**How to heat your home, and NOT the planet.**

**I’m making this video right in the middle of the second heatwave of the twenty-twenty-two British summer season. Continental Europe is suffering droughts and water shortages, and I know you folks across the pond are also experiencing record breaking heatwaves this summer, with well over a hundred million of you sweltering in temperatures above thirty-eight Celsius or a hundred degrees Fahrenheit in the last few weeks.**

**So, it might seem a bit inappropriate for me to start banging on about the desperately urgent need to find more efficient, lower carbon ways to provide heat for our homes, because right now they’re warm enough thank you very much!!**

**But of course, time marches relentlessly on, and the northern hemisphere winter will be here soon enough. Current world events are showing many of us just how hopelessly dependent we still are on fossil fuels, and how crippling the price hikes are likely to be as supply lines become ever more restricted.**

**According to recent polling, most people seem to agree that we need to move rapidly away from fossil fuel heating, but the question is what are we going to move TO? And if we’re apparently going to be relying on one hundred percent renewable energy in the future, how are we going to guarantee constant heating during the cold dark months of winter?**

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

**Arguably the first thing to consider when you’re looking at how to heat buildings with low or zero carbon technologies is whether to install small individual units for each building, like heat pumps for example, or to provide a single large solution like a district heating network for an entire town or city. We don’t yet have that kind of district infrastructure here in the UK, and there aren’t many examples over in the States either, but district heating is pretty popular in Scandinavia, Eastern Europe and China, and there’s a good chance us Brits and you Americans could see them becoming more commonplace on our shores in the decades to come. The big challenge for the operators of these systems today is how best to move away from the fossil fuels that currently provide the majority of the energy, and one of the potential solutions to that problem is thermal energy storage.**

**No doubt many of you will have seen recent media coverage of this thermal energy storage system built by a Finnish company called Polar Night Energy, which is now being operated in the city of Kankaanpää by a district heating provider called Vatajankoski.**

**I caught up with Polar Night Energy’s Chief Technical Officer and Vatajankoski’s Managing Director via Zoom recently to find out more about how the system works.**

**Essentially, it’s an energy storage unit that works as a closed air loop heat exchange system.**

**Inside this four-metre diameter silo is a hundred metric tons of nothing more exotic than bog standard sand from a local supplier a couple of kilometres down the road. Air is heated up externally to about six hundred degrees Celsius by an electrical resistance heater and fed through a system of pipes that circulate through the sand in a very specific configuration, which gets the centre of the sand extremely hot indeed while keeping the outer sections much cooler. That’s quite a smart feature which has the effect of minimising the amount of extra internal insulation needed to stop the heat from radiating out into the atmosphere. That reduces the overall size of the silo and of course it keeps the costs down too.**

**Once the sand is at full temperature it can store that heat for several weeks or even months with very minimal thermal losses.**

**And then, when the district heating system calls for heat, it’s a simple matter of running ambient air through those same pipes and, hey presto, hot air comes out of the other end. That hot air gets diverted into a standard air to water heat exchanger which is then fed straight into the district heating system.**

**This particular installation in Kankaanpää is capable of discharging heating power of a hundred kilowatts constantly for eighty hours, which means it has an eight megawatt-hour energy capacity. That’s more than three full days and nights of constant heat going into the district heating network.**

**Polar Night’s Chief Technical Officer, Markku Ylönen pointed out that while it would be technically feasible to configure a system that discharged over a much longer period of weeks or even a month or two, the size, cost, and technical challenges involved in building and running a configuration like that just wouldn’t make it economically viable. In any kind of storage system, fewer cycles always means a more challenging economic model. And anyway, as Markku explained, there’s really no need for such an extremely long duration discharge period to avert the use of fossil fuels, at least not in Finland anyway. Winter brings far more reliable high winds than the summertime, so the proportion of wind power on the Finnish grid tends to be higher during the winter months. And of course, one of the many advantages of energy storage is that the operator can chose when they want to put that energy in. Vatajankoski’s Pekka Passi explained that wind power already makes up about ten percent of the Finnish power system and more wind farms are coming on line all the time. And actually, if we look at the global situation, courtesy of this chart from the US Pacific North West National Laboratory, we can see that around two thirds of all new global power generation capacity added each year now comes from wind and solar.**

