**Back in December 2020 we had a look at a very promising new technology called hydrogen-based direct reduced iron, or H-DR that was being developed by a Swedish venture called Hydrogen Breakthrough Ironmaking Technology, or Hybrit.**

**The use of Hydrogen as part of the transition to sustainable energy seems to have gained an awful lot of media attention during 2021 and if you believed some of the more enthusiastic commentators, you’d be forgiven for thinking it was the silver bullet to solve the entire climate crisis.**

**A more level-headed assessment suggests that it’s unlikely to fulfil that destiny in areas where the direct use of renewable electricity is simply a better option, like road transport and the heating and cooling of buildings, two sectors that between them currently account for about thirty percent of total global CO2 emissions.**

**But where hydrogen really could play a transformative role is in industrial applications that are extremely difficult to decarbonise using existing technologies. And steel making is a perfect example. The iron and steel sector ranks first among all heavy industries when it comes to CO2 emissions, and second when it comes to energy consumption. According to the International Energy Agency the sector directly accounts for two point six billion tonnes of carbon dioxide emissions every year, which is just over seven percent of total global CO2 output.**

**As we hurtle towards the end of 2021 then, I wondered how the Hybrit initiative was progressing. And it turns the answer is… ‘not bad’ . They’ve just shipped their first batch of green steel to the Swedish car maker Volvo and entered a partnership with Mercedes Benz. So, is green steel one of those technologies that will actually make the transition from hopeful laboratory discovery to mainstream industrial scale reality?**

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

**One of the important lessons that we humans look like we’re going to have to learn the hard way, is that we simply cannot continue to plunder all the resources available on the Earth at the current rate of consumption without some extremely unpleasant consequences, including very inconvenient eventualities like us not being able to survive on the planet anymore. Nature will teach us that lesson, one way or another, whether we like or not, but in the meantime, it looks certain that we’ll be constructing more vehicles and buildings as economies continue to grow all over the world. So, if we’re not going to reduce consumption in the coming years then we can at least try to remove the greenhouse gases from the processes that drive that consumption. And removing carbon from steelmaking is a very significant contributor to that goal.**

**Making steel currently requires coke which is produced by super heating coal in the absence of oxygen – a reaction that releases about eight hundred kilograms of carbon dioxide for every tonne of coke produced.**

**The coke gets added to iron ore and limestone in a blast furnace, where temperatures of around sixteen hundred degrees Celsius reduce the iron ore to iron oxide then to molten iron, known as hot metal. That process releases about one point two tonnes of carbon dioxide for every tonne of molten iron produced.**

**Molten iron has a carbon content of about four percent, which makes it very brittle, so it has to go through another process in something called a basic oxygen furnace, or BOF, where a very precisely controlled amount of air is injected in at extremely high pressure. That causes oxygen to react with some of the unwanted carbon in the iron, which brings the carbon content down to somewhere between one and one and a half percent, at which point it becomes useable steel. And of course a bunch more carbon dioxide drifts gently off into the atmosphere as a result.**

**In the HD-R process, green hydrogen from electrolysis replaces the coke that would normally be added to the iron ore where it reacts at the relatively low temperature of about eight hundred degrees Celsius to make what the industry calls sponge iron. That reaction releases no carbon dioxide at all. The only by-product is water, which can be recycled back into the hydrogen electrolyser.**

**The sponge iron doesn’t need to go through a blast furnace either. It can be thrown straight into an electric arc furnace along with recycled scrap iron. You do still need to add a bit of carbon to make the iron into steel, but because the iron ore reduction work has been done by hydrogen instead of coke, the overall process emits only two-point eight percent of the carbon dioxide currently churned out by existing coke and blast furnace systems.**

**So, on the face of it, HD-R looks like a pretty compelling breakthrough. The Swedish Energy Agency reckons the process could reduce the CO2 emissions of their entire country by as much as ten percent, which is why the Swedish government stumped up fifty million Euros of the one hundred and fifty million needed to build the HYBRIT production facility set up in 2020 by steel producer SSAB in partnership with an iron ore mining company called LKAB and the Swedish power company Vattenfall.**

**In August 2021 the first batch of HD-R steel was delivered to Volvo who announced that they’ve now ordered all the materials required for a new fleet of green steel vehicles, with prototype builds commencing more or less immediately and full commercial production slated for 2026.**

**And to mark the occasion SSAB produced this HD-R Steel candle holder which they say has softly pleated rays beaming out from the candle, symbolizing the end of the tunnel. It is, they claim, “a symbol of hope” and “truly a piece of the future”, which is one of the cheesiest pieces of PR drivel I’ve heard in a very long time, but you know…marketing people eh? What can you do with them?**

**Despite that rather pointless frippery, SSAB does sound like it’s taking its responsibilities pretty seriously. Its steel making operations in Iowa in the US will be entirely powered by renewable energy by 2022 and all of its Americas operations will be offering fossil-free steel products by 2026.**

**And in September 2021, Mercedes Benz announced its partnership with SSAB for CO2 free steel. In fact, the carmaker is keen to introduce green steel into its vehicles as quickly as possible with the first prototype parts for body shells planned for production next year. Mercedes-Benz seems to be one of the automakers who have finally cottoned on to the reality of their rapidly changing industry. By the end of the decade, they say their entire range will be all-electric and by 2039 at the latest, their new passenger car fleet will become CO2 neutral along their entire value chain, including their supplier network. SSAB’s steel will play a crucial role in that enormous transition.**

**They might have been the first to deliver a batch of green steel, but SSAB may not actually be the first to hit the market at commercial scale. Another Swedish company called H2 Green Steel, is**[**planning to build a renewable hydrogen plant**](https://www.reuters.com/article/sweden-green-steel/new-swedish-venture-eyes-fossil-fuel-free-steel-production-in-3-years-idUSL8N2KT2ZC)**to make green steel by 2024, and in fact, as part of the European Union directive to become carbon neutral by 2050, no fewer than** [**23 hydrogen steel projects**](https://www.whitecase.com/publications/insight/green-edge-steel-cutting-through-carbon)**are either underway or about to start production across multiple countries.**

**The International Energy Agency has suggested that HD-R technology will need to account for at least fifteen percent of all primary steel production by 2050, which equates to one new plant every month for at least two decades starting in 2030. That’ll raise electricity demand by seven hundred and twenty terawatt hours by the middle of this century say the IEA, equivalent to sixty percent of the sector’s total electricity consumption today, all of which will of course need to be supplied via fossil free energy sources like renewables and perhaps even small nuclear reactors, known as SMRs, like the ones that Rolls Royce are hoping to bring into reality by 2035.**

**Although 2050 is often used as a target date, the IEA argues that governments and decision makers should have 2030 firmly in mind as the critical window to accelerate the transition. Heavy subsidies will most likely be required to help pay for the capital expenditure needed to get these industrial scale processes up and running, and of course a global carbon pricing structure will be absolutely essential to ensure a level playing field across the world, something that will doubtless be one of the hottest topics of debate at the all-important COP 26 climate conference in Glasgow in November 2021.**

**And as usual on this channel, that debate is likely to be one that you good folks out there may well want to get involved with too. So, if you’ve got direct experience in the steelmaking industry and you have insights that you can share, or if you’ve got strong opinions about his technology one way or the other then why not dive down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

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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**