**I don’t know about you, but I’ve been noticing a marked increase recently in the number of articles on my news feeds, and video suggestions here on YouTube, all talking about how impossibly difficult the decarbonisation of our energy systems will be, and how ignorant us ‘little people’ are about the way the ‘real world works’, and how ridiculously naïve the world is to think that it can really keep the lights on 24-7 for the rest of the twenty-first century, without fossil fuels continuing to play THE major dominant role in the mix.**

**If I was a cynical man, which of course I’m not, but if I was, then I’d almost be tempted to think there was a concerted effort being made to dissuade ordinary folks like you and me from supporting moves towards more sustainable technologies for our future energy demands.**

**Luckily for me though, I also get to read lots of peer reviewed papers and articles, based on demonstrable empirical evidence, from scientists and engineers all over the world who are quietly getting on with the job of transforming the way ‘the real world’ works, in order to pave the way for the very transition that our friends in the fossil fuel industry fear so much.**

**One of the key foundations of that transition will be a revolution in the way electricity is moved around and shared between producers and consumers, and one of the main technologies that will support that revolution is high voltage direct current transmission cables, or HVDC. They’ve actually been in operation in some parts of the world for many years, and I’ve made a couple of videos about them on this channel, but now it looks like they’re about to start rocketing up the steep section of the classic market disruption S-curve. So, what’s going on then?**

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

**I’m not going to delve into the minutiae of how alternating current compares to direct current, and why most grids around the world use AC and not DC current today, partly because I already did that in** [**this video**](https://youtu.be/rThkjp-bp8M) **a couple of years back, and partly because explaining how electricity really works is such a rabbit hole of complexity that, as a layperson, I would inevitably say something that is not technically correct, and that would cause the more fastidious electrical engineers and physicists watching this video to go into a frenzied meltdown in the comments section as they feverishly pointed out what a totally ignorant moron I was. And no-one wants that, do they?**

**Suffice to say, electricity is weird, and you can fill your boots with that weirdness either by checking out Derek Muller’s** [**explanation**](https://www.youtube.com/watch?v=oI_X2cMHNe0&t=46s) **over at the Veritasium channel, or by watching a highly entertaining** [**video explainer**](https://www.youtube.com/watch?v=DFQG9kuXSxg) **from Mehdi Sadaghdar at his ElectroBoom channel. And I’ve included links to those videos in the description section.**

**What I am going to delve into though, is the speed with which companies and countries all over the planet now seem to be racing towards HVDC technology to facilitate the rapidly accelerating roll out of renewables like wind and solar, and energy sharing across greater and greater distances, between countries and even between continents, like this astonishing project underway between Morocco and the United Kingdom, which is something I’ll come back to a bit later in the video.**

**According to our friends at Wikipedia, HVDC technology was developed in Germany and Sweden back in the nineteen thirties. Early working examples included a one hundred kilovolt, twenty-megawatt system between Gotland and mainland Sweden that was commissioned in nineteen fifty-four. There are pros and cons to both alternating AND direct current long distance transmission, many of which I outlined in the video I mentioned earlier. According to the scientific journal known as the Proceedings of the National Academy of Sciences in the US, the conventionally cited break-even distance between overhead DC and AC transmission lines is somewhere around six hundred kilometres or three hundred and seventy miles. But that break-even point drops to only about ninety kilometres or fifty-six miles for underground transmission, because Alternating Current has far more "capacitive" losses than DC power, especially when conductors are closer to the ground. For undersea transmission lines it’s even lower, at somewhere between twenty-four and fifty kilometres, or about thirty miles.**

**Today there are several HVDC connectors operating between countries in Europe. The European Commission has decreed that by twenty-thirty, every country in the Union must have power cables capable of transporting at least ten percent of domestic electricity produced to neighbouring countries. Once that network stretches to places like Romania and Georgia, both of which are enthusiastically pursuing renewable energy and HVDC technology (for reasons that I’m sure are abundantly obvious) then the time difference between them and western European countries like France and even, God forbid, the United Kingdom, would mean they could provide us with solar or wind generated electricity at our peak demand time during the late afternoon, and we could send off shore wind electricity back to them during their peak demand periods.**

**Iceland’s geothermal resources will also be shared with Europe via a thousand kilometres of sub-sea cables providing about a gigawatt of additional capacity, and construction is under way for an 1208km 2GW, bidirectional HVDC interconnector from Greece through Cyprus to Israel, planned to be operational by 2027.**

**Over in Brazil, the two thousand-five hundred-kilometre Rio Madeira HVDC transmission system has been in operation for almost a decade, boasting an enormous 3.1 gigawatts of power capacity, sent via two 600 Kilovolt transmission lines from hydroelectric plants in Porto Velho in the west of the country to Sao Paulo on the East coast.**

**You folks in the United States can rival that though. At least on the west coast anyway. The Pacific DC Intertie system, otherwise known as Path 65, also has HVDC transmission lines with a capacity of 3.1 gigawatts. They’ve been carrying electricity between the Pacific North West and Los Angeles since 1970, providing power for up to three million homes. The national US grid is a prime candidate for a much wider roll out of this kind of bi-directional HVDC technology. Despite claims by the former President of a glorious come back for ‘beautiful, clean coal’, production of that particularly dirty fossil fuel peaked in the U.S. in 2007 and has been dropping rapidly ever since, as this chart shows.**

