**One of the most common questions I get asked by you good folks out there is “what can I do as an individual to reduce my own carbon footprint?”**

**It’s very good question, and nowhere is it more relevant than in your own home.**

**In the United States, households account for more than twenty one percent of the total energy mix. Here in Europe, it’s more than twenty seven percent. So, finding ways to reduce your domestic energy consumption is one of the most impactful actions you can take as part of your contribution towards climate mitigation.**

**We’ve looked at some of the proposed alternatives for household energy generation in previous videos – things like solar PV, ground or air source heat pumps, and even the possibility of hydrogen as a fuel source. All those options look set to become more commonplace as we move towards twenty thirty, and hopefully the more enlightened governments around the world will put in place very healthy incentives and subsidies to help and encourage us all to make the change. A great deal of development work is also being carried out to produce smarter, more efficient household products and systems than can help us all achieve our carbon footprint reduction goals, and one of the most impressive designs I’ve come across in recent months is an intelligent hot water storage system from a UK company called Mixergy.**

**I caught up with the folks at Mixergy recently, to find out how their technology can not only cut down your energy consumption and save you money, but also contribute towards electricity grid stability as we move towards greater reliance on renewable, but intermittent, forms of energy like wind and solar.**

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

**If you’ve got a water storage tank in your house you may well have experienced the frustration of coming home after being away and having to wait ages before you get any hot water through your taps, or perhaps the other delight of stepping into the shower only to find that someone else in the house has used up all the hot water having a nice luxurious bath.**

**One of the many advantages of the Mixergy system is that it only heats up what you need. That means it produces useable hot water about five times faster than a standard tank.**

**Inside the Mixergy cylinder there’s a fairly standard heating coil, transferring heat, in most case from a gas boiler. The difference here is that the coil is at the top instead of the bottom. This means that initially only the top slug of water gets heated up. There’s also an electric immersion heater, which we’ll come back to in a moment.**

**One of the thermal properties of water is that, while its very good at moving heat from a surface via convection, it doesn’t like transferring heat downwards into a colder section of wate by conduction. So, unless there’s some physical mixing or stirring of the hot and cold water in the tank, then the warmer water tends to stay warm and the colder water stays cold. And for the technically minded amongst you, that junction between hot and cold is called the thermocline.**

**So, the coil heats the top section of water to the desired temperature of, say, fifty degrees Celsius. Then a pump starts moving cold water from the bottom of the tank up to the top at a precisely controlled flow rate so that the energy balance of cold water going into the hot section matches the heat input, which then stops the temperature going up any further. If that cold water was pumped straight out of a pipe then the system wouldn’t work, because the water would just sink straight back down to the bottom, taking some of the hot with it through physical churn. So, the cold is transferred into the hot via a diffuser that spreads the water out like a mist, allowing it to very rapidly achieve the same temperature as the hot water.**

**Effectively, the tank is heating from the top down instead of the bottom up, and that clever arrangement results in reduced heat losses. Overall, the Mixergy tank can save up to twenty percent on energy consumption though a combination of those reduced losses and better control of the energy source heating the tank.**

**And as you’d probably expect, there’s a smart app that allows the householder to see exactly how much hot water is available at any given time and operate the heating controls remotely. It even works with voice control via Alexa or Google Assist.**

**But the Mixergy software is also smart enough to learn the patterns of behaviour of the householders, and it uses that information to work out the optimal times to pre heat the tank, which in many cases is best done at night-time using low or even negative tariff electricity rather than gas, which brings us to that electric immersion heating element that I mentioned earlier.**

**This chart shows a typical night-time heating cycle for a Mixergy tank on a flexible energy tariff. Mixergy’s cloud software is constantly talking to the energy supplier, and it can see when the electricity supply price goes negative. Normally this tank would be receiving heat from the system gas boiler, but in this case, between two AM and two thirty AM the consumer is actually being paid a small amount for every unit of electricity they consume, so instead of using gas, the Mixergy system takes advantage of this situation, and starts using that electricity to heat the tank via the immersion heater. Same thing between two thirty AM and three AM. Then the electricity price goes back into positive territory, so the tank stops consuming for half an hour, coming back on again at three thirty AM when the consumer gets paid 1.34 pence for every unit consumed. Another pause at four AM and then a final spurt between four thirty and and five, by which time the water at the top of the tank is well over sixty degrees Celsius. And because of the astonishing level of insulation that modern materials provide, the tank stays very close to that temperature for the rest of the day.**

**That opportunistic use of electricity means the tank is sometimes being paid to heat. Plus you get the benefit of switching between gas and electricity, which is something that will most likely become more and more desirable as the grid decarbonises,**

**But the smart features don’t stop there. Because the Mixergy software is capable of monitoring the frequency and voltage of the electricity supply, it can make the water tank function a bit like a battery, to help stabilise the grid through a mechanism called frequency response. We looked at that in detail in a previous video, and you can click up there somewhere to jump back to that one.**

