Fusion reactors will generate lots of radioactive waste, be very expensive initially, and come too late to be part of the solution to climate change, argues Ross McCracken. Reply Michael Campbell

It's clean, cheap and part of the solution to climate change. Not only that, but agile, private-sector innovators will accelerate hugely its technical and commercial development. What are we taking about? Nuclear fusion apparently.

In the last 18 months, private sector fusion development companies have seen a step change in funding levels. From typically attracting sums in the low millions, Helion Energy, for example, raised $2.2 billion in venture capital in November 2021.
Reply. MIT spin-off Commonwealth Fusion Systems secured $1.8 billion last year, while U.K. company Tokamak Energy had, by May 2022, raised about $150 million in equity ahead of a planned new fund-raising initiative. These 2 are the best MFE companies at present

With enough money, the narrative runs, the private sector will achieve within years what slow-moving, cumbersome publicly-funded research facilities have failed to do in decades.
Reply. There is truth to the slowness of gov funding-look at ITER. PPPL spherical tokamak failed in 2015-will not be operational till 2026

Is fusion clean? A fusion reaction, unlike fission, does not produce radioactive products. However, 80% of the energy released comes in the form of fast neutrons which hit the wall of the containment chamber. These neutrons – necessary to breed tritium fuel to sustain the reaction – cause nuclear reactions in the containment wall, which becomes radioactive.

Ideal materials have yet to be invented, and the containment walls will weigh thousands of tons and need periodic replacement. Fusion reactors, particularly early-stage ones, are therefore likely to produce more long-lived radioactive waste than fission reactors.
Reply. Completely wrong-not sure where he gets any info from -there are some fusion concepts that have flowing walls that minimize this even further. Much of the waste in fission is from the fission products-fusion products are helium (for DT fuel)

Fusion will need strict regulatory oversight. It will also need, on an industrial scale, huge quantities of novel materials. Neither look good for costs.
Reply. When people do LCOE is it competive but I we need pilot plants etc to really be credible is saying what it will be -advocates make it ~4 cents/KW-hr

Will fusion be cheap? The idea that fusion will produce cheap energy arises from two features of the science. First, the fuel used in fusion reactions is hydrogen and there is a lot of hydrogen in water, so fuel is abundant. Second, the energy generated from a fusion reaction is so huge that the unit cost of production will be low.

Hydrogen might be abundant, but producing it sustainably is not cheap. Moreover, fusion reactions do not use simple hydrogen, but the heavy hydrogen isotope tritium, which has to be bred from lithium via neutron bombardment. Tritium's short half-life makes it highly radioactive.
Reply. True, tritium is ~12 yr half-life but is a beta emitter with end point energy less than 20 Kev -not very penetrating but must keep it from the biosphere since binds with Oxygen of course

Estimates of fusion costs are hugely speculative because of the technology's immaturity, but a fusion power plant will have a very high capital cost, most likely far beyond the risk profile of power utilities. There is no reason to think such complex machines will follow the cost trajectory of technologies like wind, solar or battery storage, which have essentially become mass manufactured items. Fusion costs and construction timescales are far more likely to have a trajectory similar to fission costs.
Reply. Generally agree but lots have been learned about fission-this is not 1950

Will fusion combat climate change? Not on a 2050 horizon and most likely not until the next century, when it will be too late. Even fusion advocates, private and public sector, admit this when pushed.
Reply. Fusion will happen this century-we will see fusion plants before 2050 and saying to late to deal with climate change is also wrong-does he think that there will be no room for new energy technologies after "2050?"

In an idealistic, accelerated scenario, which assumes the massive physics and engineering challenges are overcome, only one or two prototype fusion machines are likely to be operating in the 2040s. It will then take decades more to develop commercial reactors and decades more for their deployment to spread throughout the world – assuming commercial viability.

Publicly-funded fusion research is valuable and, unlike the private sector, largely collaborative. However, as yet, there has been no proof of concept. There has been no experimentation at reactor-relevant levels of energy gain – the core focus of the pathfinding $20 billion ITER project in France, delivery time circa 2035 – when more scientific challenges are likely to become evident.
Reply. SPARC will address Q~10 in 2026 time frame for tokamak. NIF capsule gain was 12. Scince over this decade will address fusion science issues-engineering etc are the 2030's

Fusion remains early stage because it is very complex. For society at large, it will continue to push the boundaries of science, but, today, for the individual investor, it is a high-risk, no-reward offering.
Reply. Wonder what he would have said in 1970 about mobile microelectronics future and the possibility of having 10 billion transitors in a cell phone?

Ross McCracken *is a senior energy journalist who edited Platts Energy Economist and is now the founder of Commodity Publishing. ross.mccracken@commoditypublishing.com*

Michael Campbell *is a Senior Scientist and Director, University of Rochester, Laboratory for Laser Energetics mcamp@lle.rochester.edu*