**In August twenty twenty-one the Intergovernmental Panel on Climate Change, or IPCC released their latest assessment of the state of the climate, and if you saw the news reports about it at the time, or perhaps watched the review video on this channel, then you’ll know that it didn’t paint a particular bright or uplifting picture.**

**In fact, the environmental breakdowns and their interconnected consequences appear to be so entrenched and advanced that it’d be easy to become quite despondent about what the future holds.**

**The most urgent question now, at least for any rational person, is not whether climate change is a real phenomenon– that debate is long since settled, except in the minds of a delusional minority. No, the most urgent question is - what exactly can we do to wrestle back some semblance of equilibrium in our earth systems and avoid the worst of the existential threats that we now face?**

**And in that respect, I’m reminded of the old adage about putting ten economists in a room and coming out with eleven different opinions.**

**There does seem to be a similar thing going on in the rapidly expanding global discussion space that is the ‘climate solutions debate’. There are now so many different and often competing ideas, that we risk diluting the focus of our policymakers and getting nothing ultimately useful done at all.**

**But in the midst of that somewhat discombobulating cacophony, there is some genuinely well researched and robust analysis, with properly considered and costed proposals. One of the best examples comes from an organisation called RethinkX who’ve been correctly predicting the rapid arc of progress in renewable energy for over a decade now.**

**Their latest analysis was also published in August twenty twenty-one, and it’s called Rethinking Climate Change. So, let’s take a look.**

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

**RethinkX are an independent, non-profit think tank that analyse and forecast the speed and scale of technology-driven disruption and its implications across society.**

**I’m acutely aware that many people watching this channel believe very strongly that it’s precisely the wreckless and misguided over use of technology that has got us into this mess in the first place, and I’m bound to say that I’ve got quite a lot of sympathy for that point of view. So, in an effort to encourage the sceptics among you to continue watching rather than throwing your breakfast at the screen and switching off in disgust, I’m gonna jump straight to the middle of the report to show you this chart, showing the projected percentage contribution towards decarbonisation that RethinkX say each action in their analysis will produce. We’ll come back to the chart in more detail in a moment, but if we just quickly scan across to the right-hand side you can see that passive reforestation is actually the single biggest decarbonisation factor in their projections, accounting for a twenty percent reduction in emissions, which is double the contribution that they’re predicting from changes in road transport for example.**

**In fact, the report states quite categorically**

**“Governments, communities and interest groups must therefore begin planning today to take advantage of the enormous opportunities for conservation, rewilding and ecological restoration that will emerge in the twenty twenties and twenty thirties”**

**One of the biggest barriers that we humans face in the climate challenge, according to the report’s authors, is a mindset that overlooks the non-linear nature, speed and dynamics of change in both earth systems and human systems. We’re conditioned to tackle problems as linear processes that we can set out nicely in an Excel spreadsheet, but when it comes to technological disruptions, history is littered with examples of long periods of technological stability punctuated by abrupt systemic transformations that often trigger rapid economic and social transformation. Kodaks unfortunate experience with digital film is a very famous example of an incumbent operator that failed to understand the non-linearity of disruptive technologies. Another example is this plot of predicted growth in renewable energy in a twenty fourteen climate assessment report from the IPCC. Starting at nineteen ninety they drew a more or less straight line that suggested it would take until twenty-one hundred for renewables to reach ten thousand terawatt hours of electricity generation which by then would represent just four percent of the world’s total energy capacity. But in reality, technologies like wind and solar have seen exponential growth and a precipitous fall in costs which have put them on course to hit that number by twenty thirty – seventy years sooner than the IPCC predicted.**

**Those market transformations happen as a result of the virtuous and vicious cycles that disruptive technologies always create. As the new technology drops quickly in cost, it gains increasing public acceptance, which drives better capability, economies of scale and variety of choice for the consumer. That means ever increasing demand which prompts more investment, higher margins and higher revenues that allow the producers to increase their supply to meet that demand.**

**Meanwhile, back at the ranch, metaphorically and literally, the old technology is seeing reduced demand, higher costs and a reverse economy of scale, leading to lower revenues, lower margins and reduced investment.**

**Those two cycles are feedback loops. And they’re not linear. They’re exponential.**

**To provide a range of projected technological adoption rates, Rethink X have produced three scenarios, the fastest of which they call Get Serious, with a middle road called Get Sensible and an exercise in collective societal foot shooting called Get Stuck.**

