**Right now, over in the People’s Republic of China, a company called Minyang Smart Energy is busy installing what it claims to be the world’s largest floating wind turbine – with a V-shaped design able to support not one, but two turbines on each platform, giving a total generating capacity of seventeen megawatts.**

**Meanwhile, over in the United States of America, GE already operates the two-hundred and sixty metre tall, fifteen megawatt, Haliade X offshore wind turbine, and is developing its own floating version to go further out to sea.**

**European turbine producers Siemens Gamesa and Vestas have also developed giant offshore turbines with capacities around fifteen megawatts, hundreds of which are in use in the world’s largest wind farms at Dogger Bank off the Northeast Coast of England.**

**And the new UK labour government has just reversed a de facto ban on the installation of ONSHORE wind farms, paving the way for thousands of new turbines over the course of the next decade.**

**This is all good stuff for the so-called green transition of course, and wind power is rapidly becoming a major component of electricity grids in many parts of the world. There is one major wrinkle though. All these behemoth machines have a slightly concerning characteristic in common, which is that their gargantuan blades, some reaching 230 metres in length, are almost impossible to recycle. And that means, as first-generation turbines are starting to reach the end of the operational life, those enormous components are simply being chopped up and tossed straight into landfill sites all over the planet.**

**And that is very definitely NOT what we signed up for when we all collectively decided to start giving a damn about the climate and environment is it?**

**There have been some minor improvements in recycling techniques, to be fair, and shredded blade chippings can now be used in industries like road building for example. But what if the entire industry has been focussing on finding a solution for the wrong problem? That’s what a team at the US National Renewable Energy Laboratory, or NREL. asked themselves. Instead of trying to find ever more complicated ways to recycle existing blades, how about making the blades out of something completely different in the first place, they said – something that can be easily broke down into fully organic components that can be re-used. Better still, something entirely plant-based?**

**What a ridiculous idea I hear you cry.**

**Well, they’ve only gone and on done it anyway, haven’t they?**

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

**Before we get stuck in, I must just let you know about the upcoming Everything Electric Live show in Farnborough in the south of England this October. The Farnborough International Exhibition and Conference Centre is a massive venue with tons of outdoor space, not just to display all the new private AND COMMERCIAL ELECTRIC vehicles that are now flooding onto the market, but also to house some great attractions and safe areas for the kids to run around and have some fun. Inside the conference centre you’ll find all the major suppliers of things like wall chargers, heat pumps, solar panels and battery energy storage solutions with experts on hand to guide you through the process of choosing the best system for your home. I’ll be hosting several live discussion panels there across all three days, so I’ll be around to say hello if you decide to come along. The whole thing kicks off on Friday the eleventh of October and runs through to Sunday the thirteenth. Tickets are available now at the link on screen, and in the description section below, and if you use the exclusive Just Have a Think discount code shown at the BOTTOM of the screen then you’ll get twenty percent off ALL tickets purchased. This one is the biggest event in the Everything Electric UK calendar folks, so I’m really looking forward to it and I hope to see you there!**

**Right, where were we? Turbine blades.**

**You probably know the scoop with these things already, but it’s worth a quick recap anyway.**

**Your typical wind turbine is essentially composed of a tower, a nacelle, which is the thing at the top that houses the gearbox and the generator and all the other mechanical gubbins, and then the rotor blades themselves. Most of the turbine components comprise stuff like steel, copper, and electronics, all of which can be easily recycled using well established and relatively inexpensive technology.**

**But the blades are a nightmare. They have to be light-weight and durable and capable of withstanding the stresses and strains of rotating at speeds of more than two hundred miles an hour at the tips, in conditions ranging from completely benign all the way up to gale force nine. Until recently, the best way to achieve that was to use composite materials like fiberglass-reinforced plastic and carbon fibre, all intricately intertwined and gunked together with high strength resins specifically designed to prevent the blades ever disintegrating. It’s something the science bods describe as a ‘permanently cross-linked thermoset’. That’s fantastic while the blades are in service, but absolutely horrendous when you come to dispose of them. None of it is biodegradable, so they’re not going to break down in those landfill sites. They’re just going to sit there, slowly leaching out their toxic chemicals for decades or even centuries.**

**According to** [**this**](https://www.sciencedirect.com/science/article/abs/pii/S0956053X17300491) **research paper, if we keep making these things in the way we do today then by mid-century we will have discarded something like forty-three million tonnes of turbine blades. Energy-intensive recycling processes like pyrolysis and solvolysis use high temperatures or chemical solvents to break down composite materials, and they produce secondary waste streams that typically require further treatment before final disposal.**

