Rod Liddle: the nuclear option — why fusion is the key to unlimited energy

Cheaper, cleaner power from fusion is on the horizon. Let's embrace it

The reactor — the black area — at Hartlepool
GREG WHITE FOR THE SUNDAY TIMES MAGAZINE

The Sunday Times, November 12 2017, 12:01am

hoped was a safe distance, were delighted because the bomb greatly exceeded their expectations, delivering a yield of more than 10.4 megatons of explosive energy, 700 times more destructive than the fission bomb dropped on Hiroshima seven years before.

In the first nanoseconds of the explosion, the fireball — in the manner of a somewhat reckless deity — created every element that the entire universe had ever assembled and added a couple of new ones for good measure. The transuranic actinide fermium, for example, later named after the Italian physicist Enrico Fermi — a fleeting and fairly useless addition to the stuff of which the universe is made. The enhanced energy of this terrifying device came from a nuclear-fusion reaction — basically, a barrel of liquid deuterium (an isotope of hydrogen) with a large stick of plutonium in the middle to act as a fairly powerful spark plug. To kick things off, the device utilised a fission-implosion bomb comprised of uranium-238 with a tamper to ensure the shock waves from this initial explosion did their job properly. It worked very well indeed. Island gone, just like that. Incinerated terns dropping dead out of the sky. Fish boiled alive. A fireball that shot up to 57,000ft almost instantly, 80,000 tons of intensely radioactive soil flung into the atmosphere and an ominous cloud spreading for 100 miles from ground zero over the rest of the Marshall Islands. The world looked on, a little balefully.

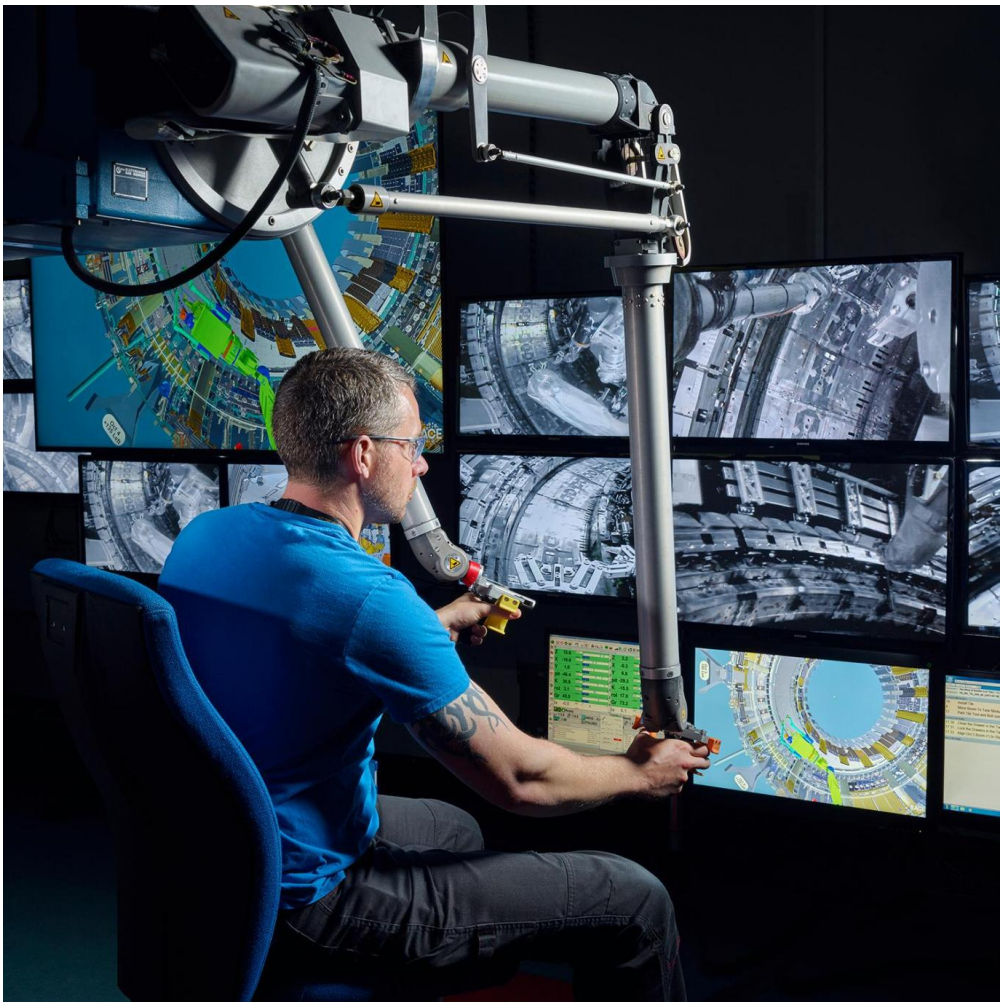
and plutonium — absorbing neutrons and splitting, quite rapidly, and creating enormous amounts of energy as they do so. Nuclear fusion — very light elements, such as deuterium and tritium — smashed together and thus releasing even greater energy, the light of the stars. Two processes that, through our ingenuity, we have learnt how to manipulate, to ends that are either martial or pacific. Fission energy, the stuff of our current nuclear-power industry, the cleanest and most efficient means we have right now of creating energy. Fusion energy, still the stuff of the future, for a while. But enormous power, right there, within our grasp — at a time when the oil reserves are dwindling and both gas and coal spew out stuff that damages our atmosphere and ecosystems; and the great suppliers of energy are not always, politically, kindred spirits.

