**If you’ve caught any of my videos over the past few weeks then you’ll know I’ve been having a bit of a trundle through the multifarious and often conflicting scientific research and articles that have been flooding social media in twenty-twenty three, all of which attempt to assess the current state of play in the global energy transition and offer wisdom on how the world is marching forward. Depending on who you listen to, that march is either taking us towards a bright and brave new world… or complete oblivion.**

**Our scientists are telling us increasingly vociferously that achieving the former and avoiding the latter will require a scale and pace of change that is arguably unprecedented in the whole of human history. We’ve looked at the implications of all of that in recent videos, so I won’t rehash them here. I mention it simply because this week’s video is what could reasonably be described as an optimistic look at a technology that could play a pivotal role in the move towards a one hundred percent renewable global electricity grid system, and whenever I make optimistic videos, I am usually heavily criticised by those that wish to remind me of the existential peril we face, and the suicidal path our global leaders are currently leading us all down. So…yes…I know.**

**But sitting down and giving up is not in my nature, and I believe it is not in human nature generally, so here's a video about something that might be more useful in the future than many commentators give it credit for. It’s closed loop pumped hydro. And before you switch off and start chuntering about how all the available sites have already been taken and there’s no more scope for expanding pumped hydro around the world. Watch this video first…then switch off…if you want.**

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

**So, pumped hydro then. Not a new thing is it, so why the sudden giddy turn of excitement Dave, I hear you ask?**

**Well, I’ll tell you…in a minute. But let’s just start with a quick 101 on how pumped hydro works.**

**Essentially you need two things: a high reservoir and a low reservoir. The higher the elevation difference between them, the better it works. Think of it like a giant battery that stores energy in the form of water! When there's excess electricity in the grid, like during periods of low demand or when renewable sources are producing more power than needed, the surplus energy is used to pump water from the low reservoir to the high reservoir. A bit like charging up the battery!**

**Then, when there's a high demand for electricity, or when renewable sources aren't generating enough power, the water from the high reservoir is released, flowing downhill through huge pipes called penstocks and across turbines that drive electrical generators.**

**Once the water has passed through the turbines, it ends up in the low reservoir, ready to be pumped back up again when more energy is available. It's a continuous cycle, always ready to store and release electricity whenever it's needed.**

**Pumped hydro facilities can store a massive amount of energy, which is great for balancing out fluctuations in the power grid. Plus, they can respond quickly when there's a sudden surge or drop in demand, providing that extra boost or absorbing excess energy. Unlike hydro electricity generation facilities, which necessarily have to employ dams on river systems, closed loop pumped hydro installations can be located well away from river locations, which means they don’t interfere with those delicate ecosystems. The faster turnover of water also means pumped hydro reservoirs are less prone to stagnation and the commensurate methane emissions that can afflict large hydroelectric installations. They don’t necessarily have to be gargantuan to be useful either. According to the International Hydropower Association, or IHA, a facility with two reservoirs roughly the size of two Olympic swimming pools, and a 500-metre height difference between them, would have an energy capacity of about three and a half megawatt hours. And they last for decades, so they're a long-term solution for our energy storage needs. Pumped hydro is also a mature technology that’s already providing an estimated nine-thousand gigawatt hours of energy globally, representing an amazing ninety four percent of all utility scale energy storage.**

**Until recently though, many energy industry commentators were telling us that pumped hydro was a bit of a busted flush and that all the easily accessible locations had already been exploited, which leads us nicely to some recent research that suggests that assertion may no longer hold water. Eh?...hold water… is brilliant!**

**Over in the states, the National Renewable Energy Laboratory, or NREL used well established Geographic Information Systems, or GIS, to assess potential new closed-loop pumped storage hydropower, or PSH, systems across ALL the states, including Alaska and Hawaii, as well as Puerto Rico.**

**That analysis turned up no fewer than fourteen-thousand-eight-hundred-and-forty-six potential sites with a combined storage capacity of three-point five terawatts that could be discharged over a ten-hour period, providing some thirty-five terawatt-HOURS of energy into the various American grid networks.**

**Unsurprisingly, the areas with the greatest density of lowest-cost sites are in regions that already have naturally occurring elevation differences, like the Rockies, the Cascade Range, and the Alaska Range, which means there’s a pretty big skew towards the western side of the country. You folks in America are really good at pumped hydro. According to the NREL, in twenty-twenty-one it represented twenty-three gigawatts of your country’s total twenty-four gigawatts of energy storage capacity.**

