**So, as you know, we’ve been reviewing one or two of the more promising sustainable energy technologies in recent weeks, like lithium sulphur batteries, solid state batteries and redox flow batteries. One of the points those videos have resurfaced is that as more and more renewables like wind and solar get added to gird systems around the world, grid operators are looking for a larger and more diverse suite of options to cover the wide gamut of power capacity, speed of response for grid stability AND longer duration energy storage solutions to get through days or possibly even weeks.**

**One technology that fits rather nicely into the longer duration end of that mix is something called liquid air energy storage, otherwise known as cryogenic energy storage. Back in twenty-twenty, we took a look at a pioneer in this field by the name of Highview Power, based here in the UK. It turned out to be one of the most viewed videos on the channel, and it really did look like a very smart, low-cost option.**

**So, you can guess the next question, can’t you? Four years down the line, how are our friends at Highview Power getting on?**

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

**So, here’s that chart of utility scale energy storage solutions that we looked at in our recent redox flow battery video.**

**You’ve got a vertical axis representing duration in minutes, hours and days, and then you’ve got the horizontal axis representing the rated power capacity of each system.**

**Lithium-ion batteries, with their instant response times and high energy density are great for frequency regulation, which takes up the slack between supply and demand on a second-to-second basis throughout the day, and they can provide extra electrons for more prolonged periods as well to get grids through peak times like early evening when everyone gets home and puts the kettle an TV on. But even though you could theoretically configure a lithium-ion battery installation to be so huge that it could provide energy for days and days, the economics pretty much stop working once you get past about 4 hours or so, possibly six at a push. Redox flow batteries are a good solution for the six-to-twenty-four-hour slot, and possibly a bit more if you’re lucky, and things like pumped hydro storage can be built with really whopping power capacity that can be delivered over many days if needed. Liquid Air can provide a cost-effective solution that can fill a very large chunk of the chart, not just in duration but also in capacity, depending on its configuration. And there’s a good reason for that, which I’ll come back to in a moment.**

**First of all, though, let’s just have a quick recap of how it works.**

**We start off with a technology that’s been used for over a century to produce gas products via the process of distillation.** **In this case it acts as a giant industrial air liquefier, drawing in ambient air, cleaning it up by stripping out moisture and carbon dioxide and cooling it down to cryogenically low temperatures so that it condenses into a liquid. Air is mostly nitrogen, so you’ve essentially got liquid nitrogen at this stage, at least in terms of how the liquid behaves anyway. Liquid air is seven hundred times denser than atmospheric air and it’s stored in very well insulated cylinders at fifteen times atmospheric pressure. As a reference, a typical gas cylinder is rated for about twenty-five times atmospheric pressure.**

**When the stored energy is required the liquid air is released from the cylinders and pumped up to higher pressure using a cryogenic pump. Exposing the liquid to ambient air temperature quickly makes it boil and turn back into a gas that can then be passed, at high pressure, over a turbine which drives an electrical generator. To optimise the efficiency of the system the heat of compression on the refrigeration side is captured in insulated cylinders and can be used to extract more energy from the liquid at the appropriate time. Then when the liquid air is raised back up to ambient temperature, the cold is also captured and stored in cylinders, and that can be used later to provide additional cooling back at the initial refrigeration stage. Over many years of testing and development, the company has managed to achieve a round trip system efficiency of about sixty percent, which is nothing like the ninety-odd percent you can achieve with lithium-ion, but it’s not a million miles away from Pumped Hydro, which comes in at between seventy and eighty percent, or flow batteries, which typically have round trip efficiencies between sixty and eighty percent. And it looks very competitive against compressed air storage too, which can range from forty to sixty percent.**

**And here’s where the cost effectiveness part comes in.**

**Highview’s entire design philosophy is heavily based on using existing, off the shelf, components, which means they can buy all the kit from Original Equipment Manufacturers, or OEMs with decades long proven track records of performance in similar industries. That also means they get the benefit of many years of field experience that those manufactures have gained, plus the assurance of warranties on all the equipment.**

