**It’s been a bit of a trip down memory lane for me recently, as I’ve been going back to refresh my memory about all the allegedly game-changing ‘sustainable’ technologies that we’ve covered on the channel over the last six years. Despite the truly cringe-worthy experience of having to watch an ever growing selection of my own previous videos, I have nevertheless found it to be a necessary chore as part of my research for our twenty-twenty-four green tech review series, partly to make sure I don’t completely contradict something I may have confidently proclaimed in the past, but also, if I’m honest, to have a quick look in the comments sections to see if anyone has pointed out any glaringly moronic errors that I may have made in the original presentations, which annoyingly enough, has happened more than once! And it was while I was carrying out that due diligence on a twenty-twenty video about green steel that I spotted this little exchange. It started very well with some positive feedback about my coverage of a Swedish green steel initiative called HYBRIT. But then it all went a bit south when another sharp-witted viewer poured a bit of real-world cold water onto the Scandinavian decarbonisation dream.**

**And in fairness to nicktecky55 – they’re quite right, aren’t they? Just as with everything else in our effort to combat climate change and move to a more sustainable world, you won’t get far working in splendid isolation if the rest of the world decides it doesn’t want to join in, will you? So, as we hurtle into twenty-twenty-four, has low-carbon green steel actually made any headway?**

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

**Regular viewers will have seen my efforts at animating and explaining how steel making works on more than one occasion in previous videos, but for anyone not conversant with the process, here’s a little potted summary.**

**Iron ore is what we dig out of the ground, and it’s oxidised, because that’s what happens.**

**We don’t want the oxygen. We just want the iron.**

**So, we chuck it in with a load of coking coal and heat everything up to about sixteen hundred degrees, at which point the oxygen decides it would be happier with carbon after all and leaves the iron to pursue a new life, either as carbon monoxide or carbon dioxide.**

**The iron that comes out of the blast furnace then goes into something called a Basic Oxygen Furnace where high pressure air reacts with the hot metal to achieve precisely the right carbon content to make it into steel. That conventional method of production, including the initial creation of the coking coal, results in the emission of well over two tonnes of carbon dioxide for every tonne of steel produced. And that’s the problem in a nutshell. It means that the global steel industry currently accounts for more than seven percent of total human induced greenhouse gas emissions. The industry is not going to capture that carbon in any kind of economical or practical way at any point in the near future, for reasons that we’ve looked at several times on this channel and that you can find out for yourself by going to your favourite search engine and typing in the words ‘why carbon capture is stupid’.**

**So, in an ideal world we want to find something other than coking coal to persuade iron to give up its oxygen, and we probably also want to use electricity instead of fossil fuels to provide all the heat for the various processes.**

**And that’s where the HYBRIT project that I mentioned earlier comes into play. The process itself is called ‘hydrogen based direct reduced iron’, or HD-R. The theory is that you make green hydrogen from electrolysis of water and use it to replace the coking coal in the reduction process. Hydrogen reacts with iron oxide at about EIGHT hundred degrees Celsius (so already you’re saving energy in the heating process) and that reaction produces something called sponge iron, with the only by-product being water, which can be recycled back into the hydrogen electrolyser. Sponge iron can then be directly processed in an electric arc furnace along with a bunch of scrap steel for recycling and a small amount of carbon as a balancing additive and lime to remove the final few bits of impurity. There’s no need to go through the blast furnace or basic oxygen furnace stages. So, new useable steel comes out of the electric furnace and the whole process results in something like a ninety-seven percent reduction in carbon dioxide emissions.**

**It’s not difficult to see the attraction of the process is it, both for steel makers and for steel consumers.**

**The first HYBRIT production facility was completed in twenty-twenty, funded by a fifty million Euro grant from the Swedish government plus another hundred million or so of investment from Swedish steelmakers SSAB, the Swedish utility Vattenfall and a mining company called LKAB. When we last took a look at the project, back in twenty-twenty-one, SSAB had just shipped the first consignment of HYBRIT green steel to Volvo, who used it to produce the world’s first ever vehicle made with hydrogen based green steel - a fully electric, fully autonomous dumper truck designed for use in mining and quarrying.**

**So, what’s been going on since then? Well, in December twenty-twenty-three SSAB and Vattenfall signed a letter of intent that will see the Swedish power giant beginning pilot projects in twenty-twenty-four using green steel for infrastructure stuff like pylons, hydroelectric dams, grid stations, and elements for onshore and offshore wind turbines, and the two firms have set their back office boffins to work crunching the numbers to provide accurate life cycle assessment figures throughout the entire value chain.**

**They apparently haven’t quite got the stage of pressing the ‘equals’ button on the calculator yet, but we’re assured those figures will be available very soon. Which is just as well for them because other European startups are also vying for a piece of the green steel action, including the SALCOS project, backed by the German steel maker Salzgitter. SALCOS essentially employs the same hydrogen reduction technology as HYBRIT and claims to be on track to achieve a ninety-five percent reduction in CO2 emissions. Then there’s Blastr, established in Norway in twenty-twenty-one. They’re also going after green hydrogen and they reckon once they get up and running they’ll be churning out some two and a half million tonnes of what they describe as ‘cost-competitive, ultra-low CO2 steel with around ninety percent lower scope 1 to 3 emissions than conventional steel production.’ They haven’t produced anything yet though, as far as I can tell, and nor has the SALCOS project for that matter, and to be honest it’s not all that clear when either of these initiatives will actually come through, so I won’t hold my breath.**