**Peer reviewed studies around the world have suggested that national electricity grids powered by one hundred percent renewable energy could potentially be facilitated by energy storage facilities with as little as five-hour discharge durations, even through northern hemisphere winters. So, pumped hydro, with typical discharge durations of eight to ten hours must surely look like an ideal candidate. The motivation for this latest NREL assessment stems from the fact that no new large PSH facility has been constructed in the United States since the nineteen nineties. The NREL found inconsistent site and cost evaluation methodologies in project applications to the Federal Energy Regulatory Commission or FERC which makes like for like site comparisons and overall assessment extremely difficult. This study is designed to overcome that problem by providing valuable national-scale insights and estimates for a range of long-term development scenarios, specifically for closed-loop pumped hydro installations located well away from riverine ecosystems, taking into account variables like reservoir volume, dam volume, and elevation. Potential sites were then filtered again to eliminate protected locations like national parks and wilderness areas and critical habitat regions, as well as incompatible land use areas like urban conurbations, wetlands, glaciers and permanent ice in Alaska. Then they applied a cost algorithm – because no modern study is complete without an algorithm, is it? That bit of code identified a final data set of the most cost-competitive technical potential systems across the country.**

**The core methodology for the NREL model actually comes from researchers at the Australian National University, which brings us nicely to this interactive map generated by a massive global study carried out by that institution. The ANU found more than six hundred thousand potential sites around the world where closed loop pumped hydro systems could work, at least from a geographical and topographical point of view anyway, representing a potential of about twenty-three million gigawatt hours of energy storage, which would be about a hundred times what we’d need for a one hundred percent renewable powered global electricity system. Now, obviously not all of those sites will turn out to be appropriate, so we need to keep our feet well and true planted on the ground here. The ANU itself points out that, apart from discounting any urban areas and known areas of environmentally protected zones, no other comprehensive geological, hydrological, environmental, or heritage studies were carried out as part of their research project, so it’s highly likely that only a relatively small percentage will prove to be viable. But, even if it’s only one percent, that still gets us over the line, doesn’t it?**

**As a rough rule of thumb, based on analysis in Australia, to achieve a one hundred percent renewable electricity grid, you need about one gigawatt of power for every one million people, plus probably twenty hours of energy storage to give yourself plenty of leeway from the five hours minimum number in the recent studies I mentioned earlier. So that’s twenty gigawatt hours of energy storage per million people in a well-connected high-energy-use country like Aus, with good wind and solar resources. That equates to a total Australian requirement of about five hundred gigawatt hours in a country that has storage potential about three hundred times that number. Applying the same criteria to the USA results in an overall requirement of about seven thousand Gigawatt hours, and the ANU study suggests the States have storage potential about TWO hundred times greater than that.**

**The Australian study also found that the water requirements of a renewable electricity system relying on PV, wind, pumped hydro storage and wide-area transmission is far less than for a corresponding coal-based system, mainly because cooling towers are not needed for renewables. The initial fill of a pumped hydro system does need to be about 20 billion litres per million people, which is not a small amount of water! But unlike a fossil fuelled power plant, that water is retained indefinitely in an off-river, closed-loop, pumped hydro system. There will of course be some seasonal evaporation of water that’ll need to be replaced, but there are several pretty-standard existing evaporation suppression systems that can be used to minimise that problem, which means the volume of water required to replace evaporation is a small fraction of agricultural water use and far less than what gets used in heavily coal-based electricity grids like those in Australia and some parts of the United States.**

**So there seems to be renewed enthusiasm for what is an extremely well established, well understood, relatively simple and environmentally friendly technology.**

**According to the IHA's recent** [**Hydropower Status Report**](https://www.hydropower.org/statusreport)**, total globally installed pumped capacity in twenty twenty one was estimated to be a hundred and sixty seven gigawatts. But the association throws a couple of caveats into the mix as well. They argue that current market regulations and policy frameworks are a disincentive to new developments and that the advantages of pumped storage hydropower are not yet adequately valued in many countries around the world. Those obstacles, say the IHA, are reducing private sector investment and acting as a brake on potential new projects. Nevertheless, there is feverish activity going on in the sector. The IHA provide an interactive map showing the existing sites I mentioned a moment ago. The map also reveals sites already under construction, pretty much all of which are one gigawatt or larger, plus the locations of equally large installations that are in the planning pipeline, AND sites that have been announced for potential commercial development. So, despite the real-world hurdles that developers face, it's already a pretty busy playing field that looks set to become a crucial lynchpin in the transition to one hundred percent renewable electricity without the need for planet-busting quantities of minerals for electrochemical batteries and insane profit-driven antics like deep sea mining that could destroy swathes of marine species that we haven’t even discovered yet. And preventing that from happening would be nice, don’t you think?**

**Well, what do you think in fact? I’m sure you’ve got your views, so 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 literally keep this channel up and running and keep ads and sponsorship messages out of all these videos. None of this would be possible without the support of those amazing people, so if you feel you could contribute to 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. And you would have my eternal gratitude!**

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