**Back in late 2018 the Intergovernmental Panel on Climate Change released their Special Report outlining just how badly our species has messed up when it comes to human induced Carbon Dioxide emissions warming our atmosphere. They showed us the now infamous ‘business as usual’ pathway that we were following back then and are still, unfortunately, following today, despite the pause caused by the global pandemic. That pathway takes us to something like four degrees Celsius of warming above pre-industrial levels. I’ve talked about the consequences of that in quite a few previous videos, and they’re not pretty. Extreme weather, sea level rise, food shortages, famine and floods, disease and regional conflicts resulting in millions of premature deaths and millions more climate refugees, not to mention wholesale species extinctions around the world.**

**The report also showed the alternative path that we need to move onto if we want to keep the global atmosphere from warming by more than two degrees Celsius above pre-industrial levels. And that pathway doesn’t just show that we need to reduce the amount of carbon dioxide we emit through our day to day activities, it actually tells us we need to draw more CO2 out of the atmosphere than we put in. In other words, we need to reach negative emissions by 2050 at the latest. In fact according to the UNEP Emissions Gap report, the world needs to be actively removing eight billion tons of CO2 from the atmosphere every year by then.**

**Most people in our apparently enlightened modern world would probably say the solutions are to ‘stop using fossil fuels’, ‘eat less meat’ and ‘plant more trees’. All of those are perfectly valid suggestions, but none of them are changing at anything like a fast-enough rate to make any appreciable difference to the catastrophe we’re all facing in the coming decades.**

**But there is a fast-growing move towards technologies that can capture and utilise carbon dioxide in ways that lock it up in products, and buildings and infrastructure for years or decades or possibly even centuries. It’s a whole new sector called Carbontech, and one of the most promising breakthoughs in that sector is a process that actually captures carbon dioxide in one of the most widely used building materials on the planet.**

**And that material is of course, concrete.**

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

**Now you might be asking what on earth has concrete got to do with global warming? After all, it’s not made from fossil fuels, so what’s the problem.**

**Well let’s get straight down to it and look at how it IS made.**

**The basic ingredient of concrete is cement, which gets churned up with water, sand and aggregates to make the stuff we see all around us in our modern-day infrastructure.**

**The current method of making cement, or Portland Cement to give it it’s full name, is to grind up limestone, which is calcium carbonate, with materials like clay, slate, silica sand and iron ore and chuck it all into a massive rotating kiln at something like fifteen hundred degrees Celsius.**

**The kiln is tilted at an angle, and as the mixture goes from the higher end to the lower end various elements are driven out to form a new substance at the bottom end called clinker, which comes out of the kiln as little grey balls about the size of marbles. A small amount of gypsum and limestone gets added in with the marbles and then they all get ground up to a powder so fine that it can actually pass through a sieve capable of holding water. That powder is Portland Cement, and it’s literally become the foundation of our modern society. The trouble is, here’s what the chemical reaction inside the kiln looks like**

**5CaCO3 + 2SiO2 —> (3CaO,SiO2) + (2CaO,SiO2) + 5CO2**

**That might not mean a great deal to you but check out the far-right hand side of the equation and you can see that one of the major products is carbon dioxide. In fact, for every metric ton of cement produced one metric ton of CO2 goes up into the atmosphere. And the world uses fours billion tons of concrete every year.**

**And then there’s the fossil fuels like powdered coal, that you have to burn at ferocious temperatures to get the kiln hot enough to melt limestone. Which of course results in even more CO2 emissions.**

**All of that means that the cement industry alone accounts for eight percent of total greenhouse gas emissions. That’s more than twice as impactful as the global aviation industry.**

**All industrialised countries use cement of course, as is so perfectly illustrated by this world map that you can find at the website Our World in Data dot org, so no country is blameless, but looking at their data chart, there is one very clear winner, and it’s our friends over in China.**

**So, cement is a problem, and it’s a problem that’s been well understood for decades. In fact since the nineteen nineties a whole new material category has been developing. It’s known as Green Cement and there are several varieties. Geopolymer cement was developed by a French material scientist called Joseph Davidovits using rocks that eliminate the need to break down calcium carbonate, and with a chemical reaction that takes place at only half the temperature, resulting in a claimed eighty percent reduction in CO2 emissions. Another approach has been something called Magnesium Oxychloride Cement or MOC, made from powdered magnesium oxide and a concentrated solution of magnesium chloride. The reaction is claimed to be carbon neutral but the end product is corrosive to steel, so it can’t be used in construction. It is used for certain interior surfaces though, like floors in public buildings. Then there’s Calcium Sulfoaluminate Cement which reduces energy consumption by twenty five percent and carbon emissions by twenty percent. It sets rock hard within 24 hours and it’s often used in the construction of runways and bridges.**