**In basic terms though, the Transmission System Operator, which in the UK is the National Grid, predicts national energy consumption on a half hourly basis throughout the day and night, and prices are set accordingly to incentivise generators to either turn up or turn down their production during each half hour segment. Once that’s set, it’s pretty much fixed, so if something unexpected happens during a half hour slot that increases or decreases demand, you need to either find extra power, or dump unwanted power. Not enough power could lead to blackouts, and too much power could lead to..you know..blowing up your substation. Which you don’t want! That mechanism corrects any imbalances between supply and demand on a half hourly basis, but other totally unpredictable events can also happen from one moment to the next – things like a power station breaking down or a large surge in wind power that wasn’t forecasted. During those brief events, the grid frequency rises or falls depending on whether there’s a surplus or deficit of power. Because Mixergy tanks can measure that frequency they can respond to those momentary fluctuations, and one of the great benefits of that is that they can help the grid accommodate more renewables on the system**

**Mixergy’s early field trials demonstrated that the vast majority of consumers rarely use more than fifty percent of their water tank’s capacity when measured. That means there’s an opportunity for the grid operators to dump excess energy into Mixergy’s water tanks, very similar to the way that utility scale battery systems are now being used. Mixergy now have just over a thousand of their tanks installed across the UK, providing about one megawatt of frequency response capability. If all the existing water tanks in the UK were converted to this smart technology, then they could provide about a hundred gigawatt hours of storage capacity. That’s more than ten times as much as the UK’s largest pumped hydro facility at Dinorwig, in North Wales. And, unlike batteries, these tanks don’t care about the number of cycles they’re put through either. There’s no degradation in the heating system capacity over time, and if in the unlikely event that an element fails, then it can simply be swapped out without having to replace the tank or any of the other hardware.**

**Mixergy provide a twenty five-year warranty on their tanks, but they expect them to last way longer than that. The tanks can fully heat and discharge up to three times a day, so over a twenty-five year period that’s potentially tens of thousands of cycles.**

**To future proof the technology as we move towards a net zero carbon world in twenty fifty, the tanks have been made compatible with any kind of power source, including rooftop solar PV systems, which can divert excess solar power into the tank instead of exporting it back into the grid, and of course the heat pumps that the UK government are extremely keen for households to adopt over the coming years. The target is for six hundred thousand heat pumps to be installed in UK homes by twenty twenty-eight. Quite how the government intends to subsidise this mass transition away from gas is the subject for a future video, but if they succeed, and hopefully they will, then the Mixergy tank is ready. It has a pre-fitted port that can accept a little plate heat exchanger to allow the system to work seamlessly with this new technology, even if they’ve initially been installed with a gas boiler or electric immersion as their main heat source.**

**Now, a question that you might reasonably ask is how these tanks compare to combi boilers in terms of efficiency for hot water supply, especially as the world moves to greater urbanisation and people transition to smaller living spaces in apartment blocks. Combi boilers don’t use storage tanks. They take water from the mains and pass it across a heating element, in theory to provide instant hot water whenever it’s required. And it works perfectly well, especially for smaller dwellings. But in 2019, Mixergy worked with a research team at Oxford University to conduct a study comparing the working efficiency of a market leading combi boiler and a market leading storage tank from one of their competitors. That study found that the combi boiler was only seventy three percent efficient compared to just over eighty four percent for the storage tank. And in fact, the smarter system in the Mixergy tank actually achieves an efficiency of just over ninety five percent. The reason for that discrepancy between tanks and combi’s is the fact that a lot of the time we consumers turn on the hot tap very briefly, just to wash our hands or rinse a plate or something. When we do that, the combi boiler clicks on and takes a bit of time to get the water flow up to temperature. In fact, sometimes the tap is on so briefly that the boiler doesn’t have enough time to get the water up to full heat. So a lot of energy has been invested just getting the heat exchanger up to temperature, and once the tap is switched off again all that energy just goes up the boiler’s flue and out to fresh air.**

**Other smart technologies are now coming to market too, like heat recovery systems that divert hot shower drainage water back into heat exchange pipes to pre-warm the cold-water supply going into the mixer tap. That means much less hot water is needed from the tank in the first place, which of course means the tanks can be made more compact to fit into smaller spaces in those urban apartments. Mixergy have also experimented with the other option for providing hot water for apartment blocks, which is to have large communal water tanks for the entire building. They recently supplied two ten thousand litre tanks to London’s South Bank University as part of a project exploring the potential of harvesting geothermal energy from an existing aquifer in Central London, and the performance results of that project will be analysed very thoroughly to help inform any future development work.**

**Mixergy aren’t confining themselves to the UK either. They’re working with a very large manufacturer in France to provide systems for the French market. And in July 2021 they’ll be shipping a hundred of their tanks to a holiday resort in Sochi in Russia.**

**Theoretically there’s no reason why this technology couldn’t be employed anywhere in the world, providing household consumers with the benefits of greater efficiency and control over their hot water supply. And that all important frequency response facility has the potential to play a vital role in helping to accelerate the integration of renewable energy sources into the distributed smart grids of the future.**

**If you’re one the thousand or so customers who already have one of these cylinders installed in your home, or if you work in the industry and have some experience of these technologies, then I’d love to hear your feedback in the comments section below.**

**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.**