rampant levels of consumption in rich western nations, a total rethink of the way we produce food and the eradication of the truly disgraceful thirty percent of that food that we westerners currently just toss into the garbage.**

**Anyway, I’m ranting now, so I’ll park the debate there, and let those of you who have strong views on the subject jump down to the comments section below to express your thoughts there, while I tell everyone else about those Everything Electric discussion panels that I mentioned at the start of the video.**

**So, on Thursday the twenty-eighth of March I’ll be asking whether the UK is being left behind in the race for cleaner energy & transport, with the help of Quentin Wilson, who many of you know from UK TV shows like Top Gear and The Classic Car Show, and who is the founder of FairCharge. Alongside Quentin will be Sarah Montgomery, the CEO and Co-founder of digital energy supply chain consultants, Infyos, Dr Richard Lowes from the clean energy think tank The Regulatory Assistance Project, and**

**Simon Price, CEO of Exawatt who are experts in supply chain analysis.**

**Following that discussion, I’ll be considering what opportunities we now have to re-invent the world our kids and grandkids might inhabit. Joining me for that little foray into the art of the possible will be another bloke that some of you may have heard of. He’s called Robert Lewellyn, and he runs a little channel called The Fully Charged Show, plus of course the Everything Electric Channel and the live events themselves. Helping me keep Robert in check will be Dr Barbara Hammond, MBE, who has been working on the challenges of sustainability and climate change for decades and who is now Chief Executive of the Low Carbon Hub, which runs a portfolio of largely community owned renewable energy projects in the Oxford area worth about twenty million pounds. Completing that illustrious panel will be Alessia Mevoli, who lectures on responsible business practices and sustainability at Anglia Ruskin University, and Alex Butcher, Co-Founder of a brilliant online home energy calculator called Warmur.**

**Then on Friday we’ll be discussing what the word will look like in ten years from now and twenty-five years from now, with help from Science Communicator and author Simon Clark, who I’m sure you already know well, James Arbib, who alongside Tony Seba, co-founded the energy think tank RethinkX, Andy Martyr-Icke who has thirty-six years’ experience in the energy industry and now heads up the environmental team at the UK National Grid, and Ajai Ahluwalia, who has vast hands on experience in the offshore wind industry and who now advises large UK businesses on supply chain issues at the online consultancy Renewable UK.**

**Then we delve into the increasingly polarised world of public opinion and ask how following the science can help us to accelerate the energy transition, with some extremely well qualified proper scientists, including Dr Simon Clark again, battery chemistry expert Dr Euan McTurk, climate science communicator Dr Ella Gilbert, and Dr Hannah Ritchie, who I’ve already mentioned a couple of times in this video, and who many of you will know from the website Our World in Data.**

**And if my brain hasn’t completely exploded by the Saturday, I’ll be exploring how you can future proof your own home with advice from Katy Davies of the Fully Charged show, Sarah Merrick, Founder and CEO of Ripple Energy, Leah Robson, co-founder of the household energy advisory service, Your Energy Your Way, and Jo Alsop, founder of the Heating Hub.**

**Last but by no means least, we’ll tackle the rather thorny issue of domestic heat pumps with expert commentary from Aimee Clark of Octopus Energy, Dan White from the standards organisation MCS, and Johan Du Plessis, founder and CEO of Tepeo.**

**And if that lot’s not enough for you then there’s more than thirty other sessions across the three days hosted by Robert Llewellyn, Dan Caesar, Jack Scarlett, Imogen Bhogal, Helen Czerski, Elliot Richards and Quentin Wilson. And of course, the event itself just happens to be the world’s number one home energy and electric vehicle show with just about every available electric vehicle on display, as well as hundreds of other exhibits and attractions.**

**So, it really is well worth a visit if you can get there. The discount code is still valid, so if haven’t got your tickets yet, and you’d like to come along and say hello then follow the link in the description or click on the link that’ll pop up on your computer or tablet screen right at the end of the video.**

**That’s it for this week though.**

**Thanks to our Patreon crew who keep me chuntering away each week and who help me keep the videos as relevant and accurate as possible, and as always of course thank YOU very much for watching!**

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

**See you next week.**