**I read a very interesting statistic from Bloomberg New Energy Finance the other day. Or maybe it was a very alarming statistic. I don’t know. It depends on who you are and what you do, I suppose. Anyway, BNEF tells us that China is now making more cheap wind and solar kit than the world knows what to do with. And of course, that means renewables are coming onto grid systems at a truly breathtaking pace.**

**Here’s just one example from the US Energy Information Administration, showing California’s net load graph across a typical day. Net load is the demand still remaining after subtracting what’s being supplied by renewables. It’s what the industry boffins call a duck curve. Here’s how much renewables bent the daytime curve by back in twenty-fifteen. And here’s how that dip changed in subsequent years to twenty-twenty-three, by which time pretty much all energy between midday and 4pm was coming directly from the big nuclear reactor in the sky. The thing is though - these bits on either side of the dip? Where net demand goes back up again? Well, that demand is still predominantly being met by fossil fuel fired power stations, which brings me nicely to the subject of today’s video… what if we could still use those same power stations, same infrastructure, same grid connections, the whole shebang in fact, but make the high-pressure steam to drive the turbines and generators without burning any fossil fuels at all, AND without resorting to small modular nuclear devices? Well, we can…**

**So, how does that work then?**

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

**Well, it’s thermal energy storage, isn’t it? There are loads of companies having a go at this technology in various parts of the world right now, and we’ve looked at most of them on this channel. The majority are optimised not only to store energy as heat but also to deliver that energy as heat for industry or district heating systems. Both of which are extremely smart applications that avoid a bunch of unnecessary greenhouse gas emissions.**

**Making enough heat to produce steam at high enough temperature and pressure to drive a synchronous turbine in a power plant is a bit of a step up though, which is why most thermal energy storage operators stick to the former and rarely stray into the latter. One company that HAS made that leap of faith, though, is E2S Power, based in Switzerland.**

**When we first assessed the technology back in twenty-twenty-two, E2S Power was in the process of evaluating what would make the optimum storage medium, looking at all sorts of material combinations. The best option has turned out to be plain old graphite though. It’s already an abundantly available material and it has the very useful feature of great thermal conductivity, which means it’s very good at transferring heat in and out, AND high specific heat capacity, which essentially means it can store a lot of heat.**

**To get the best performance out of their thermal energy storage system, the team at E2S have developed a proprietary process called Travelling Wave Energy Storage, or TWEST. Specially designed electrical heaters sit between two blocks of graphite that have a continuous loop of pipework already embedded inside them. Radiative heat from the pipes raises the temperature of the blocks up to 3:08 seven hundred degrees Celsius.**

**The blocks can be fully charged up in as little as an hour and their thermal mass can then retain that heat for many hours or even days, inside shipping container sized modules that are extremely well insulated.**

**One of the challenges that graphite does present is that it really likes to oxidise with air at higher temperatures, so to prevent that happening the enclosures are filled with nitrogen.**

**To discharge the system, water is sent through the embedded pipework where it’s converted to steam. A key feature of the Travelling Wave Energy Storage technology is that it very effectively maintains the temperature of the steam at a constant level. That makes it ideal for all sorts of industrial applications, but it also means it can be integrated very neatly into existing thermal power plants to provide the steam to drive the turbines.**

**Temperature control is achieved by splitting the whole storage volume into two sections. The first compartment is made up of that thermal storage at seven hundred degrees Celsius. and that high temperature can then be transferred to a second chamber where the system operator can very precisely bring the heat down to the level required for whichever application it’s serving. For a utility facility for example, that would typically be about five hundred and forty degrees Celsius. During discharge, the temperature control section absorbs the extra heat from the flow, and that absorbed heat is then recycled into the system and re-used to prevent the steam dropping below the target temperature. That gives you a very reliable, constant flow of high-pressure steam that can fine-tuned to plus or minus five degrees Celsius using a recuperative heat exchanger at the system outlet for final control and quick dynamic response of the system.**

**A typical E2S thermal energy set up can deliver constant steam at turbine temperature for four hours or longer, which means it could go a long way towards smoothing out that duck curve we looked at earlier.**