And yet a kind of crisis grips the UK nuclear industry, where once we led the way. The shadow of Ivy Mike, of the Cold War, of annihilation, of mutually assured destruction have always been there when we talk about nuclear power; an atavistic or ideological opposition on the part of many, both on the left and among the environmental lobby. And there are the start-up costs for our fission reactors and the expense of decommissioning. Add to that the involvement of the Chinese in financing and the fact that almost all our reactors are run by a French firm, EDF, and still more prejudice gets heaped on top. And there are strong vested interests in natural gas and coal

plants are currently supplying less energy than they were 20 years ago, down from a 26% share in 1997 to 18% last year.

There is a certain childish pleasure to be had in standing on top of a nuclear reactor and maybe dancing a little jig over the holes from which the uranium fuel rods are extracted and then taken to moulder, unpleasantly, in baths of water for a few months before being encased in concrete and steel and transported for a lengthy interment at Sellafield. I indulged myself a little at the reactor in Hartlepool, an ageing gas-cooled creature owned and managed by EDF. All that glorious power directly beneath the very soles of one's feet, the neutrons bred like lilacs out of the dead ground, a controlled chain reaction that, uniquely, gives you that thing we all want — something for pretty much nothing. Or, at least, a lot from very little. In Hartlepool's case, energy for more than 2m homes. All done from a compact box on the banks of the River Tees.

You could stand on the roof of the building and view the enormous wind farm — also owned by EDF — stretching out into the North Sea from the mouth of the Tees. That vast forest of steel, a kind of gigantic seagull Moulinex blender, provides

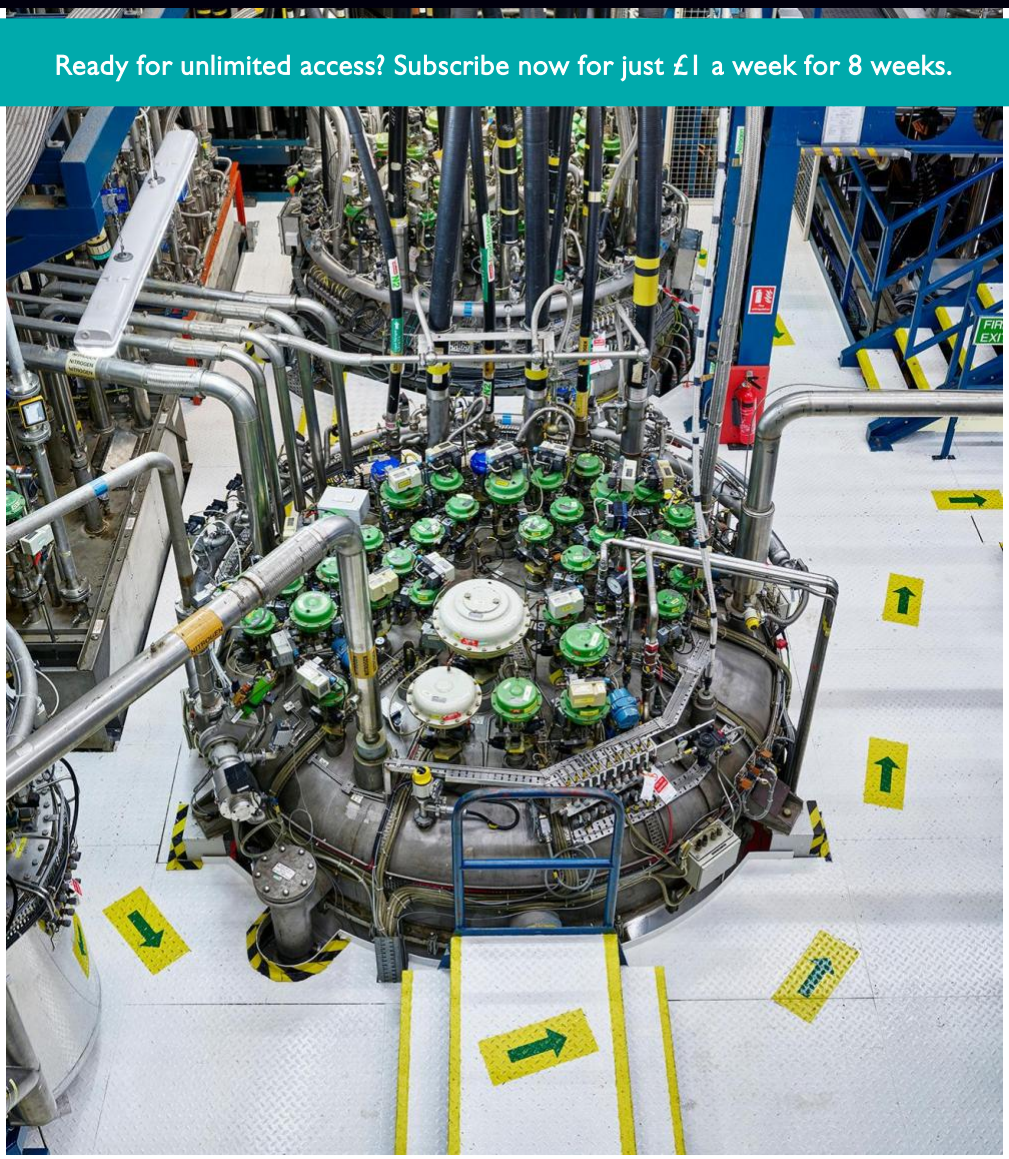


Arm's length: an operator controls robot handlers working inside Jet's reactor
GREG WHITE

