ESR NEWSLETTER
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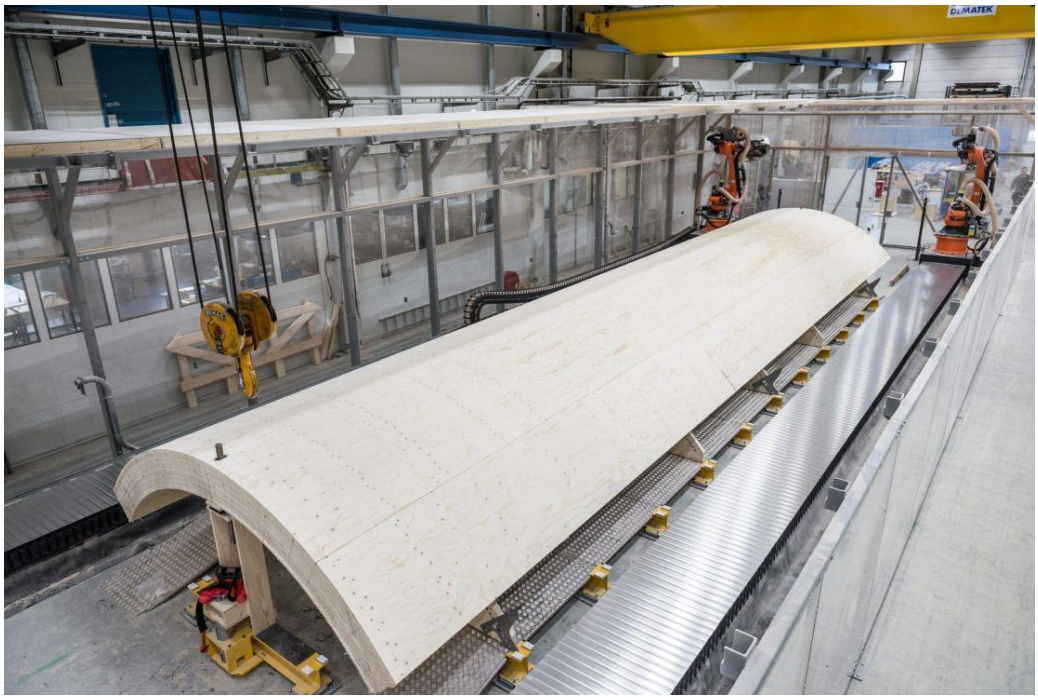
1.Wooden wind turbine towers

From an article by Arya Jyothi, CNN, 10 April 2024

Wind power is vital to help decarbonize the energy industry. However, while the electricity it generates has a small carbon footprint, the towers of conventional wind turbines are predominately made using carbon-intensive materials like steel. Swedish company Modvion believes it has found a greener alternative — building turbine towers from wood. Almost two tons of carbon dioxide are emitted for every ton of steel manufactured, and a modern onshore wind turbine "contains around 120 metric tons of steel per megawatt of capacity," according to industry group WindEurope.

Instead of steel, Modvion uses laminated veneer lumber (LVL), made from multiple layers of wood stuck together with adhesives. The LVL boards are manufactured into modules which are then transported and assembled into cylinders on site, before being stacked on top of each other, and joined with glue, to create a tower.

The company says it uses Scandinavian spruce wood sourced from reforestation-certified sustainably managed northern forests in Sweden, and a typical tower uses between 300 to 1,200 cubic meters of wood.



A wooden tower module being put together.

“Changing the perspective on wood”
Modvion was founded in 2016 by Lundman and architect David Olivegren, and four years later, with some funding from the Swedish Energy Agency, Modvion launched a prototype 30-meter tower on Björkö island, Sweden.

In 2023 the company installed its first commercial two-megawatt unit, a 105-meter-high (345 feet) wooden turbine tower, called Wind of Change, outside Skara, Sweden, for electric utility company Varberg Energi.

Besides the environmental benefits, Lundman says laminated wood has several logistical advantages. Wood has a higher strength per weight than steel, and tall steel towers need extra enforcement to hold their own weight, unlike wooden ones. That means Modvion’s towers can be 30% lighter than a steel one, according to Lundman.