**Some so-called recycling methods like incineration, release harmful chemicals and toxic fumes from the resins and other materials used in blade construction, all of which poses an additional environmental challenge. And at the end of all that, unlike the steel and copper and electronics from other parts of the turbine that can be easily re-used, blade recycling just produces shredded fiberglass, carbon fibre and resin, that often have very limited reuse potential. That means there’s a lack of demand and therefore a lack of revenue for anyone looking to recycle blades for a profit. So, in most cases, the course of least resistance, at least right now anyway, is the dreaded landfill that I mentioned earlier. Anyone who can find a workable solution to that conundrum is therefore likely to become quite popular with the world’s turbine manufacturing community as well as environmentalists concerned about the impacts of blade disposal.Top of Form**

**And I imagine that was a big part of the motivation for the team at NREL. Their research paper, published in August twenty-twenty-four in the online journal Science, outlines a method for the production of what they describe as ‘biomass-derivable thermosets’, or to give the full science-speak description – ‘biomass-derivable polyester covalent adaptable network fibre reinforced composites’, or PECAN FRCs.**

**To normal folks like you and me that means a material made from a combination of, plant remains, discarded used cooking oil, agricultural waste, and sugars extracted from wood.**

**Sounds like a bit of a hotch-potch, doesn’t it? So how have the NREL folks managed to get it to look and work like a turbine blade?**

**Well, the researchers first explained that existing turbine blade resins are typically cured in bulk at about eighty degrees Celsius for five hours. The industry standard material, called RIMR-135 goes through a second heating step at between a hundred and twenty and a hundred and eighty degrees for another two hours, which of course is very energy hungry, and adds a time-consuming extra step to the manufacturing process.**

**So, the NREL team experimented with several different versions of their PECAN composite, each with different proportions of the biomass components I mentioned earlier, to see if they could produce something that could be processed using the same 5-hour, eighty-degree Celsius curing procedure but without the need for the secondary higher temperature step.**

**The detailed science of that work is set out in the paper and is a bit outside the scope of this video to be honest, but the results were extremely encouraging.**

**The best version of their alternative material, which they called Pecan FIFTEEN, was demonstrated to be a direct drop-in replacement for traditional blade materials that can be used in the same enormous, warehouse sized moulds using the same manufacturing techniques in existing production facilities with no adaptations necessary, which of course, is an essential priority for industry adoption.**

**The NREL team built a ten-metre prototype blade and conducted tests designed to simulate twenty years’ worth of exposure to the elements. At the end of all that they were able to demonstrate a PECAN FRC with similar or in some cases even superior performance to existing materials in terms of creep, weathering resistance, and thermomechanical performance.**

**But the big question is, can it be easily recycled?**

**Well, once again there’s some pretty complicated scientific commentary going on in the paper itself, but in terms that I can get my head around, the team put their PECAN FRC into a bath of methanol and heated it up to two hundred and thirty degrees Celsius for about six hours. Now that’s still a pretty energy hungry process of course, but at the end of it they got out a sort of elastic liquid that they found could be fully remoulded into a new shape.**

**Possibly not for new turbine blades, because there may be issues with strength and durability with multiple recycling, but certainly for all sorts of different durable products currently produced by other methods. And that is very definitely not something that can be done with existing blade materials.**

**According to this separate research paper, multiple life-cycle assessments have demonstrated that the second life of a so-called ‘recyclable-by-design polymer’ such as PECAN fifteen can result in thirty to more than ninety percent in material cost and greenhouse gas emissions for the second life of the material.**

**And even greater economies of scale will most likely kick in, just like they do with all new market disruptors, and surely the more forward thinking, rational turbine manufacturers will be able to see the obvious practical, environmental and frankly public relations benefits of producing more easily recyclable and re-useable hardware.**

**So, you know, with continued innovation and investment, probably backed up by some central government subsidy in the short term, we could have a genuine solution to the turbine blade recycling conundrum here. And that has to be an encouraging development, don’t you think?**

**Well, what do you think? Leave your thoughts on the subject in the comments section below, and I’ll be keen to see what the consensus look like.**

**That’s it for this week though. Thanks, as always to the folks who support the channel via Patreon. I don’t monetise my videos on YouTube or take paid sponsorships, so this channel literally would not exist without that amazing group of like-minded souls in all four corners of the globe supporting the work I do each week. If you’d like to join them and discover the exclusive perks you enjoy at my Patreon page, then jump over to Patreon dot com forward slash just have a think. And if you found this video useful and informative then you can hugely support me absolutely for free by hitting the like and subscribe buttons on YouTube and clicking on all notifications. We’re still nudging towards the six hundred thousand subscriber mark at the moment, and it looks like with your help we could get there before the end of the year. It doesn’t cost a penny to subscribe, and it’s just a simple click away, either down there or on that icon there.**

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

**See you next week.**