Anyway, I dance a jig above the graphite and fizzing uranium and then later go through the endless safety checks to ensure I haven't been infiltrated by those busy little neutrons, or inhaled a few gusts of radon. "Don't bring anything radioactive back with you on your clothes," my wife said, testily, when I told her where I was going. And there we have one of the problems facing our nuclear industry: fear and ignorance, the two elements fissioning off one another. The sinister invisibility of radiation, its otherworldliness, its roots in the development of those genuinely horrifying nuclear weapons, those shadows on the wall in Hiroshima, the weird sickness, the scary blood count,

the nuclear industry's early military-imposed secretiveness and the terror of the unknown. All of it now militating against a source of energy that cannot and certainly should not be disinvented and which is, furthermore, natural, comparatively environmentally friendly and rather safer than any other means of generating energy that we know of. Ah well.

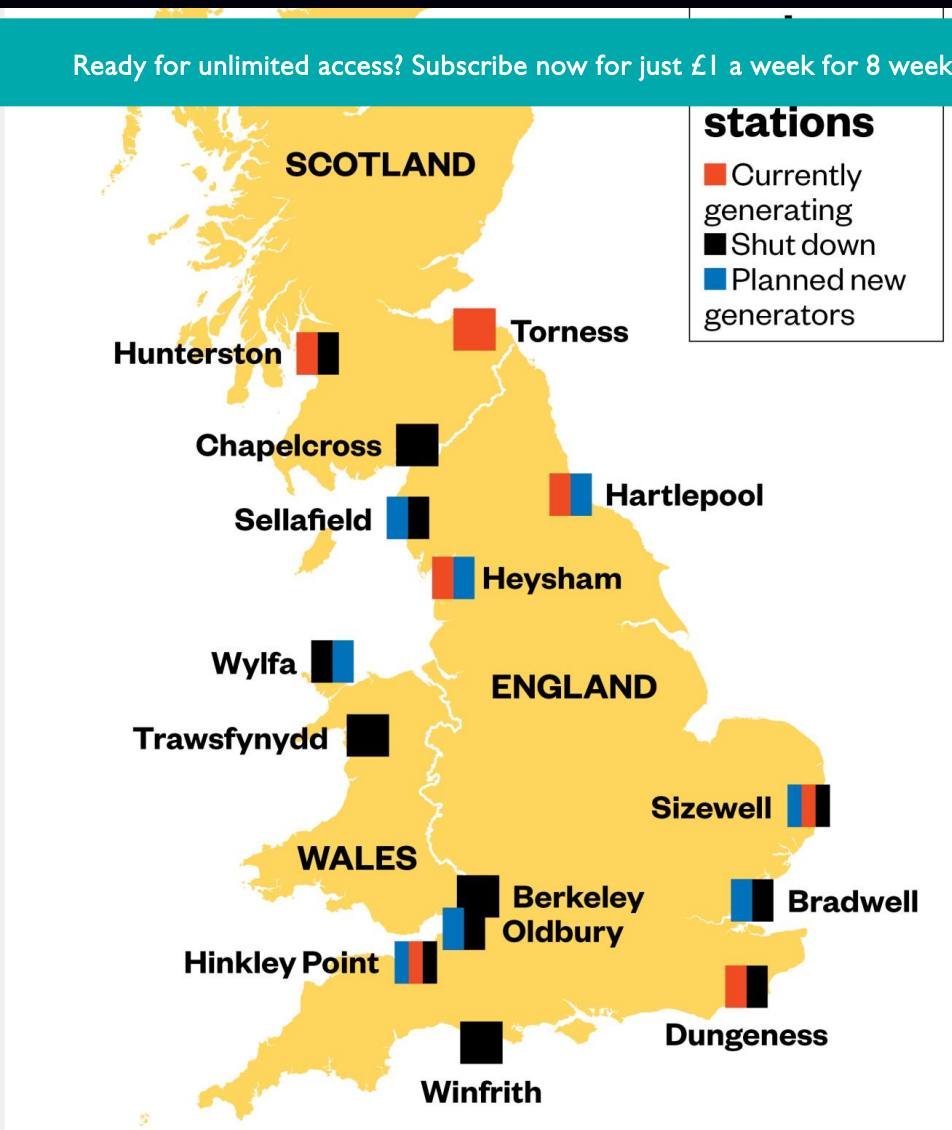
The monitoring posts at Hartlepool — I went through four of them — showed up nothing, nil, zilch. Not the slenderest millisievert. If I'd tried to walk through with a bunch of bananas or a smoke detector with its minuscule core of that transuranic bad boy americium, the red lights would have started flashing. If I'd just been treated with radionuclides for cancer, or had just come from clearing out the basement in a house built upon granite in Aberdeen or Truro, rich with radon, the sirens would have sounded and the plant would probably have been closed down. But nothing, not a thing. There is less radioactivity around a nuclear power plant than there is around a greengrocer. And much, much less than you would find in a hospital, or naturally in Cornwall. In the past 20 years, far fewer people have been injured or killed working in the nuclear industry than have been maimed or killed while maintaining wind turbines. The safety record of the nuclear industry is remarkable. Remember, the second-worst accident in history at a nuclear power station was at Fukushima Daiichi, Japan, six years ago. Fatalities from radiation: none. The worst was Chernobyl, in Ukraine in the old USSR, in 1986, a dismally administered, decrepit, jerry-built Soviet behemoth: 30 people dead, perhaps another 30 over time prematurely dead through radiation-induced cancers. Compare that mortality rate with any other energy industry, and wonder.