The towers’ modular design means they can be transported using standard trucks and roads, and once the turbine is decommissioned, the wood can be taken down to be reused in the construction industry as high-strength beams. The company says that over time, its towers are cheaper than steel ones, with taller towers giving bigger savings.

Testing the towers
Dr. Abbas Kazemi Amiri, from the Wind Energy and Control Centre at the University of Strathclyde, Glasgow in the UK, who is unrelated to Modvion, says that while wood has significant potential, there are many unknowns about laminated wood that could cause concerns. “Unlike steel, concrete, and synthetic composites, which have undergone extensive mechanical and fatigue testing over decades, this type of novel laminated wood lacks such comprehensive testing,” says Amiri. “Conducting thorough tests in the future will be crucial for the widespread commercialization of wooden towers.”

He adds: “The mechanical properties of wood can change with environmental conditions, potentially impacting the behaviour of wooden towers … Further research is needed to address these uncertainties.”

Lack of existing research and guidelines into the use of wood for giant structures like wind turbines were Modvion’s biggest challenges, says Lundman. “We’re designing our towers that correspond to the standards in both wind power and wood construction,” he explains. “But in wind power standards, wood is not really considered for the towers, it’s mostly steel and concrete. And in the wood construction standards, they don’t really get into the kind of dynamically loaded structure that a wind power machine is. “Hence, we needed to bridge this gap, and we’ve done a lot of testing of all the various parts in our towers to prove by showing in reality how these components work [over the] life of a turbine.”

Modvion towers are coated with a thick, waterproof paint, and like steel towers, they have a lifetime of 25 to 30 years, according to the company.

Currently, Modvion is in the design phase for its first six-megawatt turbine, which will be installed next year. By 2027, it aims to start commercial production of the turbine in a new factory.

2. World’s first wooden wind turbine blades installed in Germany

From Energy Source & Distribution Magazine website, May 3, 2024

German wooden wind turbine blade manufacturer Voodin Blade Technology has announced the world’s first prototype installation of its 19.3m wooden wind turbine blades.

The blades have been installed on an existing wind turbine in Breuna, Germany. Using laminated veneer lumber (LVL) as a material is more sustainable than current materials and enables noticeably better recycling of decommissioned blades, a high level of automation, and more flexibility.

Standard wind turbine blades are made of fibreglass and carbon fibre bound together with epoxy resin—a material that is difficult and expensive to break down. While up to 90% of wind turbines are recyclable, the blades are currently not.

“At the end of their lifecycle, most blades are buried in the ground or incinerated. This means that—at this pace—we will end up with 50 million tonnes of blade material waste by 2050. With our solution, we want to help green energy truly become as green as possible,” Voodin Blade Technology CEO Tom Siekmann explains.

Voodin Blade Technology’s wooden wind turbine blades are made of LVL. Wood is a much more sustainable raw material than the currently used composite materials. The company uses CNC milling machines that are particularly effective in creating complex 3D shapes. This allows for a high level of automation, as no mold is needed in the manufacturing plants.

By increasing the level of automation, the need for labour decreases. As a result, manufacturing does not need to be done in countries with lower labour costs, where it is currently often done. This then means that production is also possible closer to the wind farms, allowing transportation costs and emissions caused by transportation to be reduced.

Furthermore, wood, and especially LVL, are highly durable materials; even more durable than the currently used composite materials. Voodin Blade Technology has conducted laboratory testing to ensure the material will thrive in even the toughest conditions of onshore wind energy production, which takes up approximately 85% of the current wind energy sector.

“We have conducted hundreds of laboratory tests during the past two years to perfect the blade material. According to all our tests, our blades are even more durable than the existing fiberglass blades, as they show fewer fatigue characteristics and are proven to endure all kinds of onshore weather conditions extremely well,” Voodin Blade Technology co-founder Jorge Castillo says. The company is building new prototypes, including bigger 60m and 80m blades, as a next step.

3. Breakthrough could slash cement emissions

From an article by Justin Rowlatt, BBC climate editor @BBCJustinR, 22 May 2024

Scientists say they've found a way to recycle cement from demolished concrete building. Recycling cement would massively reduce its carbon footprint.

The team of scientists, from Cambridge University, has found a neat way to sidestep those emissions. It exploits the fact that you can reactivate used cement by exposing it to high temperatures again.

