**So, I’m guessing that by know we all know the mantra trotted out by organisations like the IPCC, the IEA and the United Nations, telling us we need to roughly halve our CO2 emissions by twenty thirty and reach Net Zero by twenty-fifty if we want to keep our planet’s average surface temperature within safe limits.**

**What seems to be slightly less well-established is exactly how on earth we’re going to achieve those goals. The answer we get from the data driven scientists is to rapidly remove the root cause of the problem. That means dropping coal like a hot stone for a start. It also means canning any NEW oil and gas exploration projects, embarking upon the long and arduous process of removing combustible hydrocarbons from the petrochemical refining process, and eliminating methane emissions from energy supply chains and production facilities.**

**The answer we get from the fossil fuel industry is that doing what I’ve just described would result in the disintegration of civilisation as we know it. What we should do instead, they tell us, is to continue producing combustible hydrocarbons, but bolt on some devices that can capture the resultant greenhouse gases and store them permanently somewhere underground.**

**It's tricky, isn’t it?**

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

**You know me folks…I do like a statistic. So, here’s a nice juicy one to get us warmed up.**

**According to analysis carried out by an organisation called Oil Change International, almost sixty percent of the fossil fuels within already operating or under-construction extraction sites cannot now be burned in an unabated way if the world is to stay within the one-point-five-degree limit. That’s before you even start discussing the wisdom of the global scale exploration for new oil and gas fields that the fossil fuel industry is still very enthusiastically engaged in.**

**And if you don’t feel like believing the data contained in that particular analysis, then you can always fall back on the good old International Energy Agency, which arrives at a similarly stark conclusion, as I quoted in a recent video…**

**“NO new oil and gas [find quote from previous video]**

**So, are we going to prevent the burning of sixty percent of fossil fuels that already exist in currently operating or under-construction extraction sites?**

**I mean, based on recent performance, it seems unlikely, doesn’t it?**

**So, what about this idea of capturing the greenhouse gas emissions from all those fossil fuels instead then? The so-called Carbon Capture and Storage, or CCS technology.**

**Well, as luck would have it, a team of researchers from the Oxford Smith School of Enterprise and the Environment spent quite a lot of time in twenty-twenty-three sorting through a truly eye-watering tangle of variables to produce a comprehensive cost-benefit analysis on several carbon capture scenarios based on socio-economic projections in what are known as Integrated Assessment Models, or IAMs, that can be found in the periodic reports published by the Intergovernmental Panel on Climate Change, or IPCC.**

**The researchers on this paper were not driven by any kind of political ideology or moral judgement though. They simply asked a single pragmatic question :**

**‘Is it likely to be cheaper for humanity to get to one-point-five degrees Celsius on a CCS-heavy or a CCS-light trajectory?’**

**Carbon capture and storage, or CCS technology has actually been known about since the nineteen twenties, and yet, today there are only forty-one full-scale commercially operational CCS projects operating anywhere in the world. And twenty-nine of them exist purely to facilitate Enhanced Oil Recovery, or EOR, supported very generously in the United States by the way, by a federal tax break called 45Q which gives the oil companies about twenty dollars for every tonne of carbon dioxide they sequester underground, rising to thirty-five dollars per tonne by twenty-twenty-six.**

**And no fewer than nine of the eleven NEW CCS projects that came online between twenty-twenty-two and twenty-twenty-three are also specifically geared towards EOR.**

**Follow the money, as they say.**

**The IPCC’s Sixth Assessment report broadly lumps CCS into the same two categories that the authors of this paper use. In other words, we either get to net zero by relying on a massive amount of CCS and not bothering too much with renewables, OR we get to net zero with a massive amount of renewables and restrict CCS only to essential industries like steel making where it's pretty much unavoidable.**

**Working out how much each of these options might actually cost in the coming years turns out to be an extremely complicated job.**

**For a start, it depends on the process and the processing facility. Basic CO2 and hydrogen sulphide scrubbers are already factored into the cost structure at many gas processing plants for example, so the on-costs of CCS here would probably only be applicable to the additional transport and storage stages.**

**By contrast, in heavy industries like steel making where CCS technology is not currently used in most cases, adding the whole shebang as a bunch of bolt-on machinery to existing plant could, according to this research, make up as much as seventy to ninety percent of the total process costs.**

**Plus, the overall cost of a given capture facility varies massively depending on the CONCENTRATION of carbon dioxide entering the machine and therefore how hard it has to work to deal with it.**

**And comparisons between those Enhanced Oil Recovery plants, that only capture as much CO2 as they need to winkle out their precious black gold, and prospective NEW carbon capture and storage projects dedicated to grabbing every last CO2 molecule and dealing with it responsibly, are extremely difficult to make using a level playing field because the parameters and variables are just completely different.**

**Many existing facilities have been financed by governments or oil companies as demonstration projects, which typically means they only have to show that the technology works in principle and don’t necessarily have to try too hard to find efficiencies and cost savings. So, their data might not be truly indicative either.**