**The global fossil fuel energy situation, and in particular the restriction of gas from Russia, has inevitably had an effect on the prices of everything in the Nordic energy market. But even so, Pekka says there are certain times during the week when the price of electricity gets close to zero at night time. There’s always a lot of fluctuation in the price of electricity on the wholesale market and that’s likely to increase as intermittent renewable energy sources play a greater role in the mix. That means it’ll become ever more important to have flexible energy storage solutions so that cheap electricity can be utilised when it’s available.**

**The optimum operational level that Polar Night Energy are aiming for is somewhere between twenty and fifty cycles per year, which corresponds to roughly a hundred hours for each charge and hundred hours for each discharge.**

**This relatively small system is serving a useful dual-purpose for both companies. Firstly, it’s proving the concept in a real-world setting, something that the bean-counters quite rightly need to assess before they start splashing millions of Euros on a new technology, and secondly it just so happens that this system is a perfect size to enable Vatajankoski to make use of otherwise wasted heat from their own data centre.**

**Right now, about a third of Vatajankoski’s energy comes from industrial waste heat and about two thirds are derived from burning wood-based biomass fuels. As a major district heating supplier, the company’s mission is to end the combustion of biomass in their system within ten to fifteen years, partly to meet ever tightening decarbonisation targets, but also because the combustion of carbon fuels will simply become so expensive in future that it’ll no longer make economic sense.**

**The waste heat from the data servers at their powerplant site gets to about sixty degrees Celsius, which isn’t hot enough to be useful in district heating – it really needs to be above seventy-five degrees. They could have used heat pumps to bump the temperature up, but when they looked at the sand battery, they realised it offered them a lot of storage capacity in a small space and they really wanted to test out its potential. This current system is big enough to supplement all of the waste heat from the data centre but also small enough to minimise the initial capex exposure for Vatajankoski. And at four metres in diameter by seven metres tall, Polar Night Energy were able to fabricate the whole thing off-site and transport it by road to its final destination.**

**But the real fun starts at scale up. The medium-term plan for Polar Night Energy is to produce gigawatt-hour energy systems with about fifteen megawatts of discharge power. That size is a good fit for the majority of district heating networks and also for all sorts of different industries that require process heat or high-pressure steam for their operations. A system that size would cost around six to eight million Euros to supply and install, which corresponds to somewhere between six and eight euros per kilowatt hour of installed capacity. A one-gigawatt hour storage cylinder would have a diameter of around twenty metres, and it would stand about ten metres high, which is big, but actually not at all unusual in an industrial setting.**

**In fact, by sheer coincidence, almost at the same time as Polar Night energy were installing their pilot system, the Swedish utility giant Vattenfall began filling up a forty-five-metre high storage tank in Berlin, Germany with fifty six million litres of water to store heat at ninety-eight degrees Celsius. When it comes online in twenty-twenty three, this enormous cylinder will have a maximum thermal output of two hundred megawatts, which will be discharged directly into the local district heating system for up to thirteen hours at a time, equating to an energy capacity of two-point six gigawatt hours. Imagine what that capacity would be if it was filled with sand at five hundred degrees Celsius!**

**These sorts of relatively simple thermal energy storage solutions use cheap, off the shelf components and abundant storage materials like sand or water, but also gravel, crushed rock, metal pellets or molten salts, all of which are readily available and which present little or no environmental risk. They sit right up towards the top end of long duration storage solutions, and they can be deployed more or less anywhere, which gives them a significant edge over other options like compressed air and pumped hydro. They typically last for decades with minimal degradation, unlike lithium-ion batteries which lose a little bit of capacity with every charge and discharge cycle. And when these facilities are used to provide direct heat rather than converting heat to electricity, they can be as much as ninety five percent efficient. Heating for buildings and process heat for industry accounts for about fifty percent of the total global energy demand. Most of that still comes from fossil fuels today, so thermal energy storage solutions like these look set to play a key role in the global decarbonisation effort that the Intergovernmental Panel on Climate Change tells us will be vital if we’re to stand any chance of keeping global temperatures below two degrees Celsius above pre-industrial levels.**

**So, what’s your view on this sort of system? Do you have district heating where you live and if so, how well do you think a thermal energy storage solution would fit into your local network? Maybe you work in the industry, and you can share a bit of insight on the latest progress? If you do, or if you’ve got other news and views on the subject, then why not jump down to the comments section below and leave your thoughts there.**

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