**So, let’s dive in and have a look at the three key sectors outlined in the RethinkX report, starting with energy.**

**Solar photovoltaics, onshore wind and lithium-ion batteries, or SWB will unsurprisingly be the biggest disruptors here. In fact, they’re already doing it, according to the data in this analysis. The report found that SWB already outcompetes conventional power generation and will displace fossil fuel and conventional nuclear power during the twenty twenties, just based on economics and market forces.**

**Since twenty-ten, Solar PV costs have fallen by more than eighty percent, onshore wind by more than forty-five percent and lithium-ion batteries by almost ninety percent. Those cost curves are ongoing and predictable so we can say with confidence that prices will continue to drop still further in the coming years.**

**A big sticking point here in the mindsets of policymakers, investors, civic leaders, and the general public is the misconception that solar PV and wind power won’t be able to supply a hundred percent of our electricity needs without weeks’ worth of battery energy storage.**

**What we’re all missing, according to RethinkX, is the fact that future solar and wind generating capacity will greatly exceed the total electricity generating capacity installed today. It’s a phenomenon that the reports authors refer to as Clean Energy Super Power. Their argument is that because the generating capacity of SWB systems will need to be large enough to get us through the dark and miserable months of northern hemisphere winters, during the other nine months of the year they’ll be massively over producing power – far more than we can use, and at very close to zero marginal cost. And when things get that cheap, people start finding ways to use them more and more, just like we did with the internet for example, only in this time it won’t be for booking more holidays or watching dodgy videos about cats doing silly things and humans doing naughty things, it’ll be used to replace a whole bunch of previously carbon intensive stuff like water desalination, road transportation, residential and commercial heating and cooling, waste management and industrial and chemical processes.**

**And unlike large, centralised fossil fuel and nuclear power plants, or hydropower facilities, operators will be able to install solar panels and batteries virtually anywhere. That’ll lead to the localization, decentralization, and democratization of energy production. That’ll be a good thing to have even in a rich western nations, but once it’s rolled out in the developing nations, many of which are in the mid latitudes where the sun shines far more consistently throughout the year, it could drastically reduce poverty and equity gaps by leapfrogging over existing technological barriers.**

**The second key sector is transport.**

**We all know about electric vehicles nowadays, so it probably won’t surprise you to learn that they play a big role in this section of the report. If you apply the same adoption curve to EVs as happened to pretty much every other disruptive technology in the last couple of centuries then you find that by the late 2020s, all new vehicles produced will be electric, as the powerful market feedback loops force the manufacturing of internal combustion engine vehicles to collapse.**

**But that’s only phase one of the disruptions that RethinkX are projecting. Phase two, they predict, will be even more transformative, as the economics of autonomous electric vehicles, or A-EVs bring about the widespread adoption of transportation as a service, or TaaS. In other words, we’ll stop owning our own private vehicles and simply call up an autonomous vehicle via an app whenever we need one, and it’ll pull up at the kerb side next to us within a few minutes.**

**You might think all that sounds like fanciful science fiction, but the report points out that the operating costs of EVs are already lower than internal combustion engine vehicles, and even their initial costs are now rapidly approaching parity.**

**And because electric drivetrains can last over a million miles under heavy usage like freight and ride-hailing, where vehicles are in service most of the day, the cost per mile of transport will plunge as the cost of the vehicle is spread over a vastly lengthened lifetime. Even without autonomous technology, EVs are already on track to make on-demand transportation cheaper than internal combustion engine vehicles. Once autonomous technology removes the labour cost of ride services, the cost-per-mile for TaaS will be ten times cheaper than privately-owned vehicles today. That’s not some sort of exercise in idealistic speculation, it’s just basic arithmetic.**

**But what will happen to the livelihoods of all those taxi and truck drivers I hear you ask – well, that’s an extremely important question of course, and one that we’ll touch on a bit later.**

**Roads aren’t the only way that people and goods get around though. Short haul flights currently make up about a third of greenhouse gas emissions from commercial aviation. That sector will be similarly disrupted by a combination of electric aircraft and overnight road trips in the newly adopted Autonomous EVs. Emissions from shipping will drop significantly too. Not just as a result of the electrification of the ships themselves, but also because of a massive drop in the demand for commodities. The largest categories of freight including crude oil, oil products, coal, natural gas, iron ore, steel, cars, grain, and livestock will all see demand plummet as a result of the three disruptions outlined in this report.**

**Which brings us nicely to the third, and arguably most contentious of the three key sectors – Food.**

**There are two innovations here that might currently feel quite uncomfortable to talk about, but which are nevertheless already on the tell-tale downward cost curve of disruptive technologies.**

**They’re precision fermentation, which enables the programming of micro-organisms to produce complex organic molecules like proteins, and cellular agriculture which is the production of meat from cell cultures. Collectively they referred to as PFCA.**