Jet's cryogenic plant — basically an extremely cold fridge for liquid helium
GREG WHITE

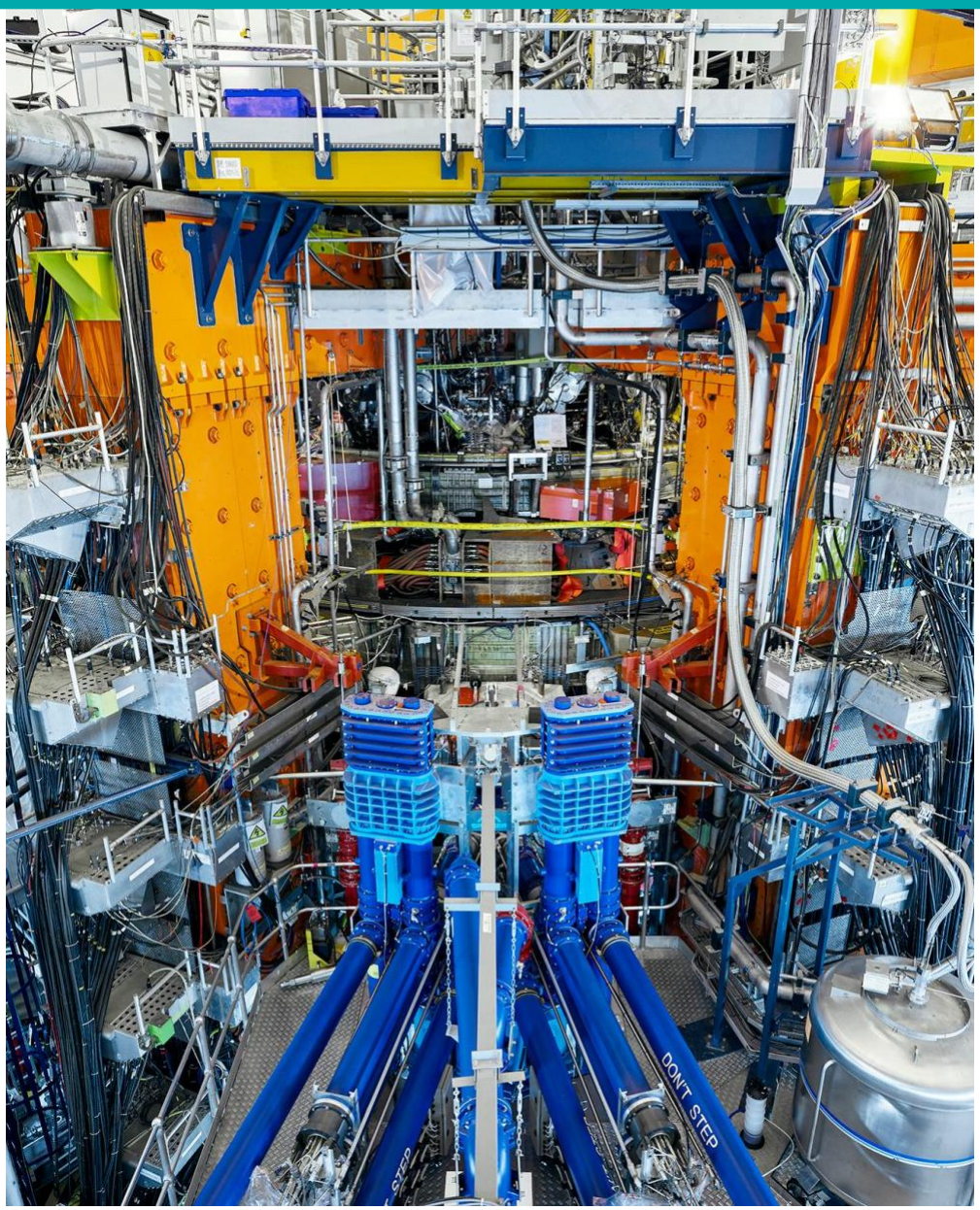
Hartlepool, originally due to be closed down next year, has just won a stay of execution and is now allowed to continue operating up to 2024 — and, one would hope, for at least a couple of years beyond. The main problem with old reactors is disintegration of the graphite base. Hartlepool's is still in fine shape, and so the site will continue to be the largest employer in the town, after the local council, and paying very good wages in an area where very good wages are something of a scarcity. There are plans to build a second reactor at Hartlepool, some way off, but given the struggles EDF has had pushing its