**But even after several decades of development, green cement still only accounts for just over three percent of all concrete usage around the world.**

**And that’s really because there just hasn’t been any economic or regulatory incentive for cement producers to invest in expensive new machinery when their current equipment still works. Or for construction companies to pay a premium for a more environmentally friendly building material.**

**That dynamic may now be starting to change though, with the introduction of cement technologies that use CARBON DIOXIDE as one of the baked in ingredients of the process rather than one of the exhaust gases.**

**There are several companies trying to grab a share of a potentially very lucrative market. They all capture CO2, but they all come at the problem from different angles.**

**CarbonCure uses CO₂ sourced from industrial emitters. Established gas suppliers collect, purify and distribute the CO₂ to concrete sites in pressurized tanks that can be regularly refilled, just like your soda stream cannister at home. CarbonCure’s technology then injects the recycled CO2 into fresh concrete where it undergoes a mineralization process and becomes permanently embedded. That locks up the CO2 and also increases the concrete’s compressive strength. They claim fifteen kilograms of CO2 can be saved for every cubic metre of poured concrete, and between fifteen and twenty three kilos in precast components.**

**Carbicrete’s technology enables the production of high-quality concrete using mineral waste and CO2 as raw materials. Using a process they called carbonation activation, they eliminate the need for cement in concrete altogether by replacing it in the mix with ground steel slag, a by-product of the steel-making industry. The concrete mix is poured into moulds just like conventional concrete and is then cured using CO2. That curing process solidifies the CO2 and binds it together with the steel slag granules, which gives the concrete its strength. It’s currently limited to pre-cast slabs and components though – it can’t yet be used with poured concrete. Nevertheless, they claim to capture about two kilograms of CO2 in a standard size concrete block.**

**Blue Planet’s technology uses CO2 as a raw material for making carbonate rocks. The rocks are then used INSTEAD of quarried limestone. The CO2 is taken from industrial flue gases and converted to a carbonate by immersion in a water-based solution. Blue Planet reckon that differentiates them from most CO2 capture methods because there’s no need for a purification step, which is an energy and capital-intensive process. The carbonated solution is then used to form a synthetic limestone coating around rock particles to make aggregates ranging from sand-sized to gravel-sized, which they claim to be the most effective way to achieve carbon neutral – or even carbon negative – concrete. In strength, performance and cost, Blue Planet say their CO2-Sequesterd Aggregate is equivalent to standard quarried aggregates and every ton captures four hundred and forty kilograms of carbon dioxide.**

**They also have a facility to upcycle aggregate from demolished concrete that they put through a calcium extraction process. These so-called reformation steps result in an upcycled aggregate that’s harder than virgin aggregates, and while it doesn’t directly sequester CO2, it offers significant benefit compared to virgin aggregate by adding recycled content value, which does at least avoid the CO2 emissions related to mining and transportation.**

**Solidia is a start-up company based in New Jersey.**

**They produce cement in traditional cement kilns using similar limestone and sand raw materials but with a ratio of fifty, fifty instead of two thirds to one third. Solidia say that allows them to run the reaction at a much lower temperature which in turn reduces greenhouse gas emissions from the heating fuels by as much as forty percent. And the process uses about thirty percent less energy too, so there’s a cost saving built in. And as an extra bonus, Solidia’s recipe produces more cement from the same amount of raw material.**

**Their process of curing the cement into concrete involves injecting carbon dioxide into the cement aggregate mix inside a drying chamber instead of mixing it all up with water like traditional concretes. That has a huge additional advantage of reducing the reaction time from a week or more down to only twenty four hours. As the mix goes off it traps the CO2 in the structure of the final product. The overall effect of the cement and curing processes is a reduction in CO2 emissions of up to seventy percent. And of course, if the industry can find a way to provide the energy for these processes from renewable sources, then carbon neutral or even carbon negative results may be achievable.**

**And let’s not overlook that point about not using water in the curing process by the way. The concrete industry uses about three trillion litres of fresh water every year. In areas of water scarcity like India, China, the Middle East and even California, concrete production represents a very impactful use of a very precious resource. Solidia’s process would liberate that water so that it could be put to use in other ways.**

**The technology is currently limited to producing pre-cast blocks in specialised facilities currently operating in North America and Europe, but Solidia say they’re developing commercial processes for reinforced applications like aerated concrete, railroad ties, architectural panels, and hollow core extrusions. And perhaps most importantly, they’re now working with some of the largest concrete suppliers in the industry to test their system with ready mix pouring concrete, which is still by far the most widely used form of concrete worldwide.**

