**One of the most common requests I get from you good folks out there is to go back every now and then and review the progress being made by the various technologies and companies we’ve featured on the channel over the years.**

**And it’s a good question, isn’t it? It’s all very well coming up with the next big game changer that could revolutionise energy use and ‘save the planet’ but if you can’t get it to work in the real world, or if you can’t find anyone to back you with a bit of working capital, then your little piece of genius insight is likely to be consigned to a metaphorical trash can marked “what could have been”.**

**So, over the coming months, I will from time to time, be delving back into the archives to see what became of some of the more promising ideas we’ve looked at in the past, to bring you the good, the bad and occasionally ugly news about how those intrepid innovators are getting on.**

**One such innovator is a US based company called Form Energy, whose simple iron-air technology we looked at back in early twenty-twenty-two.**

**Form Energy promised us long duration energy storage at much lower cost than lithium-ion batteries, using super abundant, readily available materials in batteries that could be cycled many thousands of times with very little degradation.**

**What’s not to like?**

**But is it working out for them in reality?**

**Well…could be!**

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

**A lot of the technologies we cover on this channel are essentially attempting to address the age-old issue of intermittency as more and more wind and solar power gets added to our electricity grids, which by the way is a rapidly accelerating process that in many parts of the world is really starting to hit the steep section of the exponential adoption curve. According to the US Energy Information Administration, or EIA, for example, American wind and solar generated more electricity than coal for a record five-month period at the start of twenty-twenty-three, and similar records are being achieved in various other parts of the world.**

**We all know about lithium-ion batteries for utility scale energy storage systems, don’t we? We know they’ve got relatively high energy and power density and efficiency, providing instant frequency response to our grids when intermittent supply drops or when demand spikes unexpectedly. But we all also know about the public perception around resource scarcity, alleged corruption in supply chains, and occasionally dubious working practices at some of the mining sites, most notably in the Democratic Republic of Congo. And fundamentally, lithium-ion batteries were never designed to be piled up in huge shipping containers providing megawatt hours-worth of energy discharge. They were conceived to run very small things like calculators, laptops and mobile phones. So, although they’re plugging an important gap – they’re really a bit of a square peg in a round hole that start to become problematically expensive as longer discharge times are required.**

**Quite how much energy storage the word will need in the future and how long any given type of energy storage technology will need to be able to discharge its energy for, is a matter of some debate. It depends on all sorts of variables like how much over build of wind and solar we can achieve, and how well we can modernise our grid systems, how interconnected we allow ourselves to become, from town to town or state to state, or even country to country and perhaps even continent to continent. It’ll also depend on how much more energy efficient manufacturers can make our everyday devices, and perhaps most importantly of all, how well our governments can convince us citizens to implement energy efficiency measures in our own lifestyles so that we all use far less energy in the first place. So, you know, there’s a few things to think about there! One thing that’s difficult to argue with though is that any technology that can economically discharge useful quantities of utility scale energy for relatively long periods of time, like days instead of hours, is surely going to be looked at very favourably by grid operators, governments and investors alike. Which brings us nicely to Form Energy.**

**Time for a quick recap on how their technology works…**

**The two main ingredients are basically nothing more sophisticated than good old iron, and fresh air. Both are extremely abundant, both are easily accessible, and importantly, both are cheap. The principle of Form’s technology is something they refer to as ‘Reversible rusting’. One of their batteries contains between ten and twenty stacks of cells, each of which has an anode consisting of pebble-sized pellets of metallic iron on one side, and an air breathing cathode on the other side, all immersed in a water-based, non-flammable electrolyte. As oxygen from the air floods into the battery cell, it reacts with the iron via the liquid electrolyte. That reaction reduces the air to hydroxide and oxidises the iron firstly into iron-hydroxide which releases electrons, and then into iron oxide, which releases more electrons, all of which can then be harvested to provide electrical energy. As the battery discharges, that rust slowly builds up at the cathode. A full discharge cycle can take up to 100 hours or roughly four days, and unlike lithium-ion batteries, these things can operate quite happily in a very wide temperature range without expensive cooling systems.**

**To recharge the battery, an electrical current can be passed through the cells which reverses the reaction, liberating the oxygen from the rust and turning it back into iron. That process also takes about a hundred hours, so again, not suited to devices that pander to the human obsession with instant gratification, but still perfectly serviceable in a well-planned utility scale environment.**