The chemistry is well-established, and it has been done at scale in cement kilns. The breakthrough is to prove it can be done by piggybacking on the heat generated by another heavy industry – steel recycling. When you recycle steel, you add chemicals that float on the surface of the molten metal to prevent it reacting with the air and creating impurities. This is known as slag.

The Cambridge team spotted the composition of used cement is almost exactly the same as the slag used in electric arc furnaces. They have been trialling the process at a small-scale electric arc furnace at the Materials Processing Institute in Middlesbrough. They are calling it “electric cement” and described the event as a world first. The lead scientist, Cyrille Dunant, told the BBC it could enable the production of zero-carbon cement. “We have shown the high temperatures in the furnace reactivate the old cement and because electric arc furnaces use electricity they can be powered by renewable power, so the entire cement making process is decarbonised.,” he said.

He said it also makes steel recycling less polluting because making the chemicals currently used as slag has a high carbon cost too.

Mark Miodownik, Professor of Materials and Society at University College London, described the way the Cambridge team have combined cement and steel recycling as “genius” and believes, if it can be made to work profitably at scale, it could lead to huge reductions in emissions.

The hope is electric cement will be cheaper to manufacture because it uses what is essentially waste heat from the steel recycling process. Spanish company Celsa will attempt to replicate the process in its full-scale electric arc furnace in Cardiff this week. The Cambridge team estimate, given current rates of steel recycling, their low carbon cement could produce as much as a quarter of UK demand.

But the use of electric arc furnaces is expected to increase in the future, potentially allowing more “electric cement” to be produced. And, of course, the process could be duplicated all over the world, potentially cutting the emissions from cement dramatically.

4. Aussie breakthrough claimed to reduce green hydrogen costs by 40%

From Energy Source & Distribution Magazine website, May 9, 2024

Sunshine Hydro, known for its pioneering Superhybrid technology that enables carbon-free energy, says it has discovered a breakthrough process to substantially lower the cost of producing green hydrogen.

By harnessing the ultra-efficient electrolysers developed by Australian renewable energy manufacturer Hysata, Sunshine Hydro's Superhybrid technology is now capable of delivering clean hydrogen up to 40% cheaper than previously achievable.

Hysata's proprietary electrolysis technology optimises energy consumption, reducing the power needed per kilogram of hydrogen produced by 20%. This breakthrough process raises the bar for the entire sector, ensuring a sustainable and more efficient production pathway.

Sunshine Hydro has separately developed ways of better utilising fast-acting electrolysers, including those developed by Hysata. The Sunshine Hydro technology supports the smooth operation of pumped hydro systems, balancing generation profiles and driving down hydrogen production costs by up to 20%, depending on seasonal patterns.

Achieving 24/7 carbon-free electricity requires the application of pumped hydro energy storage as part of the mix. To provide grids with round-the-clock and seasonal energy to power data centres, industry, and other power-demanding applications, a hydrogen electrolyser can be matched with pumped hydro turbines in such a way that they support the variable load even though needed using renewable energy sources.

Six years of extensive research at Sunshine Hydro reveal the indispensable role of hydrogen electrolysers in supplying continuous, carbon-free electricity. Importantly, the solution is designed to respond flexibly to energy market conditions. During peak periods when prices surge, energy can be temporarily redirected from hydrogen production to meet market demand.

Sunshine Hydro's innovative approach yields up to a 20% reduction in hydrogen production costs. Coupled with Hysata's efficient electrolysers, cumulative cost reductions reach up to 40%. By pairing these advancements with clean energy generation, these two Australian

innovations are poised to transform its energy landscape and play a crucial role in the nation's green energy and industry independence.

5. New catalyst could advance green hydrogen production

From Energy Source & Distribution Magazine, August 9, 2024

A team of Australian and Japanese scientists has developed an effective catalyst with the remarkable ability to enhance the efficiency of ammonia conversion, which could significantly advance wastewater treatment, green nitrite and nitrate, as well as hydrogen production.

Catalysts are substances that speed up chemical reactions by providing a more efficient route for a reaction to occur and making it easier to start and finish. Since catalysts are neither consumed nor altered in the reaction, they can be used repeatedly, and they are essential in a variety of industrial, environmental, and biochemical processes.