**An arguably rather more bankable prospect though, is yet another SWEDISH outfit, by the name of H2 Green Steel, or H2G for short, which appears to be bubbling up as the biggest competitor to SSAB’s HYBRIT program. In Twenty-twenty-two they teamed up with a US firm called Midrex, a world leader in direct reduction of iron using methane gas instead of coking coal. H2G will take that know-how and essentially swap out the methane for green hydrogen at a brand-new state of the art production facility in the northern Swedish town of Boden, where they will have access to an abundant local supply of hydropower to run their electrolysers. The company aims to have the plant up and running by twenty-twenty-five, initially producing two-point-five million tonnes of steel per year and then five million tonnes when it reaches full capacity. Commercial partners include Mercedes-Benz and Cargill. And even Volvo has decided to add H2G to its list of green steel suppliers, with a twenty-twenty-three deal that’ll see H2G’s Boden plant supplying green steel to the entire Volvo Group by mid twenty-twenty-six.**

**H2G say that green steel produced via the hydrogen direct reduction process is currently between twenty and thirty percent more expensive than steel made in the traditional way. You might think that would be an immediate deal breaker, but the thing is, global steel producers and consumers are under enormous commercial, political and public pressure to demonstrate their willingness to contribute towards reducing the massive impact that steelmaking is having on the climate and environment, so there is a growing acceptance among many companies that the premium for low carbon steel may be a price worth paying in order to keep them in everybody’s good books.**

**Another US firm, by the name of Boston Metal, is coming at the green steel challenge from a slightly different angle. You may have already seen the brilliant video tour of their factory that Rosie Barnes recently posted on the Engineering with Rosie channel, but as a very brief summary, Boston Metal has developed an electrochemical process called Molten Oxide Electrolysis which breaks iron ore down in a sort of giant, battery-like cell, and apparently does away with all of the carbon-heavy stages of steel production.**

**The company seems to have attracted a great deal of backing from some very well-known names in the industry, but the technology is not yet at fully proven commercial scale production levels just yet, so it’s one that I’ll make a note to come back to in a later video.**

**Anyway, encouraging updates from both sides of the pond, I think you’ll agree.**

**We all know what the elephant in the room is though, don’t we? If you’re not sure what I’m talking about, then then let me help you a little by showing you this pie chart based on data from World Steel dot org. Yes, that’s right folks, you’re not misreading the graphic. China does indeed produce more steel than the rest of the world put together.**

**So, are there any signs that the world’s industrial workhorse is embracing the brave new world of fossil free steel?**

**Well…sort of… I suppose.**

**According to a twenty-twenty-two analysis by S&P Global, China is on course to have more than eight million metric tonnes of low- or zero-carbon direct reduction steel-making capacity by twenty-twenty-five, driven predominantly by the world’s first and third largest steel makers, The Baowu Group, and Hebei Iron & Steel. Baowu’s subsidiary, Baosteel, is aiming to have as much as ninety percent of its direct reduction processes driven by hydrogen instead of methane gas by twenty-thirty. Trouble is, direct reduction represents a tiny percentage of their overall steel making operation. The company churned out a hundred and fifteen million tonnes of the stuff in twenty-twenty and more than ninety-three percent of that was produced via the blast furnace-converter route, and it’s a similar story for the rest of the Chinese steel making industry. So while they’re busy completely upending yet another of their enormous industrial sectors, they will most likely have to rely on carbon capture and storage to keep them on track for their twenty-sixty net zero target.**

**Super.**

**It is a bloody big nut to crack though is this one. The highly respected industry consultancy Wood Mackenzie recently suggested it would require something like one-point-four TRILLION dollars to achieve a globally decarbonised steelmaking sector by twenty-fifty, and according to Global Energy Monitor, a lot of conventional coal-based steel making is still heavily subsidised in many countries around the world. If green steel is to stand any chance of making a dent, then those subsidies will need to disappear very quicky and be redirected into the new technology.**

**But if that can be somehow achieved, and if the world ever gets itself organised onto a properly internationally agreed and aggressively prohibitive carbon price, alongside the appropriate financial protection mechanisms to ensure it’s not the poorest and most vulnerable in our societies that get clobbered as a result, then, well you never know…**

**No doubt you’re keen to express an opinion on those sorts of lofty, lefty ideals, or maybe you’ve got some direct experience in green steel production, and you can share some knowledge with us all. Whatever your views or news, the place to leave them, as always, is in the comments section below.** **Before I go, just a very quick note to let you know I'll be hosting discussion panels on each of the three days of the upcoming Everything Electric LIVE event in London this Easter, organised by our friends over at the Fully Charged channel, and when I'm not on stage I'll be mooching about having a look at the astonishing array of exhibitors and new electric vehicles that you only get to see at the world's Number one Home Energy and Electric Vehicle show. If you fancy coming along to say hello then you can get twenty percent off your tickets using the discount code on the screen, exclusively for viewers of the Just Have a Think channel. Follow the link on screen or in the description section below.**

**As always though, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**