**One of the most contentious talking points in today’s noisy global conversation about how best to get to a net-zero-carbon future is of course the dreaded subject of nuclear energy.**

**I’ve looked at Nuclear Energy a couple of times on this channel. In 2019, I considered the question of why large-scale nuclear power has fallen out of favour with some governments and populations, and more recently I looked specifically at Molten Salt Thorium reactors, which developers believe is a technology that addresses the issues of cost, safety and waste.**

**In both episodes I tried to give a balanced view of the pros and cons, but at the back of my mind I knew perfectly well that whatever I said and however I said it, I could look forward to an inevitable verbal evisceration by angry voices from both ends of an extremely polarised opinion spectrum.**

**So, a smart person looking for an easy life might conclude that a good idea would be to never touch on the subject of nuclear power again and just focus on all the other forms of low or zero carbon energy technologies that are being developed all over the world.**

**And as I am neither particularly smart, nor apparently interested in an easy life, what I thought I’d do this week, is touch on the subject of nuclear power again.**

**Specifically, this time around, I will be doing my very best to offer you good folks a dispassionate, fact-based review of the latest industry buzz around a technology known as Small Modular Reactors.**

**Hello and welcome to just have a think**

**Small nuclear reactors are not a new concept. The world’s superpowers have been using them to power naval vessels safely for millions of miles, both on and under our seas and oceans since the nineteen fifties.**

**Back on terra firma, governments have traditionally gone for massive scale centralised nuclear facilities with multi-decadal construction times and, often, with very heavy budget overruns. According to this Forbes article, the average cost of constructing a nuclear plant had reached eleven billion US dollars by 2018.**

**These things take up a huge amount of land, and that limitation, coupled with the fact that the majority of citizens are instinctively worried about their safety, has meant that nuclear power stations have had to be located well away from big cities. That adds even more cost for high voltage power cables to take the electrical supply to where it’s needed.**

**The Fukushima accident back in 2012 caused such public concern that it very nearly wrecked the global nuclear industry for good, and there are some voices in the environmental movement that suggest the demise of the industry would be no bad thing.**

**But as this chart from the website Our World in Data shows, statistically, at least from an operational point of view Nuclear power is one the safest form of energy available, alongside wind, solar and hydropower**

 **The IPCC has warned that the world needs to reduce CO2 emissions radically by 2030 if we’re to stand any chance of avoiding the catastrophic consequences that our current trajectory towards 4 degrees Celsius of global atmospheric warming will bring. In fact, the reduction in emissions that we’ve witnessed so far in 2020 as a result of the global lockdown is about the scale of reduction that we need to achieve every single year for at least the next decade.**

**So, in very recent years, there’s been something of a reconsideration of the role that nuclear power might need to play in our energy mix if we really are going to go Cold Tukey on our fossil fuel addiction.**

**In an assessment report published in May 2019 by the International Energy Agency, their Executive Director Dr Fatih Birol said this**

**“If governments don’t change their current policies, advanced economies will be on track to lose two-thirds of their current nuclear fleet, risking a huge increase in CO2 emissions.”**

**“Wind and solar energy need to play a much greater role in order for countries to meet sustainability goals, but it is extremely difficult to envisage them doing so without help from nuclear power.”**

**The International Atomic Energy Agency, or IAEA, defines 'small nuclear' as under 300 Megawatts, compared to a traditional full-size nuclear installation, which can produce the equivalent of up to 1600MW of power.**

**Enthusiasts of Small Modular Reactors point out that, as well as a much smaller footprint, SMRs also have better safety, faster build times and a unit cost somewhere between eight hundred million and 3 billion US dollars compared to the eleven billion we just looked at for traditional nuclear plants.**

**There are currently about 50 different designs and concepts for SMR technology being developed all over the world, including the molten salt thorium reactors that we looked at in a recent episode, so it would be impossible, and probably not all that helpful, to get into the weeds of the technical differences between them all in this video.**

**But according to the World Nuclear Association, SMR technology in general has several attractive selling points.**

**The WNA say that because of the small size and modularity of SMRs, they could be almost completely fabricated in factories and then transported and installed as modular, possibly even pre-fuelled components. That strategy would build in significant cost efficiencies and quality improvements in the tightly controlled factory production line environment.**