**CO2 is already being captured from ambient air by companies like Carbon Engineering and Climeworks, and it’s also possible to capture it directly from the smokestacks of power plants and industrial manufacturers, but there’s currently not a huge amount you can do with it to make any money. And when push comes to shove, commercial enterprises are only really driven by money, whatever they might say about their green credentials. In fairness to Climeworks, they are genuinely sequestering CO2 by pumping it down into the basalt rocks of Iceland, but the volumes are currently very small. Carbon Engineering markets itself as a green carbon neutral company, but they use the Carbon Dioxide they capture from the air to recreate hydrocarbon fuels which of course release CO2 back into the atmosphere as soon as they’re burned, so it’s hard to see how that will really facilitate the radical changes needed to limit atmospheric warming.**

**Very few large power plants or industrial companies capture the carbon dioxide they produce at their smokestacks either, because it adds about twenty percent to the cost of their operations. Ironically, where it does get captured, at least in the United States, it’s often used by big oil companies who inject the gas at huge pressure into depleted seams to displace the final hard to reach pockets of oil and drive it up to the surface, leaving the CO2 down underground. That increases the efficiency of the seam and ramps up the company’s revenue and profits. The oil gets burned and releases carbon dioxide back into the atmosphere, more or less negating the volume of gas that got pumped underground, and the icing on the cake for the oil company is that under the US government’s carbon capture incentive program known as FORTY FIVE Q, they get a massive tax break for apparently sequestering CO2. According to the think tank Carbon 180, a large coal-fired power plant that was able to capture and use ninety percent of its emissions could generate nearly three billion dollars in savings over its lifetime.**

**So, if carbon-cured concretes were embraced on a global scale then there’d be a much bigger market for captured CO2, which would make smokestack and direct air capture technologies more economically attractive, which in turn would significantly drive down CO2 emissions from the construction industry.**

**Cynics will no doubt suggest that this is precisely the reason why a company like Solidia received seed funding from the Oil and Gas Climate Initiative, which has big oil companies like Shell, BP and Total as members. Those fossil fuel giants see the benefit of putting their CO2 emissions to some kind of use that might get them off the hook with governments and investors, which in turn would enable them to keep digging the black stuff out of the ground for a much longer time.**

**That may be true, but big oil already faces a pretty big existential challenge from a rapidly growing renewables industry so it’s not clear that even these extra tax breaks, which by the way would come on top of the 5 trillion dollars of global government incentives they already receive, will make a huge amount of difference to their fate.**

**If big industrial CO2 producers and carbon capture companies like Carbon Engineering and Climeworks can be properly incentivised to divert their CO2 into carbon cure concrete instead of using it for enhanced oil recovery or reconverting it into hydrocarbons, then we might just be stumbling upon a good solution. We’re certainly pushing at an open door in the construction industry, which has long been acutely aware of it’s appalling carbon footprint. In September the Global Cement and Concrete Association launched its 2050 Climate Ambition program with a pledge to deliver completely carbon neutral concrete by 2050 by increasing efficiencies, using alternative fuel sources and by embracing carbon capture technologies.**

**Now I know there’s a growing argument for far greater use of timber framed designs in the construction industry, which can fix carbon into the structure of buildings for decades, and it’s also highly likely that carbon sequestration in our SOILS via systems like Regenerative Agriculture, rewilding and reforestation will also need to play a key role in the urgent carbon drawdown challenge we face over the coming decades. Those are topics we’ve covered in previous videos on this channel and we will most certainly be returning to them in future programs. But whether we like it or not, today’s construction industry is set up and organised to use massive quantities of concrete in the majority of major building developments and civil engineering projects, so if they can be provided with a low carbon or even carbon negative alternative, then that must surely be a positive development.**

**If you’ve got strong views on this one, or if you have direct industry knowledge or experience, then dive down to the comments section below and share your thoughts there.**

**That’s it for this week though.**

**Thanks as ever to the channel supporters over at Patreon for keeping us independent and ad free. And I must just give a shout out to some new people who’ve joined since last time with pledges of ten dollars or more a month. They are:**

**Tom Aminikharrazi**

**Harry Eakins**

**Raymond Leury**

**Brigs Porter**

**AJ Siegel**

**Andy Hunt**

**Isa Farnik**

**Laura Flavell**

**Dennis Young**

**Mike Doughty**

**David Philpott**

**and**

**The How to Dad ( check out his You Tube channel by the way – it’s really good)**

**And of course, thanks to everyone else who’s joined since last time too.**

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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**