**According to the International Energy Agency, our global leaders have three quite specific blind spots when it comes to the international effort to reduce our global carbon footprint. The first of the three is trucks, which the IEA tell us are the largest consumer of diesel on the planet, guzzling up about half the total global demand and spewing out 7% of all annual CO2 emissions. The second blind spot is cooling, in other words air conditioning. The IEA projects a tripling of global energy demand up to 2050 just from air conditioning units alone, and if, like me, you find it hard to compute exactly how much energy that would be, well the IEA have worked it out for us. It’s equivalent to the total amount of power consumed today by India and China combined.**

**I’ll be taking a deep dive into both of those challenges in future programmes, but this week I’m taking a look at the third of the three blind spots identified by the International Energy Agency…**

**Petrochemicals.**

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

**We’ve all heard of petrochemicals. They are, unsurprisingly, chemicals derived from petroleum, which is of course a fossil fuel.**

**But it’s worth reminding ourselves just how ubiquitous they’ve become. They’re in, like, well almost everything really.**

**In our homes they’re in the insulation in the walls, the plastic pipes in our plumbing systems, the textiles in our living rooms and much of the synthetic clothing we wear. They’re in the electronics in our computers and the food packaging and storage in our kitchens. Plastics are of course a massive driver of petrochemical demand, as this IEA chart of the largest consuming countries shows us pretty clearly. The growth of plastics since 1970 has been pretty astonishing. Here’s another IEA chart showing us that from then until the present day, aluminium, steel and cement have all grown roughly in line with global gross domestic product, with cement out pacing the curve more than the others. But when we overlay the growth line for plastics we get a pretty good idea of the extent of the problem.**

**Then of course there’s pharmaceuticals, cosmetics and perfumes. All derived from petrochemicals. And 50% of all the food we eat is grown using synthetic nitrogen fertilizers, also derived from petrochemicals. And even some food additives and flavourings are made from petroleum derivatives.**

**We all know about petroleum FUELS for TRANSPORT of course – they’re a different subject altogether, but petroCHEMICALS find their way into vehicles too in the form of engine components like batteries, lubricants and coolants and in the interior fittings like dashboards upholstery and luggage compartments. Even rubber tyres have petrochemicals in them. An average tyre uses seven kilograms of oil in its production.**

**All in all, the IEA estimates that thirteen million barrels of oil PER DAY are currently used just for petrochemical production.**

**That equates to four million tons of CO2 EVERY DAY or nearly 1.5 billion tons every year either emitted directly from things like fertilizers or perfumes or at the end of life of plastics and synthetic clothing, when they often end up being incinerated.**

**If we stay on our current ‘business as usual’ trajectory, then by 2050 that number is predicted to rise to twenty million barrels a day and more than two billion tons of CO2 per year.**

**And while stricter measures are being put in place to help alleviate air pollution, it’s not that easy to do the same with CO2 emissions. And just look at the impact on our rivers and seas. Water pollution from petrochemical production is set to almost double in severity in the next 3 decades unless rapid action is taken.**

**So, as part of the global push towards a carbon neutral future, there’s a bit of a race on around the world to develop alternatives to petroleum-based chemicals and establish a firm foothold in what looks like becoming yet another multi-billion dollar sustainable industry to replace the rapidly fading oil, gas and coal giants.**

**The products are known as Bio-based chemicals and they’re generally derived from plants instead of crude oil.**

**Many of the useful molecules in fossil fuels are derived from molecules that existed in ancient trees and plants. And those same molecules exist in modern day trees and plants as well. The trick is finding a way to extract them and make them into something useful.**

**Now you might already be screaming “what about land use” at me, and we WILL have a think about that a bit later on but, first of all, let’s have a look at some of the main bio-based chemical contenders that are aiming to disrupt the established petrochemical industry.**

**Up first is polylactic acid which can be produced by the fermentation of starch or sugar. That means it can be derived from a range of crops including potatoes, corn, cassava plants and sugar cane.**