The team, which included researchers from Hokkaido University, the University of Technology Sydney (UTS) and elsewhere, developed the catalyst, called NiOOH-Ni, by combining nickel (Ni) with nickel oxyhydroxide.

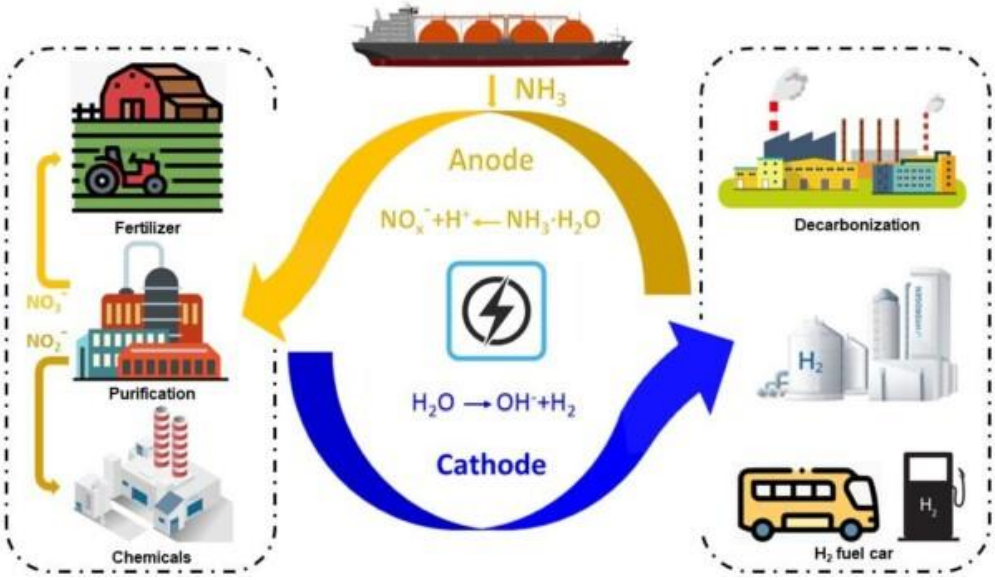
The researchers developed NiOOH-Ni using an electrochemical process. Nickel foam, a porous material, was treated with an electrical current while immersed in a chemical solution. This treatment resulted in the formation of nickel oxyhydroxide particles on the foam's surface.

Despite their irregular and non-crystalline structure, these nickel-oxygen particles significantly enhance ammonia conversion efficiency. The catalyst's design allows it to operate effectively at lower voltages and higher currents than traditional catalysts.

"NiOOH-Ni works better than Ni foam, and the reaction pathway depends on the amount of electricity (voltage) used," explains Professor Zhenguo Huang from the University of Technology Sydney, who led the study. "At lower voltages, NiOOH-Ni produces nitrite, while at higher voltages, it generates nitrate."

This means the catalyst can be used in different ways depending on what is needed. For example, it can be used to clean wastewater by converting ammonia into less harmful substances. But in another process, it can also be used to produce hydrogen gas, a clean fuel. This flexibility makes

NiOOH-Ni valuable for various applications.



Electrolysis of ammonia aqueous solution produces nitrite and nitrate on the NiOOH-Ni anode, and green hydrogen on the Ni2P-Ni cathode. This presents advantages over the currently used thermal ammonia cracking due to the simultaneous formation of hydrogen as an energy carrier and nitrite and nitrate as valuable chemicals under ambient conditions. (Hanwen Liu, et al. Advanced Energy Materials. August 7, 2024)

“NiOOH-Ni is impressively durable and stable, and it works well even after being used multiple times,” says Associate Professor Andrey Lyalin from Hokkaido University, who was involved in the study. “This makes it a great alternative to traditional, more expensive catalysts like platinum, which aren’t as effective at converting ammonia.”

The study has been published in *Advanced Energy Materials*.

6. Big truckmakers bet on hydrogen to extend combustion engine life

Extracts from an article Christina Amann and Nick Carey, Reuters website, Berlin/London, 1 August 2024

Some of the world's biggest truckmakers, including Volvo and MAN, are reworking combustion engines to run on low-emission hydrogen instead of polluting diesel, a quicker low-cost fix to their energy transition challenge that may give the dying technology a fresh lease of life.