**One of the smartest US initiatives happening right now is being developed by a company with the incredibly snappy name of SOO Green HVDC Link. They’re building an HVDC connector from a converter station in Northern Iowa to a second station about 560 kilometres or 350 miles way in Chicago. The reason I say smart is because the company has employed some of that lateral thinking, that I’m such a big fan of, to co-locate the cables underground along existing railroads and highways. Those routes are sited on land that’s already covered by so-called ‘right of way’ legislation. That does away with the extremely time-consuming requirement to obtain something called ‘eminent domain’ authority, and it means the cables are following a path that has essentially already been carved out for them. That means the company can build fast, which is what’s absolutely required in order to keep up with the pace of change necessary in America right now.**

**If only there were railway tracks and roads everywhere in the world that connected cities to each oth…oh, hang on..!**

**Quebec in Canada has a massive amount of hydroelectricity, and it also boasts the largest wind farm in that country. Those facilities have been supplying New England and New York with clean electricity via high-voltage ALTERNATING current, or HVAC, lines since about 1980. There are now two new HVDC lines planned, with a 545 km, 1.25 GW line to New York already under construction, and expected to be fully operational in 2025.**

**And of course, just as you would expect, China is also now a major player in the development of HVDC capacity. The one-million-volt, 12 GW capacity ULTRA high voltage direct current or UHVDC line sending power over 3,293km from wind and solar farms in China’s North-West to more than 12 million people in cities on the East coast is currently the largest of its type anywhere in the world, paving the way for truly intercontinental interconnections in the future.**

**There are now competing HVDC proposals to connect members of the Association of South East Asian Nations, or ASEAN, including countries like South Korea, Singapore, Indonesia and the Philippines as part of China’s vision for an Asian Super Grid that will include Japan, which already has multiple HVDC connectors between and within its various islands.**

**Not to be outdone, India’s Prime Minister Narendra Modi proposed the One Sun, One World One Grid project back in 2018, with the grand ambition of connecting vast amounts of readily available solar PV generation from the sub-continent to African nations and beyond, via HVDC transmission cables, a project which was endorsed by more than 80 countries at the COP26 climate conference in Glasgow in 2021.**

**Arguably one of the most ambitious and impressive HVDC projects currently underway though, is the Morocco-UK Power Project that I mentioned at the start of the video. You may have seen the video I made about this project back in twenty-twenty-one.**

**The fifteen hundred square kilometre site is being constructed by a UK firm called X-links. When completed towards the end of this decade it will be home to seven gigawatts of solar PV panels, plus three point five gigawatts of wind power and a five gigawatt/ twenty-gigawatt hour battery energy storage facility, providing enough firm power for more than seven million UK homes or about eight percent of total UK electricity demand. That’s roughly equivalent to the output of the Hinkley Site C nuclear power plant, but at a much lower cost. The HVDC transmission distance is three thousand eight hundred kilometres, and to ensure security of supply, X-Links will be installing four cables, that will hug the coastline to avoid deep-water risks and costs. That’s a total of fifteen thousand two hundred kilometres, which represents about four years’ worth of current global manufacturing capacity. That a major challenge to the viability of the project, so a new company called XLCC has now been set up with its own deep sea HVDC cable manufacturing facility in Hunterston on the West Coast of Scotland, creating nine hundred well-paid, high-tech manufacturing jobs in the process. XLCC has now also completed the tendering process on what will be the world’s largest cable laying vessel, powered by hybrid engines with an upgrade path enabling them to be run on hydrogen fuel in future years. The ship will be more than two hundred metres, or about 650 feet long with a carousel capable of carrying 26,000 tons of cable.**

**Laying cables on the seabed is nothing new of course. We’ve been doing it ever since the first trans-Atlantic telegraph cable was laid way back in 1858, and nowadays modern subsea internet fibre optic cables can be found all over the planet. So, it’s a tried and tested technology that has been de-risked over the course of more than a century and a half. In this fascinating article published in April 2023 in the online journal Clean Technica, green tech expert Michael Barnard stacks up wind and solar power installations and energy transmission projects against all the other major infrastructure work that takes place in our modern world, and he demonstrates that they compare extremely favourably in terms of cost overrun and benefit goals achieved.**

**According to Goldman Sachs, the global HVDC transmission market is set for a compound annual growth rate, or CAGR, of 27% over the next five years as the world transitions as rapidly as possible away from its current dependence on fossil fuels.**

**Such is the pace of change in the energy sector that global supply of HVDC cables is in danger of falling well behind demand during the course of this decade, even without the vast X-Links project, so new manufacturing facilities like the one that XLCC are constructing up in Scotland represent a crucial investment to facilitate the necessary speed of transition. They’re likely to find themselves with burgeoning order books for the foreseeable future, providing gainful employment for thousands of people for decades to come.**

**No doubt you’ve got your views on the pros and cons of this gargantuan global infrastructure challenge, so why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though. Thanks, as always to our brilliant and crucial Patreon supporters, who are the sole reason this channel exists and who enable me to keep ads and sponsorship messages out of all my videos.**

**If you’d like to support the development of the Just Have a Think channel, then you can get involved in the selection of future content and get early access to new videos by visiting Patreon dot com forward slash just have a think where you’ll also find exclusive additional monthly content from me. And if you feel I’ve earned your support here on YouTube then you can demonstrate that absolutely for free by subscribing and hitting that like button. It’s dead easy to do that. You just need to click down there or on that icon there.**

**Most importantly of all though, thanks very much for watching! Have a great week, and remember to just have a think. See you next week.**