**I’ve got my dangerous hammer out again folks, which means yet another slightly lame attempt at demonstrating a physical concept in order to introduce a video.**

**Don’t knock it though - it’s cheap and it’s quick, and it was the heaviest thing I could find in my drawer of many things, so it’ll have to do.**

**You might remember I last used it when I looked at Liquid Air batteries a few months ago. Back then I pointed out how, in very basic terms, if you can find a way to use energy to make something physically happen in a reversible way, then you’ve probably created an energy storage device.**

**And then I lifted the hammer and dropped it and explained that if I’d tied a piece of string to the end of the handle and attached that to a dynamo then I could have briefly generated electricity.**

**So I thought to myself, why don’t I actually do that for this video to really show you that it works.**

**And then I saw these young shavers from the Reconstrained Design Group in Madeira, led by an extremely talented British designer called James Auger. They had the distinct advantage of a fourth-floor balcony and they’d upped the ante a bit by using a fifteen-litre water cooler bottle and a smart-arse gearing system which I hadn’t thought of.**

**Anyway, the result is that they were able to very slowly lower the water bottle to generate enough energy to run a turntable playing Folsom Prison Blues by Johnny Cash. I can’t let you hear the music – not because I don’t enjoy a bit of the old Man in Black, but because despite being dead, Johnny still insists that people pay him whenever they use his stuff. So, I’ll leave a link to this video in the description section and you can listen to his unmistakable dulcet tones there instead.**

**The point is – the system works. And if you’re clever you can control it extremely precisely, either to deliver energy very quickly, like my design,**

**or in a very controlled and gradual way like their contraption.**

**And that means if you could scale it up you might have yourself yet another solution to grid scale energy storage.**

**Simple right?**

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

**Using gravity to provide electrical energy is of course nothing new. We’ve been doing it with pumped hydro since 1907 when this facility was first started up in Schaffhausen in Switzerland.**

**But not many pumped hydro facilities are being built anymore, mainly because they take years to construct, cost about a billion dollars, and quite rightly need all sorts of long winded and difficult environmental permits.**

**But there are a couple of companies now working on the same concept as James Auger and his mates - literally lowering extremely heavy weights off to top of tall buildings, but at a much, much larger scale.**

**This one hundred and fifty metre tall tower system has been developed by a company called Energy Vault, led by co-founder and Chief Executive Robert Piconi, and it’s really very clever indeed.**

**Essentially you’ve got four big cranes bolted to the top of a thirty five storey steel structure surrounded by a stack of huge blocks arranged very precisely into a tight cylinder. They look like concrete don’t they? And if they had actually been cast from brand new concrete, that would have been a very bad idea indeed from an environmental point of view. But Energy Vault have partnered with Mexican materials company Cemex to develop a composite material made up of waste products. There is some concrete in the mix but it all comes from demolition debris. That’s added to coal ash, industrial slag, and even some of the soil from local building sites, all of which would most likely otherwise have just been dumped in landfill.**

**There’s six thousand of these composite bricks in the structure, and each one weighs thirty-five tonnes.**

**A system of pulleys and motors, all controlled by mind bogglingly sophisticated software, can move several blocks at a time, shifting them from their pre-determined positions in the tall tight stack to another very precisely controlled position lower down, creating a lower outer cylinder. As the blocks are lowered the pulleys cause a rotation that generates electricity. Then when the structure needs to be recharged, renewable energy from surrounding wind turbines powers the winches to pull the blocks back up into their original location.**

**The company developed their system in Switzerland and built their first full scale commercial demonstration unit, or CDU on the outskirts of a town called Arbedo Castione in 2020. They claim a standard configuration can provide thirty-five megawatt hours of power to the grid.**

**It’s pretty quick too. Piconi reckons the system can go from zero to four megawatts in just two point nine seconds and provide instant response within milliseconds. That means it rivals lithium-ion batteries as a frequency response grid balancer. But it can also be used as a black start service, which in other words means bringing a grid system back online in the event of a blackout, or it can be run more slowly to provide up to ten hours of continuous baseload discharge.**

**Energy Vault are backed by some pretty hefty investment too, in the form of a hundred and ten million dollars from SoftBank – a Japanese investment bank specialising in bringing sustainable technologies like this to market. Softbank already invest in large scale renewable energy projects all over the world, so their partnership with Energy Vault should be a kind of symbiotic relationship with the bank opening new doors for Energy Vault, and Energy Vault’s system facilitating even more competitive cost structures for Softbank’s investments. Piconi says they’ve got their levelized cost per megawatt hour down to somewhere between thirty and forty dollars, which if combined with renewable energy sources can potentially undercut existing gas fired power plants.**

**Hot on their heels, but not quite so far ahead on development, is this Edinburgh-based start-up called Gravitricity founded by a guy called Peter Fraenkel. Fraenkel is perhaps best known for inventing the world’s first full scale tidal energy turbine, which was bought by the German energy and manufacturing giant Siemens.**

**Gravitricty are working on the same basic principles of physics as Energy Vault, but their unique selling point is that they intend to utilise disused mine shafts as underground void spaces into which they can lower their electricity generating weights.**

**You might think that’s a bit of a serious limitation, but actually there’s a surprising number of these shafts strewn all over the planet.**

**A full size version of their system will be able to move weights of between five hundred and five thousand tonnes up and down within the shaft using multiple cables to distribute the loads evenly. They claim a fifty-year design life with no cycle limit or degradation – something that represents a significant advantage over lithium-ion batteries. Just like Energy Vault they reckon they can hit a zero to full power response time of less than one second with a system efficiency of somewhere between eighty and ninety percent and each of their units will be configurable to provide between one and twenty megawatts of peak power delivered either in fifteen minute frequency response bursts or as long duration discharge up to eight hours.**

**Gravitricty are currently building a demonstration prototype in Scotland as part of a one-point five- million-pound project funded by a six hundred and forty thousand pound grant from a British government agency called Innovate UK, and around eight hundred thousand pounds that the company have generated themselves via crowdfunding.**

**The scaled-down demonstrator will use two twenty-five tonne weights suspended from the opening of the shaft by steel cables. The company will first drop both weights at full tilt to record the maximum instant generation speed for grid frequency response, and then they’ll conduct a second test, lowering the weights more gradually, one by one to establish the parameters for longer duration supply.**

**If the tests go to plan then that should lead on to their first full scale model some time in 2021, with a capacity of four megawatts and if they do manage to successfully exploit all the available mine shafts, then eventually they plan to sink their own drop shafts in new locations, opening up even wider markets.**

**Li-ion batteries currently dominate the grid scale energy storage market. It’s a sector that Bloomberg New Energy Finance projects to grow from nine gigawatts in 2018 to more than one terawatt in 2040. But there’s a growing number of alternatives, including these gravity systems, that are now challenging lithium-ions supremacy. We’ve already looked at liquid air batteries and Redox Flow batteries. Zinc Air is another option too being developed by a Canadian firm called Zinc8, and that’s something we’ll have a closer look at in a future program.**

**In the meantime if you have views or direct experience of these technologies then why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

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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**