The global truck making industry faces a complex balancing act to get to zero emissions. Electric batteries are too heavy for long-haul freight

operations and take long to charge. Using hydrogen fuel cells to generate electricity reduces the weight and extends the range of trucks, but switching to this technology is expensive as companies need to design new truck systems.

That is why truckmakers and their suppliers have shifted their immediate focus on developing hydrogen combustion engines as a quicker, cheaper solution that can rely on existing manufacturing lines that have for years been a key economic motor for countries like Germany, executives at major truck brands and their suppliers told Reuters. Concerns over what will happen to thousands of jobs in engine-making plants have grown as truckmakers shift towards battery and fuel cell options.

Truckmakers are still investing in developing hydrogen fuel cells as they say there is room for both technologies to exist side by side for different vehicle types and uses.

In its first pilot project, MAN will deliver around 200 trucks with engines that run on hydrogen to European customers next year to test in their fleets, a key step on the way towards mass production.

Swedish truckmaker Volvo AB , which says it will also have hydrogen fuel cell trucks "commercially available in the second half of this decade," is planning customer tests of hydrogen combustion engine models starting in 2026. Hydrogen combustion engines "will not be the majority" of Volvo's sales, said chief technology officer Lars Stenqvist. "But it will be a substantial volume."

Anders Johansson, vice president for heavy-duty vehicles at Vancouver-based Westport Fuel Systems , said his company has already provided fuelling systems for 6,000 combustion engine trucks in Europe that run on natural gas or biogas and can easily be adapted to hydrogen. Westport's engine system currently uses 1% diesel to ignite hydrogen, which Johansson said will be reduced and eventually replaced with a carbon-free fuel.

Even though the technology is relatively mature, there are challenges to overcome. Unlike fuel cells, burning hydrogen in an engine can produce some harmful emissions that Michael Krueger, senior vice president for engineering at major supplier Bosch said will require a filter.

Also, hydrogen trucks need pressurized tanks that are larger than the ones used for diesel, so firms like Munich-based startup Keyou are working on different shapes to shrink them down. And the tanks need to be safe under all conditions as hydrogen is a highly flammable gas.

By far the largest problem for hydrogen combustion engines and fuel cells alike is the scant availability of green hydrogen. The European Union and the United States are funding green hydrogen projects alongside truck makers like Daimler and energy giants like BP. But the rollout has been slow, and it will take years to build up sufficient fuelling infrastructure.

Despite the challenges, major suppliers like Bosch and Cummins say truck makers have embraced the hydrogen combustion engine because they already have factories and supply chains dedicated to the technology.

Rather than leave truck fleets waiting for green hydrogen to become widely available, some truckmakers and suppliers say combustion engines running on natural gas or biogas can provide an interim, lower-emission solution than diesel.

Cummins' Wood said making a hydrogen combustion engine involves changing some key components in its natural gas models, which will allow customers to work their "way down the carbon emissions curve", from diesel to natural gas then hydrogen.

As well as being an easier switch for manufacturers, trucks running on combustion engines will be easier for fleet customers to handle in the medium term than fuel cell models because it's a technology they are familiar with, Wood said.

7. Denmark’s measures to reduce methane emissions

7.1 Cattle feed additive

From The Cattle Site, 15 April 2024

Denmark has agreed to help farmers finance a feed additive that is expected to reduce methane emissions from cattle by up to 30%, as part of efforts to meet ambitious climate goals, Reuters reported.

Denmark, a major dairy exporter, could become the first country in the world to price agricultural emissions, including methane emissions from burping cows, a move that has broad political backing. The country has pledged to reduce emissions by 70% by 2030 compared to 1990 levels.

More than half of Denmark's land is farmed, with agriculture accounting for about a third of the country's carbon emissions, according to Danish climate think tank Concito.

Farming has not yet been subject to any climate regulations, but the industry has expressed concerns that a carbon tax would force them to reduce production and close farms. Instead, farmers and the dairy industry have advocated the use of additives that stop the fermentation process inside the cows' stomach, preventing the production of methane.

The government set aside 518 million Danish crowns (US$74 million) to finance the feed additive, which is expected to reduce methane emissions from the country's roughly 550,000 dairy cows by 30% in 2030.