**What you get from the process is a biodegradable polyester that can replace the plastics currently used in packaging, automotive parts and textile fibres. There’s also an application for them as a replacement coating for medicines and medical screws which are used in certain operations and which stay inside the body once the op is finished.**

**And more recently, PLA has attracted great interest from the cosmetics industry as a replacement for the dreaded microplastic beads in creams, shampoos and skin exfoliants.**

**The PLA market was already worth about 1.2 billion US dollars in 2018 and it’s projected to grow to about 3.4 billion in the next five years.**

**Next up is the wonderfully named Furandicarboxylic Acid, or FDCA. This stuff’s been around since 1876 when it was first synthesized by a chemist called Rudolf Fittig using a concoction of Mucic acid and Hydrobromic acid. But it never got ramped up into industrial scale production. Modern chemistry has found a way to synthesize FDCA from fructose, which itself can now be chemically derived from starchy crops like corn. The big selling point for this bio-based chemical is that it outperforms the gas barrier function currently served by Polyethylene Terephthelate, or PET. That gas barrier function is what keeps fizzy drinks fizzy and its why almost all plastic soda bottles today are made from PET.**

**Two of world’s largest chemical manufacturers, DuPont and BASF are both now producing new polymers from FDCA derived from fructose. BASF, and have teamed up with a renewable chemical company called Avantium in a joint venture called Synvina, to produce what they call polyethylenefuranoate or PEF.**

**DuPont’s version of the polymer is called polytrimethylene furandicarboxylate, or PTF. Both companies face stiff competition though if they want to disrupt the global plastic bottling industry. PET itself is made by combining the two petrochemicals ethylene glycol and terepthalic acid. Some firms have now started deriving the ethylene glycol component from fermented sugar, and that’s enabled the world’s largest plastic bottle consumer, Coca Cola, to market something called the PlantBottle, which sounds like it’s entirely plant based but in reality is only about 30% bioplastic. In fairness to Coca Cola, they do say they’re committed to reaching 100 percent as soon as possible though by investing in technologies like those being developed at DuPont and BASF, so there is potentially a very bright future for FDCA products.**

**Then comes Levoglucosenone or LGO. This stuff is derived from cellulose which is found in all plant cell walls. The process has been developed by an Australian company called Circa in conjunction with The Green Chemistry Centre of Excellence at York University in the UK, headed up by Professor James Clark. Circa have been using their proprietary Furacell technology since 2006 to produce LGO from waste materials like saw dust and biowaste from food production. Professor Clark brought an extra level of experience and chemical knowledge to play which resulted in a new LGO derivative called Cyrene, which acts as a solvent for all sorts of secondary applications. Solvents are used in a wide range of manufacturing processes, but of course most of them are made from petrochemicals. Some of them are also are highly toxic and stay that way after they’ve been disposed of, so even if they’re buried deep underground, they can still cause lasting damage. Cyrene is entirely plant based and completely non-toxic and it’s growing a pretty healthy portfolio of sustainable products including bio-solvents, food flavourings and bio-polymers for pharmaceutical, agricultural, and clean technology companies.**

**Now, if you’re a parent, you most likely have some experience of nappies or diapers, and unless you’re committed to the daily ritual of boil washing terry towelling, you most likely use the disposable kind. And THEY are filled with something called superabsorbent polymers or SAPs. I’m sure you don’t need me to point out what function they perform, but suffice to say – you guessed it, they come from petrochemicals.**

**Itaconic Acid is produced through the fermentation of glucose and it can replace ACRYLIC acid for applications that need to USE superabsorbent polymers. It can also be made into something called unsaturated polyester resins or UPRs, which can be used in pipes and high-performance marine and automotive components. A start up in the United States called Itaconix is a leading developer of the technology. They’ve partnered with some big industry names like Nouryon, Croda and Solvay to produce a pretty wide variety of products using Itaconic acid, including replacements for phosphates in detergents, water soluble odour neutralizers, and 100% bio-based hair styling ingredients. The technology is at a relatively early stage in its development but potentially it opens up access to an existing ten-billion dollar industry which today is heavily reliant on petrochemicals.**

**And then there’s lignin, which is a natural polymer that you’ll find in a tree. An average tree is made up of about 40 percent cellulose, and fifteen percent Hemicellulose which are glued together by the remaining twenty five percent lignin. Our modern global paper industry converts hundreds of millions of tons of wood into paper each year using mainly the cellulose.**

**But in the process the Hemicellulose and Lignin become very difficult to break apart, and that’s a shame because the lignin polymer has massive potential to do the work that many petrochemical polymers do today. So, until recently lignin has been little more than an inconvenient by-product of the wood and paper processing industries, disposed of either by burning or sending to landfill**.