**All the storage cylinders are bog standard thin-walled steel vessels that are modular and easily scalable, allowing systems to be constructed anywhere in the world in size capacities from five megawatts to many hundreds of megawatts if required. So, start-up costs are comparatively low and from an environmental point of view the system doesn’t require any rare or toxic or difficult to mine materials, nor does it give off any greenhouse gas emissions in operation.**

**As a rough rule of thumb, doubling the power output of a liquid air installation adds about fifty percent to the overall system cost. That’s a big advantage in system flexibility and future proofing. If an operator wanted to double the power of a lithium-ion installation they would have to buy twice as many lithium-ion batteries which, unless they were incredibly good negotiators, would DOUBLE the cost.**

**So, that’s the theory. What about reality? Well, last time we looked, back in January twenty-twenty, Highview Power had teamed up with energy developer Carlton Power to develop an eighty-million-pound, fifty-megawatt liquid air battery facility in Manchester, UK, backed by a ten-million-pound grant from the UK government and a thirty-five-million-pound investment from the Japanese Sumitomo group. The plant was originally planned to be operational by twenty-twenty-two, employing two hundred skilled workers and providing additional daily energy storage of about six hours or so for nearly half a million homes.**

**But…COVID happened, and frankly so did the local planning department, which appears to have gone into a bit of a melt down trying to assimilate such an innovative new development into a bunch of badly outdated policies. Anyway, don’t get me started! Suffice to say, those wrinkles have now been ironed out, and although they put the project at least two years behind where it would otherwise have been, it is now very much going ahead as an integral part of what will be known as the Trafford Low Carbon Energy Park. The entire site will include green hydrogen electrolysers and a one-gigawatt lithium-ion battery installation, with a revised completion target of sometime in twenty-twenty-five.**

**Two more UK projects are now in the planning phase, one in Scotland and one in the North-East of England. Both installations will be located adjacent to existing wind farms and right on the national transmission network. They’ll both be significantly larger than the Manchester installation, with a 200megawatt/ 2.5-gigawatt hour capacity, adding to what is increasingly looking like a genuine northern powerhouse of low-carbon sustainable energy and industry, creating much needed infrastructure investment and skilled employment for that part of country.**

**Highview has also struck deals to develop up to six renewable energy power stations in the Northern Territory of Australia, two of which are already well into the development planning phase. The first is a ninety megawatt / eleven hundred- and seventy-megawatt hour facility on the Katherine-Darwin network, and the second will be a slightly smaller, twenty-two megawatt / three hundred- and eight-megawatt hour installation next to the Owen Springs Power station just outside of Alice Springs.**

**The latest news is that in late November twenty-twenty-three, Highview Power and Danish power giant Ørsted completed a joint investigation into how Liquid Air Energy Storage can be most effectively combined with offshore wind to unlock greater value for investors and consumers. The results are apparently very encouraging, showing that the system could greatly reduce the dreaded curtailment problem that we’ve talked about many times on this channel. That obviously increases productivity and contributes towards the ultimate aim of amore flexible, resilient zero carbon national grid. They also crunched the numbers on build out time and found that an appropriately sized liquid air installation could be fully constructed and commissioned in the same time as an offshore windfarm, which is very good news for the blood pressure of the Project Manager!**

**The findings of this joint research project will be fed into the UK Government’s ‘Long Duration Energy Storage’ consultation process, at what most analysts agree is a critical point, not just in the UK’s journey to net-zero, but for every nation around the world.**

**So, despite lockdowns and regulatory hurdles and site management challenges and all the other battles that green energy developers have to face, the future looks very bright for a low-cost, completely modular, highly scalable technology that can be built out pretty much anywhere in the world and that can occupy a very useful space in the energy storage matrix. I’ll keep a close eye on progress at Highview power in the coming months and I’ll bring you an update when the Manchester site is up and running.**

**If you’ve got news or views on cryogenic air energy storage, or if you’re actually involved in one of the projects, then I’d love to hear from you. So, as always, the place to leave your thoughts is in the comments section below.**

**Before I go…**

**That’s it for this week.**

**Thanks, as always, to our Patreon crew who keep me on the straight and narrow, and without whom this channel would simply not exist.**

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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.**