**If I said the word Hemp to you, I wonder what image it would conjure up in your mind?**

**I guess it could mean many different things, depending on your own life experiences.**

**As you probably know, Hemp is a variety of the cannabis sativa plant. It grows pretty rampantly, very much like a weed, which is probably why some people call it… weed!**

**But to associate it only with that particular ‘recreational activity’ is to do it a severe disservice. Hemp is in fact an extremely useful and versatile plant. It can grow in all sorts of soils and climates with little or no need for pesticides or fertilizers. We humans have been using it to make fabrics for thousands of years. It’s six times as strong as cotton and much, much less environmentally impactful to grow.**

**Our English king, Henry the Eighth, actually made hemp cultivation mandatory during his reign in the sixteenth century. Not because he was particularly partial to a nice long evening chill out session (he was more of a chicken drumsticks and mead kind of a guy) but because the fibres in hemp made extremely good quality ropes, and that was very handy for the rigging on all his ships.**

**During the latter half of the twentieth century, the whole “it’s made of cannabis” thing convinced successive governments to look less favourably on the humble hemp plant, even though the variety grown for non-drug applications contains low or even negligible levels of the psychoactive THC component that seems to terrify some legislators so much.**

**Now though, Hemp is staging a bit of a comeback. Along with bamboo, it’s one of the fastest growing plants on the planet, and that makes it an extremely good candidate for rapidly capturing carbon back out of our atmosphere.**

**The challenge is where to grow it without destroying already existing ecosystems and biodiversity – that’s a lesson the world has learnt through bitter experience with crops like corn, soybeans and sugarcane to name just a few.**

**So how about this for a concept…build a big hydroponic crop growing warehouse on an industrial estate somewhere, a bit like the vertical farms we’ve all seen in the news recently, only instead of lettuce and kale, grow hundreds of tons of hemp and then use it to make useful things that capture the carbon content permanently?**

**Sounds like a plan doesn’t it?**

**And that’s exactly the mission currently being pursued by a Florida based company called Carbotura. So, the question is – can hemp become a trailblazer for the twenty first century carbon capture program that’ll be essential to keeping our global atmospheric temperature below 1.5 degrees Celsius?**

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

**Regular viewers will know that we’ve talked about carbon capture and sequestration, or CCS several times on this channel. Pulling carbon dioxide back out of the atmosphere is, according to the IPCC and most other climate scientists, the only way we stand any chance of stopping our global atmospheric temperature reaching existentially dangerous levels.**

**But exactly how we achieve that goal has become a very contentious issue. Carbon capture from the exhaust stacks of factories, and coal and gas fired power stations, adds about twenty percent to the cost of operating those plants, so it really hasn’t been widely adopted. Bioenergy and carbon capture, or BECCS, is disputed by many environmental groups as a true carbon capture method, at least in it’s current form, because when the fuels are burnt they release CO2 straight back into the atmosphere faster than the replacement crops can pull it back out again, and the change in land use required to grow those crops impacts heavily on indigenous plants and animals. Direct Air Capture, which uses mechanical fans to suck air across a chemical concoction that reacts with the CO2 to remove it, is also looking somewhat fanciful. It’s pretty expensive, and we would literally need millions of facilities all over the planet to get anywhere close to offsetting the forty gigatons of CO2 that modern human activity currently spews out.**

**So, the concept of hydroponically growing hemp in huge, closed-loop systems on brownfield sites, looks like it really could play a genuinely important role in contributing towards the carbon capture challenge.**

**Carbotura is an environmentally focussed company operating within a group called Gravitas Infinitum. The fundamental basis of the operation is something that Carbotura refer to as a Direct Carbon Sequestration System, or DCS. And those big warehouse style units that’ll house the production facilities are called High Density Biofactories or HDBFs.**

**The HDBFs will vary in size from 30,000 to 100,000 square feet, depending on the location, and in basic terms, the process works like this…**

**Just like a vertical farm, thousands of hydroponic growing trays will be populated with seeds – in this case hemp seeds- and stacked up in warehouse style racking systems. Carbon dioxide will be pulled out of the atmospheric air by the plants during photosynthesis. A pumped irrigation system will deliver about 400 litres of water to each pallet location every three hours, which, in the largest facilities, equates to nearly sixty million litres per day. Sounds like a terrible drain on precious water supplies doesn’t it? But here’s the first of many benefits of the system. That water is continuously recycled as part of the closed loop cycle, so the overall usage is very low relative to the production throughput quantities. And the system has the potential to contribute towards cleaning up the contents of wastewater ponds called stacks, which are currently a very problematic biproduct of the phosphate mining industry in Florida and many other locations throughout the United States and wider world. Phosphate is a component of agricultural fertilizers, so it’s mined in vast industrial quantities. If those phosphate ponds are not carefully managed, they can contaminate local water systems with disastrous consequences, as was so graphically demonstrated by the evacuation of hundreds of residents in Manatee County, Florida over the Easter weekend in 2021, when water levels in phosphogypsum waste stacks threatened to overwhelm their containment walls and send a tidal wave of contaminated water into peoples’ homes.**

**But to the hemp plants in the biofactories, that wastewater represents a rich source of nutrients that can be used by the plants’ root systems to accelerate growth. The hemp effectively acts like a biofilter, and after about forty or fifty circulation cycles over a four or five day period, the water coming out of the process will be clean enough to be assessed by local environmental agencies for potential return back into local lakes and river systems.**