**And that’s it in a nutshell. It just needs electricity, ideally from excess wind and solar generation during the middle part of the day, and water to produce the steam. There are no separate heat exchangers or working fluids or compressors like you find in other configurations. The whole thing really is dead simple. And because it’s a modular ‘drop in’ system, it can be tailored to fit perfectly with whatever existing infrastructure each power plant currently has. The same voltage and current levels as the existing generators can be used to feed the electric heaters and the system can use the same high-voltage switchgear, existing steam turbines, and all the other plant, like condensers, cooling towers, heat sinks, generators, and transformers.**

**Perhaps one of the most important advantages of retaining that infrastructure in the same geographical location as an existing power plant, is the ability to retain the local workforce in well paid skilled jobs, potentially providing a crucial transition to clean energy for communities historically dependent on fossil fuels all over the globe as we move to a more sustainable energy future.**

**E2S reckon their system achieves an electricity to steam efficiency of ninety-nine percent and they claim that by replacing coal or gas fired boilers in a typical power application, their TWEST system actually improves the efficiency of the existing plant. So why is that then? Well, E2S say it’s because the TWEST system generates steam via CONDUCTIVE heat transfer, instead of the much less efficient CONVECTIVE heat transfer in a classical boiler. The total ROUNDTRIP efficiency of the thermal plant will obviously depend on the existing steam turbine though, which is usually somewhere around forty-five percent.**

**Now, if you’re a power plant operator, you’re clearly looking at some significant upfront capital expenditure to swap out your existing boilers for this new kit. But let’s think about the advantages once you’ve done that…I mean apart from the blindingly obvious fact that you’re no longer sending huge quantities of greenhouse gases into the atmosphere. You’ve immediately isolated yourself from the price volatility in today’s fossil fuel markets, and the very low cost of charging the system using renewable electricity means the efficiency of the existing turbine-generator infrastructure becomes less of an issue. Maintenance costs are also lower. Much lower in fact because once it’s installed there’s really very little else you need to do during the operational lifetime of the system PLUS the gride operators will be very pleased with you because you will have maintained the inertia that you get from the flywheel effect in the turbines themselves, providing the all-important voltage and frequency support that prevents transmission networks from overheating or tripping out.**

**And as a further bonus for existing power plant operators, the footprint of the E2S thermal energy storage system is much smaller than the area required for an equivalent battery energy storage system.**

**So, what’s the latest news then? Well, in twenty-twenty-three E2S Power successfully integrated its first pilot plant into an existing operating coal plant in India and that installation has now satisfied all the required performance testing criteria.  This is the first time any operator anywhere in the world has been able to run a thermal energy storage unit charged by electricity, supplying high temperature, high pressure steam to the turbine of a power plant.  And the whole installation was apparently achieved and commissioned in less than a month. The testing was witnessed by NTPC, who are the largest power generating company in India. That gives E2S Power the important advantage of prequalification for use in NTPC power plants across the country.**

**The company is also in advanced discussions with an industrial park operator in Europe for a thermal energy storage system charged by electricity from wind power supplying steam for industrial applications and there are ongoing discussions for UK combined cycle power plant applications to provide additional power and flexibility, allowing the operator to take better advantage of wholesale electricity price spreads, grid balancing mechanisms and capacity markets, while reducing fuel consumption and carbon emissions.**

**So, still relatively early days, but unquestionably an encouraging step forward from the first time we took a look at this technology a couple of years ago, with a proper, real-world working example now in operation in one of the most populous countries in the world currently which, according to the International Energy Agency, currently burns more coal than Europe and the United States combined. So, if the E2S system can get a foothold there, then it could be a very significant driver of global progress towards the twenty-fifty net-zero goal.**

**Let me know what you think in the comments section below, but that’s it for this week.**

**Before I go though, I must make amends for a couple of omissions in previous videos. With all the preparation for the recent Everything Electric live show, I carelessly overlooked the Patreon anniversary shout outs for April and May, and of course we’re now well into June, so what you’re seeing here is a sort of triple whammy of anniversary names for April. May AND June. If you are one of these folks and you manage to spot your name in the cacophony of information now scrolling up the screen, then you have keener eyes than me. Needless to say, a huge thank you is due to all these folks, some of whom have been supporting the channel for the best part of four years.**

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**And if you don’t want to miss out on notifications of new videos each week, then make sure you click on that subscribe button. It won’t cost you a penny to do that, and it’s just a simple click away either down there somewhere or on that icon there.**

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

**See you next week.**