7% of the country's electricity. "Some 25,000 jobs in construction, 1,000 apprenticeships and 650 to 700 people to run the reactor ... it's a huge boost to the local economy," says Brian Cowell, EDF's generation managing director. "A project like Hinkley is always going to have its detractors," Cowell adds, in a valiant attempt to win this year's prestigious Master of Understatement award. The UK's first new nuclear power station in 20 years is a little over budget and behind schedule, a consequence in part of UK regulations. But it is EDF and the investors who will take the financial hit. The project is costing UK taxpayers nothing at the moment. And yet the blows come down. There are, of course, the inevitable protesters, holding hands in symbolic chains around the plant to demonstrate their outright opposition to anything with the word "nuclear" in it. Every year sees a demo of one kind or another. The press and opposition leapt on a National Audit Office report that suggested British energy consumers were being exposed to a "high cost" and "risky deal" with Hinkley Point C, although it also tempered its warnings with caveats that "time will tell whether the deal represents value for money".



And there is the muttered disquiet about EDF's partner, China General Nuclear Power Corporation. The prime minister's former adviser Nick Timothy advanced the argument that the perfidious Chinese might well build flaws into the computer system at Hinkley so that they can shut down our power supply at the mere flick of a switch, no doubt cackling in a demented manner as they did so.

But still, Hinkley at least is a done deal. A third-generation pressurised water reactor that will use roughly 17% less uranium per unit of electricity than the second-generation advanced gas-cooled reactors (AGRs), such as the one at Hartlepool, and will therefore be much more efficient. It is a little sad to see the

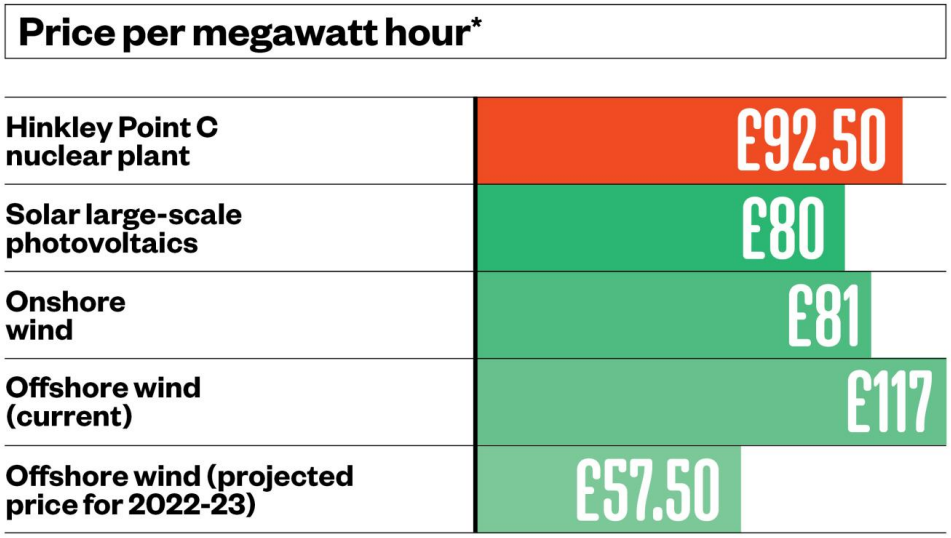


Pioneering spirit: Jet, the prototype nuclear-fusion reactor, in Culham, Oxfordshire
GREG WHITE

Science moves ever onward, though, even if the UK is, for most of the time, a rather passive bystander. Work is already advanced on the next generation of fission reactors, under the Generation IV International Forum, of which the UK — along with Argentina, Australia and Brazil — is a "non-active member". The Generation IV designs — including the Very High Temperature Reactor, which uses helium or molten salt as its

There was a time, a brief time, when we were a little ahead of the curve. On April 14, 1932, two physicists at the Cavendish Laboratory in Cambridge bombarded lithium with high-energy protons in an accelerator that they themselves had designed and built. The Englishman John Cockcroft and Irishman Ernest Walton were mildly surprised to discover no gamma rays resulting as a consequence of their experiment. Instead, what they got, delightfully, were alpha particles zipping about, hither and thither, very quickly. And so they had become the first people on earth to, colloquially, split the atom. Earlier, another Brit at the same lab, James Chadwick, had discovered the neutron, and before then the brilliant, if slightly barking, Ernest Rutherford had demonstrated theoretical nuclear fission.

We were ahead of the game, then, for about 15 years. But only 20 years after Cockcroft and Walton effected the first artificial disintegration of an atomic nucleus, we were in danger of dropping out of the nuclear race altogether. There was a transfer of power — as monumental and exponential as that which occurs within a nuclear reactor — away from the UK and towards America and the USSR, driven, of course, by the arms race. Desperate to keep pace, we were a little ramshackle, underfunded and, it has to be said, horribly premature in our claims of discovery.



