**In today’s tech driven world there are two main ways to access the ever-increasing quantity of lithium needed to power just about every battery powered electrical device on the planet. It’s either drilled or blasted out of the ground in a rock called spodumene at open pit or underground mining sites in countries like Australia Canada or China, OR… it’s pumped up in aqueous brine solutions from huge underground aquifers, most notably in the Salar de Atacama in Chile, that sit for months in evaporation ponds, allowing the strong sunshine to do it’s work. Both these methods have their environmental impacts of course, which is an argument that occasionally and rather ironically unites environmentalists and fossil fuel propaganda merchants. What would be helpful is if those commentators provided some context for the scale of lithium operations compared to existing mining and drilling for the fossil fuels that lithium is helping to replace. For example, while there is a pretty substantial carbon footprint for spodumene mining and processing – something like twenty tonnes of carbon dioxide for every tonne of lithium carbonate equivalent, or LCE, produced, the global average for extracting, processing and transporting oil and gas is about sixteen tonnes of CO2 per tonne of fuel produced. And that’s BEFORE those fuels get used in combustion engines in a one-way, entirely unrecyclable process that, according to the Global Carbon Project, in twenty-twenty-four released more than thirty-seven BILLION tonnes of carbon dioxide into our atmosphere – an increase of almost one percent on the previous year.**

**So, you know – nothing we humans do comes without a planetary cost, does it?**

**But while the entrenched processes of the fossil fuel industry are unlikely to change in any meaningful way in the coming years, there is an alternative technology for extracting LITHIUM, which potentially has a far lower environmental footprint than existing methods and which is being developed at pace all over the world.**

**So, has the lithium industry stumbled upon an actual breakthrough, or are we being fed another dollop of greenwashing?**

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

**So, what we’re talking about here is a process called Direct Lithium Extraction or DLE, and it does appear to be causing a measure of quiet excitement among proponents of the green transition. So, what’s it all about then?**

**Well essentially, it’s a method of targeting and extracting lithium IONS directly from underground reservoirs while leaving other unwanted ions behind. Each reservoir has its own particular characteristics depending on the geographical conditions in the region, so each DLE operation has to be tailored to its location. Broadly speaking though, there are four main ways of achieving the extraction goal.**

**First up is ADSORPTION. The idea here is to pass a lithium-rich solution over an insoluble, aluminium based material which acts as a sorbent. As the lithium ions come into contact with the aluminium, they nestle or intercalate onto the surface and into the atomic layers of the aluminium particles. Once the sorbent is sufficiently saturated, the lithium ions can be removed using a warm dilute solution of lithium chloride.**

**A similar effect can be achieved via the process of ION EXCHANGE, typically using manganese or titanium-based sorbents that act like sieves, blocking large ionic materials and only allowing lithium and hydrogen ions to pass through them. Instead of nestling into the atomic structure of those sorbents, the lithium ions are swapped with hydrogen ions, or protons, and then liberated later by washing with a low pH solution.**

**Both these sorbent methods do need a well concentrated solution for them to work effectively though – typically something above a hundred milligrams of lithium per litre, but they have lithium recovery rates above ninety percent compared to only forty to sixty percent in the evaporation ponds, and they’re fast too! On average these two processes take somewhere between one and six hours to complete, and unlike the evaporation ponds, the water used in the process can be recycled within a closed loop system.**

**Another approach is to use SOLVENT EXTRACTION to exploit the different solubilities of various compounds.**

**Essentially a selective organic solvent combines with the lithium in the solution to form a new compound that can then be passed through a second process to strip the lithium away. The so-called ‘organic solvents’ in question though are things like kerosene, benzene, chloroform, cyclohexane and other petrochemical derivatives, and the secondary stripping process I mentioned is typically achieved using hydrochloric acid or sulphuric acid, so there are one or two environmental concerns here, and at the moment the solvent extraction process is relatively expensive. On the plus side though, it’s even faster than the sorbent process, taking about four hours to liberate the lithium, and it offers extraction efficiencies well above ninety percent.**

**It also has the potential to be utilised as a post-treatment step to purify the end product to achieve battery quality grades.**

**The fourth system is still a bit further down the technology readiness or TRL ladder, at least as a DLE method anyway, but it’s arguably the least environmentally impactful, so it’s definitely worth a look.**

**This one involves the use of membranes to physically filter the lithium out of the brine.**

**You might be familiar with the idea of using membranes, or more correctly, ‘pressure assisted membranes’ in desalination processes like reverse osmosis and nanofiltration.**

**They can split off so-called multi-valent ions like magnesium and calcium from monovalent ions like lithium, sodium and potassium.**

**Now you’re all smart people, so you’re probably already two steps ahead of me here, and you’ve already figured out that membrane DLE technology could therefore represent a nice synergistic way of dealing with what is currently a waste product of the desalination industry.**

**Co-locating DLE plants with desalination plants could save infrastructure, water, and energy, and membrane research and development in the desalination industry, which is already taking place to reduce unwanted side effects like scaling and biofouling, could be directly transferred over to membrane DLE development.**

**Which would be rather a convenient piece of serendipity, don’t you think?**

**This twenty-twenty-four study by the International Lithium Association analyses the pros and cons of each DLE method in far more detail than I can provide in a single video, but I’ve left a link to it in the description section below if you’re keen to know more about the technical minutiae.**