**Unsurprisingly then, research teams and commercial companies around the world have been looking for methods to economically separate the lignin out into a useable form.**

**One of those organisations is called Liberate. They’ve developed an electrochemical depolymerisation process to convert the lignins in wood and straw into flavourings, antioxidants and polyamides.**

**The University of Delaware in the United States are also using the process of depolymerization to break down the lignin and then build it back up in a form that can recreate petrochemical-based adhesives, and specifically a sector of that market called pressure sensitive adhesives, or PSAs, which as the name suggests are the ones that can bond two surfaces more strongly as you press them together more firmly. It’s a pretty big market too – worth about thirteen billion US dollars.**

**Professor of Chemical and Biomolecular Engineering at Delaware, Thomas Epps, explains**

**“We can use the same separation, purification, polymerization, and characterization methods to make these materials as they use to make the current commercial, petroleum-based, analogues, but we can get better properties, and we can use a much greener source.”**

**The team claim their tape performs on par with Fisherbrand labelling tape and Scotch Magic Tape, and their ambition is to rejuvenate the paper industry by enabling companies to sell their waste lignin to adhesive manufacturers rather than tossing it into the fire or sending it to the local landfill site.**

**Now, the elephant in the room, as I mentioned at the start of the video, is land use. The real danger with these otherwise wonderful transformational technologies is that in our rush to maximise commercialization and profit, we forget to implement sustainable land management programmes to grow the feedstocks. We already have far too many examples of rich forestry land containing delicate ecosystems being ploughed up to make way for monoculture plantations that rapidly destroy the biodiversity and remove all the nutrients from otherwise fertile soils. It’s not just the well-publicised palm oil plantations of Indonesia or the sugar cane and soy crops in places like Brazil. Biomass is a perfect example of an industry that started life in the Unites States as a smart and efficient way to utilise the piles of saw dust created by the timberyards but which has ended up with vast monoculture plantations across the southern states producing trees that are grown specifically for the purpose of being pulped into pellets to be shipped across the Atlantic for burning in European power stations instead of coal, so that countries like the United Kingdom can pretend they’re meeting their carbon reduction targets.**

**I guess it’s yet another reminder of how careful we need to be as a species not to go diving headlong into what appear to be better solutions that are more friendly to our climate and environment without ensuring that they don’t themselves end up having similar consequences. I know that’s a subject that many of you are quite passionate about so I’ll be interested to read your thoughts in the comments section below.**

**Thanks to those of you that downloaded the app since last week by the way. If you haven’t already sampled it, you can get it by typing just have a think into the search bar at the Apple store or Google Play. It’s completely free and it keeps you up to date with all the latest news and articles on the climate and sustainable technology. And while you’re at it, why not have a quick look at the new website too at**

[**www.justhaveathink.com**](http://www.justhaveathink.com)

**Now, some of you regular viewers may be wondering about the new addition to the shelves behind me.**

**This portrait was sent in by Glen Underhay from Australia. Gooday Glen.**

**Glen says he was watching a recent video with his young daughter sitting on his lap doodling away with paper and colour pencils. By the end of the video she had produced this masterpiece, which I think you’ll agree is a pretty good likeness. So that’s gonna get pride of place back here from now on.**

**I must also say a big thank you to our amazing supporters over at Patreon who allow me to keep the channel ad-free and maintain independent content. And a special shout out to the folks who've joined since last time with pledges of ten dollars or more a month.**

**They are**

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**And**

**Matt Fisher**

**and of course a big thank you to everyone else who's joined since last week 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**