**What this energy storage system is NOT though, is delicate! Each individual unit was originally conceived to be about the size of a washing machine, but as you can see from this recent footage, they’re actually quite a bit large than that, so you won’t be seeing an iron-air battery in your smart phone in the future, and they won’t be used for anything mobile either, like cars or planes – they’re just far too heavy for that sort of application. But for stationary utility scale long duration energy storage, Form’s iron air technology looks like it could be an ideal solution.**

**Theoretically, iron-air has a far higher energy density than LFP batteries, which is why it makes such a good candidate for long duration energy discharge. It also has a very long operational lifetime at around ten thousand cycles compared to two thousand for LFP.**

**Then there’s the all-important costs, which ultimately is what all projects live or die by. That gets a bit more complicated, as this table shows us. What we’ve got in the first three columns are low, medium and high projections for the overall capital cost of building out a facility and getting it up and running. Clearly a set of lithium-ion batteries configured to provide no more than four hours of discharge time, is currently the cheapest installation to achieve. They already exist and are becoming the go-to choice of grid operators for replacing the very expensive and inefficient gas peaker plants that have previously taken up the slack in grid demand and supply spikes.**

**But it’s at the longer duration end of the scale that iron-air starts to look more attractive. Although it’s capital set up costs are currently still higher than eight-hour lithium-ion, Form Energy claim that at full scale production, their cells will be able to store energy at around six dollars per kilowatt-hour, and even when those cells are properly packaged up into a full battery unit, the operating cost will still be around nineteen dollars per kilowatt-hour – less than half that of eight hour lithium.**

**Full scale for a Form Energy installation will look a bit like this – a massive warehouse sized operation containing tens of thousands of battery units, all hooked up together to provide enormous quantities of energy storage. Form claim their least dense configuration would get one megawatt of capacity into about an acre of land, with the high density configurations reaching three megawatts for the same amount of space.**

**So, what’s the latest progress then? Has Form Energy actually built one of these facilities yet? Well, not quite, but in July twenty-twenty-three they made their first major commercial breakthrough when the Public Utility Commission of Minnesota approved plans for the construction of a ten-megawatt facility capable of discharging one gigawatt-hour of energy into the electricity grid controlled by local utility firm Xcel Energy. The warehouse will be built on the site of a former coal-fired generating plant on the banks of the Mississippi River. That’s a smart use of an obsolete brownfield site, qualifying for an additional ten percent tax credit under the terms of the US government’s recent Inflation Reduction Act.**

The reverse reactions represent charging the half-cell. The discharge reaction at the air electrode also involve 4 electron

**The energy storage facility site is conveniently located near to Xcel Energy’s seven hundred and ten megawatt Sherco Solar project, developed partly with twenty million US dollars of funding from the Breakthrough Energy Catalyst Fund which includes billionaire investors like Bill Gates, Jeff Bezos and Jack Ma. Construction of the Form Energy facility is due to commence in mid-twenty-twenty-four with completion slated for mid-twenty-twenty-five, after which Xcel and Form Energy are planning a second battery installation on the site of a soon to be retired Comanche Coal Powered Generating Station in Colorado, subject to regulatory approval.**

**So, while Form Energy are not quite up and running with a commercially operational plant just yet, they are getting tantalisingly close, and they’re arguably shaping up to be a real American success story that could play a crucially important role in the rapidly accelerating US energy transition.**

**No doubt, as always, you’ll have your own views and possibly even more up to date news on Form Energy and the wider energy storage industry, so if you do then why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though. Thanks, as always to our Patreon supporters, who have single handledly enabled me to keep ads and sponsorship messages out of all my videos over the years. And I must just give a quick shout out to some folks who’ve joined recently with pledges of ten dollars or more a month. They are**

**Charles Behrens**

**Oliver Hilton**

**Harry P.**

**Alan Hamilton**

**Stuart Eades**

**Lander Stoddard**

**Denis Ball**

**Xander Koevoet**

**Sidney Jones**

**Ted Schnur**

**Barry & Nan Oliver**

**Johannes Riedinger**

**Rez Kitten**

**Michael**

**John Highet**

**Marco De Dominica**

**and**

**William Parker**

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

**If you’d like to get involved with all that, then why not head over to Patreon dot com forward slash just have a think to find out about all the exclusive stuff you can access there.**

**And if you feel you’d like to support me right here on YouTube then you can demonstrate that absolutely for free by subscribing and hitting that like button. It’s dead easy to do that. You just need to click down there or on that icon there.**

**As always, thanks very much for watching! Have a great week, and remember to just have a think. See you next week.**