**The paper does provide us with a very useful environmental analysis chart though, showing CO2 emissions, water consumption and land use for direct lithium extraction compared to solar evaporation and hard rock mining. There is apparently quite a lot of data variation in the existing literature from studies in different parts of the world, but the authors of this paper crunched through the numbers to get to a best overall estimate, which they show here. Water consumption for DLE is reckoned to be well below a hundred cubic metres per tonne of lithium carbonate produced, and as low as ELEVEN cubic metres for some DLE facilities using closed loop water systems,**

 **like the Lake Resources Kachi ion exchange project in Argentina.**

**Water consumption for evaporation ponds depends on what you measure.**

**Basic consumption to drive the process itself comes out at around thirty cubic metres per tonnes of lithium carbonate produced, but if you add in the volume of water that evaporates off into the air over the eighteen months or so that the ponds sit in direct sunlight, then you’re looking at an average in excess of four hundred and fifty cubic metres per tonne. By contrast, water consumption for hard rock mining comes in at an average of seventy-seven cubic metres per tonne.**

**The comparison gets pretty wild when we look at land use though. Direct Lithium extraction facilities have a pretty small footprint, averaging something like sixteen square metres for every tonne of lithium carbonate produced. By comparison a typical hard rock plant like Greenbushes in Western Australia comes out at about three hundred and thirty-five square metres per tonne of Lithium Carbonate, and the vast evaporation ponds in places like the Salar de Atacama in Chile wade in at an eye-watering three-thousand-six-hundred and fifty-six square metres per tonne of lithium carbonate.**

**Then there’s the carbon footprint of each technology. This one depends on various parameters, but it is of course quite heavily affected by where you get your energy from. For example, an earlier study on lithium extraction from brine in Clayton Valley, Nevada found CO2 emissions of twenty-two tonnes per tonne of lithium carbonate when using a diesel generator, just over seventeen tonnes of CO2 per tonne when using the Nevada grid and only seven-point-six tonnes of CO2 when the process energy was coming from solar panels.**

 **The International Lithium Association paper calculated a global average of about twenty tonnes of CO2 per tonne of lithium carbonate for hard rock mining, roughly three tonnes of CO2 per tonne of lithium carbonate for evaporation ponds and between three and seven tonnes for direct lithium extraction. But according to the paper’s authors, DLE offers the advantage of modularity, enabling seamless integration with renewable energy sources to completely offset CO2 emissions. And if a direct lithium extraction system is set up to exploit an existing GEOTHERMAL brine reservoir that already contains the thermal energy required, then the carbon footprint starts to approach zero.**

**That’s a method being developed by Cornish Lithium here in the UK, who in March twenty-twenty-five received planning approval to build Britain’s first commercial geothermal lithium plant at their site in Chacewater, with a projected annual throughput of twenty-five thousand tonnes of lithium carbonate equivalent by twenty-thirty. We also have a company called WaterCycle here in Blighty, developing membrane-based water treatment and extraction systems that not only allow for primary extraction of lithium from aqueous solutions but can also address the tricky problem of lithium extraction at the end-of life recycling stage. Over in the States, several firms have been working on DLE for some years now, including Energy X, whose patented LITAS technology can use any of the direct extraction methods depending on the location and application, resulting in what they describe as a Brine to Battery process for producing high quality lithium hydroxide, lithium carbonate and even lithium metal.**

**There are challenges of course. Right now, DLE is generally more expensive than traditional lithium extraction methods, and large investors might be dissuaded by recent price instability in the lithium market. Every brine deposit has its own unique composition as well, as I mentioned earlier, so there’s no ‘one-size fits all’ solution. New DLE facilities will have to address their own specific design and operational considerations. And of course, navigating the complex battlefield of regulatory approval presents the same headache for DLE operators as does for all new energy projects.**

**From a technical perspective though, the outlook for DLE does look quite promising, with new advances in the technology coming online all the time, aimed at improving the efficiency and effectiveness of lithium recovery while minimising the impact on local water supplies, and ecosystems and significantly reducing greenhouse gas emissions.**

**But what’s your view. Have we got a winner here, or are there challenges in the pipeline that we haven’t addressed today? Maybe you work in the industry and you can share YOUR experience with us all. Whatever your opinion, the place to voice it is in the comments section below.**

**That’s it for this week though. Thanks, as always to the amazing folks over at Patreon, who make this channel possible and enable me to keep ads and sponsorship messages out of your way. And I must just give a quick shout out to some folks who joined recently with pledges of ten dollars or more a month. They are Maarten de Moor, Paul Moran, Rosie Barnes, Peter Vittali, Vince Gabor, Gary Robottom, Jane, Stephen Einhorn, John Page and Michael Payne**

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

**If you feel you’d like to get involved with that then jump over to Patreon dot com forward slash just have a think to find out how you can join the team and have a look at all the exclusive perks you can get there, including direct access to me via dedicated chat forums, early access to all my videos and an opportunity to shape the direction of the channel in monthly content polls.**

**And if you enjoyed this video then you really can hugely support the work I do here by hitting the subscribe button on YouTube and clicking on all notifications. It won’t cost you a penny to do that and it’s just a simple click away, either down there or on that icon there.**

**Most important of all though, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**