* The price of renewables is falling, however the fixed price per MWh is only part of what consumers pay. Different technologies have different characteristics (construction costs, operating costs, life assets). Contract lengths differ, which also affects any calculation of value for money

Zeta (Zero Energy Thermonuclear Assembly) was an experiment run at the old Atomic Energy Research Establishment at Harwell in Oxfordshire to — hopefully — produce fusion reactions. In 1957, the establishment's director, John Cockcroft — by now a Nobel prizewinner — announced to an incredulous press that he was "90% certain" that the enormous bursts of neutrons generated by Zeta were the consequence of fusion. This was front-page news all around the world — unlimited energy, for ever! Oh dear. While some fusion researchers eagerly trumpeted Zeta's accomplishments, there were a few sceptics around. Sceptics who knew a thing or two, such as the Russian plasma physicist Lev Artsimovich, who has

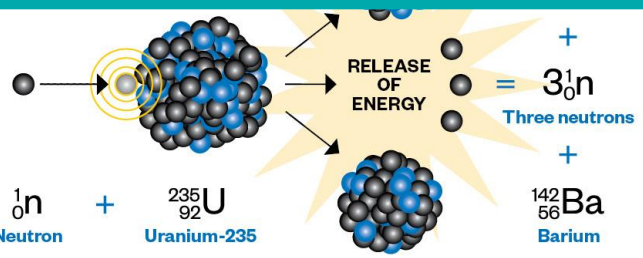
be overstated. It set fusion research back by a decade or more and cast a gloom over the British scientific establishment. Cockcroft soldiered on, but somewhat chastened.

Six miles due north of Harwell is the Oxfordshire village of Culham, a quiet satellite of Abingdon set in a loop of the Thames. This is nuke country, even if the landscape is dominated by the huge, lumbering, natural-gas power station at Didcot B and its now-dead older brother, the coal-and-oil-powered Didcot A. It's here, at the Culham Centre for Fusion Energy, you'll find Jet, the Joint European Torus. Jet is the largest tokamak the world has right now.

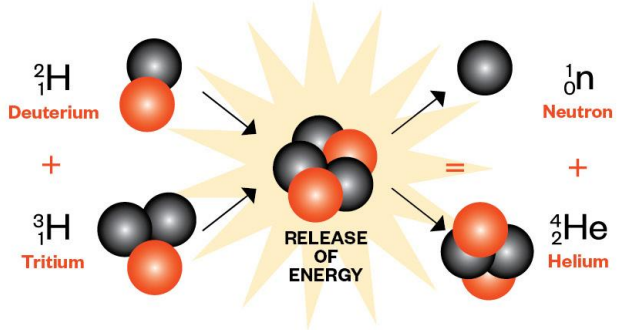
A replica control room, for training, at Hartlepool Nuclear Power Station
GREG WHITE

A tokamak — from an original design overseen by Artsimovich — is a device that uses magnetism to confine the unimaginably hot plasma needed to produce thermonuclear energy: fusion power. The magnets control a 90-cubic-metre soup of deuterium and tritium, the elements fused together at

seawater, the tritium bred (within the tokamak) from lithium, which itself is the 25th most abundant element on our planet. They are far less dangerous to handle than plutonium or uranium and the radioactive waste is negligible in comparison. The problem with fission is that the nasty stuff needs to be buried, at a very great depth, for hundreds of thousands of years. The likely waste products from a fusion reaction — largely the stray neutrons colliding with the walls of the giant machine — will have half-lives of between 50 to 100 years, after which they will be harmless. And you get a bigger bang for your buck: the energy created through fusion is much greater than that produced through fission, which was why the race began to develop the hydrogen bomb and why the crude device dropped on Hiroshima became, very quickly, passé.



SMASH A NEUTRON into a bunch of uranium-235 (as in the formula above) or plutonium-239 and the individual atoms will split — fission — forming two new, smaller nuclei, while releasing huge amounts of energy as well as two or three more rogue neutrons. These neutrons will find other atoms to invade, releasing more neutrons and more energy: voila, you have a nuclear chain reaction, which in power stations such as Hartlepool is controlled via the means of inserting graphite rods (elsewhere sometimes steel, silver or other elements). In a nuclear-fission bomb the chain reaction is not moderated. Quite the reverse, in fact.



THE LIGHT OF THE STARS, including our sun, is the consequence of nuclear fusion. Fusion power utilises the lightest of elements — usually the two less common isotopes of the lightest element of all, hydrogen. Here, two atomic nuclei are forged together to form a larger nucleus, releasing even more energy. The problem is that to effect fusion, the hydrogen isotopes must be heated to enormous temperatures — more than 100m degrees Celsius — until they become a plasma. This plasma must also be contained — the stars use gravity, whereas experimental nuclear fusion research uses extraordinarily powerful magnets.

The problems? Ah, yes. We haven't managed to do it just yet. Professor Ian Chapman is the chief executive officer of the UK Atomic Energy Authority and de facto boss of Jet. A brilliant young scientist — always wanted to work in fusion, even as a kid. We sit in his office, a stone's throw from his beloved tokamak. "It generates 16 megawatts of electricity," he explains, "about the same as three or four windmills. It's not nothing, but ..." And how much electricity do you need to shove into the thing for such a result? "About 25 megawatts ... so you can see why right now it is not a commercial proposition."

And here is the problem. "We know fusion power works," Chapman says, adamantly. But it still takes more energy to run

tokamak we can try to contain the plasma for a lot longer period, when you get to a burn where it self-sustains. And then generating power commercially becomes a very viable option."