**A large HDBF facility will house up to 38 million hemp plants, with about 600,000 plants being harvested every day.**

**That enormous volume of carbon rich biomass will then be fed into something called a microwave plasma pyrolysis system. This is an existing technology, normally used for the conversion of solid waste materials into useable fuels. Essentially, it’s a very sophisticated industrial scale oven, arranged in a tall stack, with the capacity to process a thousand kilograms of biomass every hour. The system produces different outputs at different points in the combustion process. At the top of the stack, synthetic gas is drawn off, cleaned, condensed, and stored. Then, at the next level down, heavier oils come out, which again are condensed and stored. Both those fuels will be used to drive a turbine providing all the power for the factory’s working systems, and the exhaust gases can even be diverted back into the initial combustion process to ensure the maximum amount of CO2 is captured.**

**The product coming out at the bottom of the stack is biochar. That’s a commercial product in its own right that’s rapidly gaining popularity in many applications, not least as a soil additive to help deliver large quantities of carbon back into the earth. But it also provides the feedstock for two other far more commercially valuable commodities: graphene and industrial diamonds.**

**The biochar is fed into a second chamber where oxygen has been replaced by argon gas. That prevents the carbon in the biochar from oxidising. Inside the chamber is a 200kW pulsed plasma reactor, again an existing technology used in various industrial processes. The reactor converts the biochar into a product that Carbotura have now trademarked as Bio-Graphene TM which, according to Carbotura, is the highest purity, and lowest cost graphene available on the market.**

**The same plasma equipment can also make industrial diamonds using another existing process called CHEMICAL VAPOUR DEPOSITION or CVD. Essentially a copper or steel plate is seeded with microscopic fragments of an existing diamond. The plates are then flooded with high carbon-atom atmospheres, again in a deoxygenated environment, so instead of oxidising, the carbon atoms crystalise around the diamond seeds, taking on the same shape and form, growing the diamond layer by layer. That gives you a product worth something like $100,000 per ton, that can be used for things like drill tips and tunnel boring machines.**

**Further down the line, the plan is to diversify the initial raw material feedstocks by setting up separate microwave plasma pyrolysis systems for solid waste materials and waste plastics.**

**The pyrolysis process dismantles the materials down to a molecular level, potentially producing a vast array of end products, including bioplastics, each of which has its own commercial value.**

**But graphene is the focal point for the first phase of the business. That’s where the economics stack up most favourably for Carbotura. And of course, graphene is predicted to become a pretty ubiquitous material for all sorts of industries in the future.**

**Unlike the fossil fuel industry, this carbon capture process has none of the upfront costs for discovery and exploration or extraction of materials. In fact, once waste materials and plastics are introduced alongside hemp production as feed stocks, Carbotura will actually be getting paid a tippage fee of between $35 and $65 per ton to take the waste away.**

**Both the main hemp biomass and the supply of waste materials are effectively unlimited too. Because it’s grown inside a closed loop system in an industrial facility, there’s no negative impact from the hemp production on existing ecosystems or biodiversity. And, as for the solid waste and plastic…well, the more of that that gets used in processes like these, the less of it is available for land fill, which can only be a good thing.**

**According to Carbotura, each large HDBF facility will be capable of capturing about 44,000 tons of carbon dioxide per year which is not only a net benefit to our warming atmosphere, but also yet another revenue stream thanks to current US incentives for CO2 capture, including carbon sequestration credits of about $20 per ton and a federal tax credit called 45Q worth $32 for every ton of CO2 sequestered. And of course, the price of carbon and carbon credits is only going to increase over the coming years as efforts to reduce atmospheric CO2 levels accelerate all over the world.**

**The Direct Carbon Sequestration System has won Selected Project status with the US Department of Energy, and Carbotura are in the final stages of securing funding for the first round of construction, is scheduled to start in South-West Florida later this year.**

**There’s no doubt this is a very ambitious and ground-breaking initiative. You could also argue that it’s yet to become a proven technology, and that might feel a little intimidating to some investors. But projects like this, and others that are in development elsewhere in the world, are precisely the kind of thing that will be required on a massive global scale if the challenge of removing billions of tons of carbon dioxide from our atmosphere stands any chance of succeeding.**

**And I know I’m starting to sound like a broken record here, but it’s always worth reminding ourselves that these pioneering companies also represent the future employment opportunities for our kids and grandkids.**

**This is quite a complex concept at first glance – it certainly took me some time to properly understand all the elements at work here. And no doubt it will provoke some strong reactions one way or another from you folks out there, so if you do have constructive and objective feedback that you’d like to share, then jump down to the comments section below, and leave your thoughts there.**

**That’s it for this week though. We’re taking a short break next week, so there’ll be no video on Sunday 27th, but I’ll be back in my regular slot on Sunday 4th July, which I’m given to believe is a date of some significance to our friends in America!**

**As always, my thanks go to the Patreon supporters who allow me to remain completely independent and help me to keep all these videos ad free.**

**And I must just give a quick shout out to the folks who’ve joined since last time with pledges of ten dollars or more a month. They are**

**Javier Dominguez**

**Alfred Berkeley**

**Lark Cyphron**

**Peter Ross**

**Matthew Hunt**

**Jeff Rinck**

**Lemmi B**

**Mark Giese**

**Ranjiv Sandhu**

**Jessica Feinleib**

**And**

**Rogelio Blanco**

**And of course, a big thank you to everyone else whose joined since last time too.**

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**And you can really support the channel by subscribing and hitting that like button and notification bell.**

**It’s dead easy to do all that, you just need to click 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.**