Such additives have been met with scepticism from Danish politicians and animal welfare groups, as it is still unclear whether it would meet Danish animal welfare standards.

7.2 Proposed tax on livestock emissions

Extracts from Nature Biotechnology, volume 42, page1161 (August 2024)

Denmark is taking aim at agricultural practices and land use, backed by $1.4 billion from the Novo Nordisk Foundation. The so-called Green Denmark agreement between the Danish government, conservation groups, and agricultural and industrial sectors, launched in June, plans to facilitate a reorganization of land usage across the country to promote natural ecosystems and biodiversity. The Green Transition Plan includes a tax on livestock emissions — relevant as Denmark is a major producer and exporter of dairy, pork and young pigs — that would cost farmers around $95 per year per dairy cow, with rebates for those who follow climate-efficient practices.

Denmark is ramping up other initiatives to make its agricultural sector more sustainable and boost crop resilience to climate change. A crop-improvement project led by Eske Willerslev, an evolutionary geneticist based at the Universities of Copenhagen and Cambridge, UK, will receive $83 million from the Novo Nordisk Foundation and the London-based Wellcome Trust to focus on environmental DNA —DNA fragments left by ancient organisms and isolated from sediments. The aim is to learn how ancestral crops, which had much more genetic diversity than modern varieties, adapted to past environmental challenges.

Meanwhile, Novo Holdings, the investment company of the Novo Nordisk Foundation, has acquired a 25% share of Sejet Plant Breeding, an agricultural company that develops crops including wheat, barley and maize (corn). The partnership will invest in technologies such as CRISPR-based editing to speed crop development for climate resilience and disease resistance. Although EU regulations currently limit the use of genomic

techniques in farming, the European Parliament earlier this year voted to lessen the regulatory oversight of crops created through gene editing.

8.Oceans face ‘triple threat’ of extreme heat, oxygen loss and acidification

From an article by Oliver Milman, Guardian website, 5 Jun 2024

The world’s oceans are facing a “triple threat” of extreme heating, a loss of oxygen and acidification, with extreme conditions becoming far more intense in recent decades and placing enormous stress upon the planet’s panoply of marine life, new research has found.

About a fifth of the world’s ocean surface is particularly vulnerable to the three threats hitting at once, spurred by human activity such as the burning of fossil fuels and deforestation, the study found. In the top 300 meters of affected ocean, these compound events now last three times longer and are six times more intense than they were in the early 1960s, the research states.

The study’s lead author warned that the world’s oceans were already being pushed into an extreme new state because of the climate crisis. “The impacts of this have already been seen and felt,” said Joel Wong, a researcher at ETH Zurich, who cited the well-known example of the heat “blob” that has caused the die-off of marine life in the Pacific Ocean. “Intense extreme events like these are likely to happen again in the future and will disrupt marine ecosystems and fisheries around the world,” he added.

The research, published in AGU Advances, analyzed occurrences of extreme heat, deoxygenation and acidification and found that such extreme events can last for as long as 30 days, with the tropics and the north Pacific particularly affected by the compounding threats.

Climate scientists have been alarmed by the relentless onward rise of heat in the ocean, which has hit extraordinary heights in recent months. “The heat has been literally off the charts, it’s been astonishing to see,” said Andrea Dutton, a geologist and climate scientist at the University of Wisconsin–Madison, who was not involved in the new research. “We can’t fully explain the temperatures we are seeing in the Atlantic, for example, which is part of the reason why hurricane season is such a concern this year. It’s quite frightening.”

But on top of the heat, which forces fish and other species to move, if they are able, to more suitable climes, the oceans are also paying another heavy

price for soaking up huge volumes of heat and carbon dioxide from fossil fuel emissions that would otherwise further warm the atmosphere for people on land. The extra CO_2 is making seawater more acidic, dissolving the shells of marine creatures, as well as starving the ocean of oxygen.

“This means that marine life is being squeezed out of places it is able to survive,” said Dutton. “This paper makes clear that this is happening now and that these compound threats will push organisms past their tipping points. People have to recognize that oceans have been buffering us from the amount of heat we have been feeling on land as humans, but that this hasn’t been without consequence.”

Ross Rutherford

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