**They also point to passive safety features that they say would make SMR technology attractive to countries with less experience of nuclear power. That term ‘Passive safety’ refers to systems and procedures that don’t require active intervention by an operator or any kind of elaborate shutdown mechanism that could fail if it lost electrical power. Instead these SMR reactors would work in such a way that they could take advantage of natural forces like gravity, buoyancy, pressure differences, conduction or natural heat convection, all of which would cause the nuclear reaction to slow down rather than speed up in the event of an accident or loss of power. And as well as greater safety, those simpler systems mean less cost and fewer operatives on site.**

**And smaller reactors, say the WNA, mean a smaller radioactive inventory, with the implication that the construction would be inherently safer and there would be less nuclear waste produced. They point out that many designs are being developed for underground or underwater locations providing greater protection against natural disasters like earthquakes or tsunamis and man-made disasters like lunatics in hijacked aircraft.**

**The very fact that SMRs are modular and small means that multiple units could be installed on the same site, and the reduced need for cooling water would make SMRs suitable for more remote regions.**

**Their reduced size also means that SMRs could potentially be located in brownfield sites left vacant by decommissioned coal-fired plants, and at the end of the reactors working lifecycle, their modularity would make removal or on-site decommissioning much easier.**

**Some developers predict that by 2030 SMRs could be cost competitive with Natural Gas Combined Cycle plants or NGCCs. Forbes point out that current estimates for Levelised Cost of Electricity from SMRs are around a hundred US dollars per megawatt hour, while NGCCs are in the fifty-five to eighty-five dollar per megawatt hour range. In 10 years, however, SMR costs could drop below sixty-five dollars per megawatt hour, putting them on par with cheap gas and renewable energy.**

**So, should we be going all in for SMR technology as an additional fast track technology to help renewable energy sources like wind and solar displace fossil fuel carbon emissions in the timescales that the IPCC tell us are necessary?**

**Well, just like everything else in the world of energy technology, it’s never quite as clear cut as the marketing bods of any particular industry would have you believe.**

**The Union of Concerned Scientists have highlighted some counter arguments that would need to be carefully considered before rushing headlong into what appears to be a global panacea for a sustainable energy future.**

**On the issue of safety for example, they point out that those passive safety cooling systems are not infallible, and in practice, in order to achieve regulatory approval, developers may well be forced to install secondary active backup systems, which would eat up a good chunk of the cost savings over traditional nuclear.**

**The UCS also argue that because SMRs will have smaller, cheaper and less robust containment systems than current reactors, they carry a higher risk of hydrogen explosions. More robust containment, similar to existing plants, would minimise this risk but again it would add significantly to the overall cost.**

**They also point to the proposal to utilise underground installation as an extra safety measure. The UCS agree that this would indeed offer greater protection from earthquakes, tsunamis and jumbo jets, but they suggest that it also increases the constructions vulnerability to flood damage. And floods are something we’re seeing more and more of as our climate continues to warm.**

 **The UCS say that while it’s true that on an individual level, smaller reactors are likely to be inherently safer than larger reactors, they also generate less power than large reactors, so we’ll need more of them to meet the same energy needs, and lots and lots of small nuclear reactors in multiple locations may well present a higher risk than a small number of large centralised plants, especially if plant owners try to cut costs by reducing support staff or safety equipment per reactor.**

**And of course, the virtue of scaleable modularity that the World Nuclear Association espoused earlier is only really a valid argument up to 300 megawatts. If modules are combined to result in an installation of more than 300 megawatts, then according to the definition set out by The International Atomic Energy Agency themselves, it would effectively cease to be a small modular reactor and become a medium or full sized nuclear power station, so opponents might be forgiven for supspecting that this is a way to slip nuclear power stations into the energy mix through a loophole in policy and regulation.**

**And then there’s that point about siting SMR reactors in remote locations. Modularity would certainly make them transportable. And the installations wouldn’t necessarily even have to be connected to a large electrical grid, so you really could reach some of the furthest flung and least hospitable territories in places like Alaska and Siberia or the vast tracts Africa that are still without electrical supply today. In fact, there’s a subcategory defined by the IAEA as very small reactors, or VSMRs, which are units proposed for provision of less than 15 Megawatts, designed especially for just such remote communities.**

**But according to this 2018 UN analysis, by 2050 almost 70% of the entire human population will live in densely populated cities served by distributed smart grids with demand spikes smoothed out greatly by millions of vehicles and devices that will by then be capable of giving energy back to the grid as well as receiving it. That may make the need for SMRs redundant in the longer term.**