The criticism frequently made of fusion energy is that its potential is always 30 years from being realised. Always a few decades in the distance. So it was in the 1950s, so it is now. There is a certain dumb truth in this allegation. But the fusion researchers face essentially the same problems that faced those trying to develop nuclear fission 80 years ago. The process was by now well understood, but critics — including Niels Bohr, along with Einstein perhaps the greatest physicist of the last century — shook their heads, suggesting that in order to realise the power of atomic fission you would need to put in much more energy than you would ever get out. And, in Bohr's words, direct the entire US economy to this end, so expensive and scarcely attainable were the potential dividends. This view held sway in many quarters until that first atomic pile was built — by hand! — on a football field at Chicago University: criticality was achieved just before teatime on December 2, 1942. After that, the science raced ahead in an exponential manner, and we had nuclear-fission power, for bombs and, later, domestic-energy generation. So it will be with fusion. A new, larger tokamak, Iter, is being built in France, with enough space to contain the plasma and stop it being sapped of its mind-boggling heat. Within a quarter of a century or so, we'll have commercially viable fusion power. We know this now.

Show of power: the mushroom cloud from Ivy Mike, 1952
GETTY

Misplaced scientific doubt isn't the only problem afflicting Jet. There is also Brexit. Extracting ourselves from the European Union seems to have meant that we are also less pleasantly extracted from the Euratom treaty, which predates the EU and regulates the free movement of nuclear scientists (and materials) across Europe. It also pays for Jet, to the tune of some £50m per year. If we don't negotiate a bespoke associate membership of the treaty — as have Ukraine and Switzerland — then the funding will go altogether. Jet is an enormous achievement for the UK: we are, once again, ahead of the world. Once again, but perhaps only briefly.

in millions and millions. Scientific research purely for its own sake is worthy of rather more in terms of investment than we are prepared to pay at the moment. Scientific investment in such a crucial project, which we know will work, is surely beyond argument, isn't it? You would hope and pray that Culham continues. But you might not bet on it.

Fission and — soon — fusion. There is not the slightest doubt that we need nuclear power, regardless of how animatedly Friends of the Earth and Greenpeace and others imagine a (literally) sunlit upland where waves, wind and solar panels keep us warm at night. Not a chance. These renewables will always be at the margins and scarcely more than an expensive genuflection towards a misguided political conviction. But it is far more difficult for a democratic government to commission a nuclear reactor than it is to shove a few more revolting wind turbines in a pleasant part of the countryside, or to stand like mad sentinels off our coasts. You could argue that nuclear power is a gift we gave to the world, through the brilliance of those early British scientists — Rutherford, Chadwick, Cockcroft. But then we also gave railways to the world and, since the turn of the last century, have starved our own network of proper investment and are left trailing our economic partners. Seems to be a national trait.

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28 comments

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Smoky Ashton 10 hours ago

An interesting article but doesn't bite the bit between the teeth. If we are to build the very latest nuclear plants then logic would have us build small and build manageable - once we have proved that a small scale plant can be built for an affordable cost and this same plant spews out energy at a cost which is cheaper than alternatives, we may say further nuclear power investment is justified. Instead, the powers that be, always spending someone else's money, jump in at the deep end / read "Hinckley" / buy something not working anywhere else in the world, for a cost totally out of this world, giving energy costs, at absolute best, well in excess of any other power generator anywhere in this world. Stupid stupid stupid

1 ★ Recommend Reply

YORKY69a 10 hours ago

@Smoky Ashton we are not building or buying Hinkley Point PS only the electricity which is produced. We have agreed a pricing plan and as with all long term financial predictions will be at risk to error, that is reality when planning for the future.

★ Recommend Reply

Brilliant Mr Liddle, where did you get the balls to write such an hysteria spouted by UK media and Emotionalists in the self serving pseudo environmentalists. I am sure that you have consulted the skilled, experienced engineers and scientists as so much rings true in my experience. I am still dubious about time and cost predictions for fusion but this is currently the best future.

3 ★ Recommend Reply

Sean Bain 12 hours ago

I found the article interesting although I have a concern about the authors depiction of the dangers that surround nuclear power. I would agree that the safety levels are probably the best of any industry. However, he describes the 2 major major incidents as virtual non-events. Not so. With the Japanese one there was lots of notice and people were evacuated hence no deaths. In the Ukraine it was a whole different scenario where he states 'The worst was Chernobyl, in Ukraine in the old USSR, in 1986, a dismally administered, decrepit, jerry-built Soviet behemoth: 30 people dead, perhaps another 30 over time prematurely dead through radiation-induced cancers.'.
Not sure where he did his research. As was reported years ago, in the aftermath of the accident, 237 people suffered from acute radiation sickness (ARS), of whom 31 died within the first three months. In 2005 the Chernobyl Forum, composed of the IAEA, other UN organizations and the governments of Belarus, Russia and Ukraine, published a report on the radiological environmental and health consequences of the Chernobyl accident. On the death toll of the accident, the report states that 28 emergency workers ("liquidators") died from acute radiation syndrome, including beta burns, and 15 patients died from thyroid cancer in the following years, and it roughly estimated that cancer deaths caused by Chernobyl may reach a total of about 4,000 among the 5 million persons residing in the contaminated areas.
I'm not against clean energy or nuclear power but neither am I blind to the potential fallout should it go pear shaped.