**So, the research team trawled through years and years’ worth of academic literature to compile some kind of coherent comparisons. One of the key themes that started to emerge from that research was that those IPCC Integrated Assessment Models, or IAMS that I mentioned earlier, appear to have been underestimating the cost of CCS and overestimating the likelihood of technological advancements. They were kind of assuming that CCS would follow those lovely cost reduction curves that we’ve seen in the last decade or so for technologies like wind and solar. But CCS technology has been around for decades now, and the cost has so far remained stubbornly static. The IPCC models also assumed that new facilities would be clustered together, conveniently close to each to each other in order to achieve huge savings in transport costs –projecting something like ten dollars per tonne instead of the current real-world numbers that can be as much as forty-five dollars.**

**And then, there aren’t really any numbers to account for who’s going to monitor all these billion tonne capacity CO2 reservoirs that we’re apparently going to magic up from nowhere all over the planet. After all, we can’t just shove the gas down into rock formations and expect it to stay there forever, because that’s not how nature works. So, we’ll need to keep our eye on them for multiple decades into the future. And if we do stump up the cost of global monitoring, who’s going to decide when a reservoir is full up and pumping therefore needs to stop. Will the pumping company (who’s financial viability relies on continuing to pump) voluntarily shut down their pumping operation without being forced to do so by regulation and legislation? Based on about a century’s worth of operational track record from the oil and gas industry, a cynic might suggest that this would be unlikely.**

**And then there are the potential costs of fixing leaks or any other unhappy surprises that are bound to occur from time to time. Do we pay for a bunch of mostly redundant back-up reservoirs to sit idly next to operational facilities just in case of emergency? Or do we factor in costs for simply shutting down a faulty facility and building a new one?**

**I could go on, but you get the idea. None of these numbers have been worked out or made available.**

**Then there’s something called Capture Rate which, as the title suggests, is a measure of how well any carbon capture technoogy actually performs in a real-world operational setting. The IPCC models assume a capture rate of between eighty-five and ninety-five percent. But when the researchers for this paper delved into the historical data from previous academic studies, they found that carbon capture from the iron and steel sector ranged from eight to sixty-five percent. CCS at petroleum refineries could be anything from eight to fifty percent. And a couple of studies from the paper and pulp industry found capture rates between sixty-two and seventy-three percent.**

**Well, we’ll just make those capture technologies perform better in future, say proponents of the technology. But even if that was possible, which is debatable, who’s going to pay for that very significant and possibly profit smashing extra on-cost? Because you can be damn sure the plant operators aren’t going to want to.**

**And even if all those objections were somehow overcome, ten years down the line when everyone had apparently agreed to fully commit to CCS as our climate saviour, if for some mysterious reason it turned out that the CCS equipment operators had been removing far less carbon dioxide than they’d initially promised, then the world might be forced to start leaning even more heavily on so-called negative emissions technologies like BIO-ENEGRY with Carbon Capture and Storage, or BECCS, which has a whole bunch of its own associated problems that we looked at in this video a couple of years ago, not least of which would be industrial levels of deforestation and land use change that would exterminate entire ecosystems.**

**Honestly, there’s a whole host of other parameters and variables explained in painstaking detail in this paper, and going through all of them would take about three hours, so rather than putting you through that endurance test, I’ve left a link to the paper in the description section below for anyone who wants to trawl though the methodology in greater depth.**

**For the purposes of this little summary though, let’s cut the chase and have a look at how the numbers worked out. This chart represents levelised system costs for high-CCS, low renewables scenarios in red and low-CCS, high renewables scenarios in blue from twenty-twenty-one to twenty-fifty. The two dotted lines represent the ‘mean’ value of all the projections, and what THEY tell us is that the high CCS scenarios would cost roughly a trillion US dollars more PER YEAR than low-CCS scenarios, ultimately because, for many fossil fuel technologies and applications, it’s much cheaper to reduce emissions by REPLACING them with clean electricity technologies than by ADDING CCS to them, or by compensating for them with BECCS or DACCS.**

**The low-CCS pathways in the chart mean the deployment of more solar, wind, electrolysers and energy storage, which means the price of those technologies keep tumbling down their already precipitous cost curve.**

**The bottom line, according to the authors of this paper, is that we will definitely need carbon capture and storage technologies, but the economically and environmentally prudent strategy is to use them ONLY where other options are unavailable or very expensive.**

**Governments and businesses should therefore regard CCS in this way and understand that it CANNOT be used as a get out of jail free card for oil and gas producers to continue business as usual.**

**Now, you’ll have your own views on CCS, I’m quite sure of that. So, as always, why not jump down to the comments section below and share your thoughts there.**

**That’s it for this week though. Thanks, as always, to our Patreon supporters, who enable me to keep ads and sponsorship messages out of all my videos. And I must just give an extra special thank you to the folks whose names are scrolling up the screen beside me here, all of whom celebrated an anniversary of Patreon support in January.**

**If you’d like to get involved with the work I do here at the channel, then why not pop over to patreon.dot.com forward slash just have a think to have a look at all the extras you can get hold of there.**

**And you can hugely support the channel right here on YouTube absolutely for free by subscribing and hitting the like button, which of course is just a simple mouse click away, either down there somewhere, 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.**