**Nevertheless, some of the world’s largest energy consumers are pursuing the technology. China plans to raise domestic nuclear energy output from 43 gigawatts to 300 Gigawatts by 2030. Part of that strategy is a floating SMR system called the ACP100, earmarked for installation in the island province of Hainan.**

**Russia is also getting in on the game, launching its first floating nuclear power station Akademik Lomonosov by the end of the year.**

**And India is looking carefully at the potential of SMR technology, although in a recent Q&A with the news outlet Nuclear Asia, Secretary of the Indian Department of Atomic Energy , KN Vyas, said that while the Indian DAE has design teams working on SMRs, they already have their resources fairly well occupied in the construction of previously planned reactors, and they will take priority before SMR is seriously considered in that country.**

**In the States, the Department of Energy has a cooperative agreement with a private company called NuScale will provides them with up to 217 million dollars in matching funds to support the accelerated development of their SMRs, and similar agreements are in the pipeline with domestic reactor designers like BWXT, mPower, and SMR Inventec.**

**That’s a profound shift from the government controlled nuclear industry we have today. Perhaps unsurprisingly, The Nuclear Regulatory Commission are working alongside the current administration’s Department of Energy to eliminate what they refer to as regulatory hurdles to facilitate funding mechanisms and licensing opportunities in order to encourage the deployment of SMR by these private corporations.**

**Nuclear power plants driven largely by a corporate profit incentive might be tempted to cut corners by using inferior materials or of course by the time-honoured corporate strategy of shedding jobs when the numbers don’t add up. That risks making remote locations less safe and, more worryingly, it may even leave them vulnerable to attack by bad actors with the potential for nuclear proliferation.**

**And of course, the inconvenient question of nuclear waste won’t disappear with SMR technology either. SMR’s still fundamentally work in the same way as traditional nuclear power stations, and nuclear waste is still a by-product.**

**According to the IAEA there’s about 35 million cubic metres of solid radioactive waste currently in existence. 28.5 million cubic metres has been permanently disposed of in sites that’ll remain no-go areas for anything between 10,000 and 100,000 years.**

**The remaining 6 million cubic metres or so is being held in storage awaiting final disposal, including untreated nuclear waste in the United States that’s been sitting in interim storage since the 1940s.**

**Despite all that though, the simple fact remains that SMR technology can provide base load energy provision in place of fossil fuel.**

**At the COP26 climate summit, now rescheduled for 2021, all participating nations will be required to confirm and put in place their nationally determined contributions towards achieving global net zero carbon emissions by 2050. As part of that herculean task, countries will seek to utilise all forms of very low and zero carbon energy sources available to them, and the reality in many cases is that Small Modular Nuclear Reactors may well be called upon to plug some of the baseload gaps left by a rapid move way from gas and coal fired power plants.**

**As usual with any video that contains the words Nuclear and Energy in the same sentence, I’m expecting that there will be strong views on both sides of the argument. I hope what I’ve presented today is somewhere approaching a balanced assessment. That’s certainly how it was intended, but I’ll be keen to hear your thoughts in the comments section below**

**That’s it for this week, but before you go, I just want to let you know about some new work being carried out by an organisation over on the US called the Centre for Climate and Behaviour to adapt selected Just Have a Think videos into educational self-teaching modules on their already well established website. This is a completely non-financial arrangement – I don’t pay them to use my footage and they don’t pay me to promote their website. It’s simply an extra resource that we hope will be useful to individuals and educators to more easily get across some of the concepts around climate change that I present on this channel. The first module now online is based on a recent episode on Blue Carbon, and there are plans for several other modules to be developed over the coming months. Their website address should hopefully be scrolling across your screens right now and you can also click on the link that I’ll leave in the description box below this video.**

**I also need to give a big thank to the channel’s supporters over at Patreon without whom these programs simply would not happen, and a special shout out to the folks who joined the Patreon team since last time, with pledges of ten dollars or more a month.**

**They are**

**Geir Ove Bolli**

**Jonathon Alsop**

**Chris Devenish**

**Nicola Lionello**

**Ron Kidder**

**Annalien De Ruiter**

**And**

**Michael Beckett**

**And of course, thanks to everyone else who’s joined our Patreon page since our last video.**

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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.**