**The trajectory of the cost curve shows that PFCA will be making protein products five times cheaper than existing animal protein by twenty thirty and ten times cheaper by twenty thirty-five. The report’s authors tell us that the precision with which proteins and other complex organic molecules will be produced will mean safer, more consistent, and higher quality foods available in a far wider variety than the animal-derived products they replace. Again, the simple economics of the disruption will be overwhelming. The research shows that precision fermentation foods will be as much as a hundred times more land efficient, ten to twenty-five times more feedstock efficient, twenty times more time efficient, and ten times more water efficient.**

**But it won’t just be direct, one-for-one substitution of end products like burgers. Pretty much any product that we currently extract from animals will be replaced by superior, cheaper, cleaner, and tastier alternatives, triggering what the RethinkX team refer to as ‘a death spiral of increasing prices, decreasing demand, and reversing economies of scale for the livestock and seafood industries.’**

**Today, animal agriculture consumes three point three billion hectares of land in the form of pasture and feed cropland. The disruption of these industries will free up eighty percent of that land. That’s an area the size of the United States, China, and Australia combined.**

**So, now is probably a good time to go back to that first chart I showed you right at the start of the video. Because it’s that staggering transformation in land availability that will lead to the unprecedented opportunity for conservation, rewilding, and reforestation that’s reflected in the huge emissions reduction figure on the right-hand side, essentially just by doing nothing and letting nature regenerate the land on its own.**

**It’s just one example of what the research team refer to as the cascading effects of disruptive technologies that lead to some big surprises. This isn’t some new pseudo-science dreamt up by the authors of the report either, it’s based on solid data derived from multiple historical examples. Let’s take the automobile for instance. It didn’t just replace the horse and carriage, it created entirely new markets and business models based on previously unmet needs, generating trillions of dollars in additional value as a result. It was the same story with electricity, personal computers, the internet and smart phones, all of which totally disrupted existing markets and created new systems, new benefits, and of course in many cases new hazards, like a massive increase in the greenhouse gas emissions that these NEWER market disruptors are aiming to reverse.**

**This chart is a bit busy at first sight, I grant you, but what it shows us is that because energy, transportation and food are fundamental, foundational sectors in human society, their disruption will also have the knock-on effect of disrupting all other secondary sectors, just like the older technologies I just mentioned. But this time they’ll be generating all sorts of benefits and opportunities for further emissions reductions and environmental restoration.**

**So, with just three disruptions in key sectors, RethinkX project that we humans can eliminate ninety percent of net greenhouse gas emissions globally by twenty-thirty five, largely because the technologies we need to achieve that goal all exist today and are either ready to deploy to market or are already deployed and can be scaled up immediately. And we won’t need governments to impose draconian restrictions and austerity measures either because the new technologies will just be better and cheaper than the old ones.**

**It’s easy to assume that reducing greenhouse gas emissions will be prohibitively expensive. It’s an argument you’ll often hear from folks with vested interests in incumbent monopolistic industries like fossil fuels, big pharmaceuticals and agribusinesses.**

**In fact, the data in this report show completely the opposite and suggest that sheltering those industries would in fact be a multi-trillion-dollar mistake. Anyone investing in those older technologies today risks losing most, if not all of their money on assets that will become stranded in the next decade as a result of the basic market forces that the new disruptive technologies will activate.**

**If governments need to intervene at all, then it’ll be to play the vital role of protecting the hard-working people who are going to lose their livelihoods in those older industries. They will need financial support as well as priority retraining and re-employment in the new industries of the future, so that societies can be well placed to take advantage of these new disruptions as they accelerate.**

**And as a final caveat, the report reminds us that although new technology paired with market forces is, in their view, the most realistic option for achieving net zero emissions as soon as possible, the world cannot afford to be complacent. They point out that unless societies make the right choices, we could significantly slow down these key sector disruptions, which in turn would dangerously delay the achievement of net zero and push us past the thresholds for tipping points in our planetary systems that would lead to catastrophic consequences.**

**So, you know, just one or two things to have a think about there!**

**I will of course leave a link to the full report in the description section of this video, and I imagine many of you will have a great deal to say one way or the other about it’s contents and conclusions, so if you do then jump down to the comments section below and leave your thoughts there. And if you can make them constructive and reasonably polite then all the better, eh?**

**That’s it for this week.**

**As always, a big thank you to the folks at Patreon who keep these videos completely independent and add free, and I must give a shout out to the folks who’ve joined recently with pledges of ten dollars or more a month. They are**

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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.**