★ Recommend Reply

Mimir 9 hours ago

better protected from flood.)

★ Recommend Reply

Henry Adam 4 hours ago

@Sean Bain Fusion carries virtually zero risks compared to fission, generates no long-term waste and requires minimal raw materials to fuel it. Sad statistic from a couple of years ago - the UK spends less on fusion research than it does on buying mobile phone ring tones.

★ Recommend Reply

Michael Ridyard 14 hours ago

I am watching the wind turbines off Walney producing oodles of power today - probably more than we know what to do with - plus jobs plus they look awesome!

★ Recommend Reply

Yersinia Pestis 13 hours ago

@Michael Ridyard

I am watching the wind turbines off Walney producing oodles of power today - probably more than we know what to do with ...

That is exactly why they are a waste of of time and money.

4 ★ Recommend Reply

Graham 12 hours ago

@Yersinia Pestis @Michael Ridyard Please produce some evidence to support your extraordinary claim.

Remember that extraordinary claims require extraordinary evidence to support them.

★ Recommend Reply

@Graham

It's a Sunday - the day of the week we need the least power. I assume you've a means of storing it until tomorrow?

★ Recommend Reply

Graham 7 hours ago

@Yersinia Pestis @Graham First the wind is set to blow tomorrow at walney the 11 mph of today will be 20 mph so turbines will be generating power.

Wind turbine technology is advancing rapidly, from the 25% average power v rated power the latest offshore farms are averaging 50%.

The marginal of each unit of power from a turbine is effectively zero, so the penalty of not harvesting surplus power today is zero. So simply by not harvesting peeks you reduce the fluctuations in power generation further.

In addition we have a multitude of ways of balancing he grid with wind power, some 10% can be handled through the interconnectors with the European grid.

Then we have new technologies, from managing demand side by using technology to turn storage heaters, hot water heaters etc on off 24/7 depending on grid load.

Then we do have ways of saving it for tomorrow, we have the pump storage schemes which used to be fed by nuclear power because that needs to run at full power 24/7 to get close to being economical, can now be fed by wind turbines.

Then we have grid storage, with prices having more than halved in two years and continuing to fall. Tesla look set to win their challenge to install the first 100 MW battery in less than a 100 days build time. Already new build houses are being built with battery storage to leverage not only solar roofing but also to leverage fluctuations in electricity

Wind is providing 7.43 GW which is over 21% of the UK current demand of 35.31 GW, so hardly a waste of time and money. In the next 5 years we have an additional 25 GW of offshore wind alone coming online so that percentage will very soon be over 50%.

★ Recommend Reply

conedia 15 hours ago

I have no doubt that nuclear power generation will always be here, and will be the only way to satisfy the world's need for electricity for generations to come.

What's worrying though is why Germany is shutting down all its nuclear plants. What do they know that the rest of the world doesn't?

1 ★ Recommend Reply

Nicholas Reger 12 hours ago

@conedia Politics and a Green Party that is always hovering around coalition. Dirty coal lives on after a panic reaction to the Japan situation. Just where does all that Columbian and South African coal that is delivered by the day to Rotterdam actually end up? Up a German chimney.

4 ★ Recommend Reply

John Evans 15 hours ago

Rod Liddle has like many others been seduced by the promise of fusion energy. It will never happen; the technical problems are immense. Not surprisingly, with the complexities of having to understand plasma physics, irradiation damage to materials used, tritium breeding processes, neutron multipliers, and the massive problems of large scale tritium handling and reprocessing, it is hard for a layperson to take on board the difficulties. All these add up to one understandable fact - the expense. Even a fusion study in about 2008, had the capital cost some six times that of fission energy, with

4 ★ Recommend Reply

Alan McRae 17 hours ago

Brilliant piece. I too was some what apprehensive about nuclear power. The actual process and the waste. Until some one offered me work in this industry. They made me an offer I could not refuse. Nearly all the work was maintaining and checking the vision and sensor equipment that monitors the reactor, the core and the containment. Mostly in areas of high radiation levels, yet even after that,I could pass through the body scanners without a bleep.
Not that I ever became complacent, always being aware of the dangers.
Some times the safety rules were a little OTT, when in practice they had to be given lip service.
Sadly the greens and others only pick up the bad bits, and have no idea as to the general good.
I had a friend who took a job on windmills. On one of his first climbs to the top, the generator burst into flames. He had to abseil down the outside. He quit. The number of deaths and injuries from building these monstrosities are given very little publicity, yet a minor happening in the nuclear business gets all the doom and gloom they can muster.
I have another friend who is involved in the future of fusion. He loves it and is in a continuous state of excitement . I wish him well. It is where we must be.

18 ★ Recommend Reply

Michael Ridyard 13 hours ago

@Alan McRae Hi, Alan, honestly you should see the wind turbines from the point of view of Barrow. They are producing enormous amounts of power and providing a new industry

1 ★ Recommend Reply

Alan McRae 11 hours ago

maintenance costs, never mind the manufacturing cost, a relative dribble of power.
I worked on old plants. 20 plus year old , big electric kettles, and they made 1 plus Gwatt, 24 / 7, wind or snow. There were 3 reactors on one site.
Brilliant fishing in the warm water outflow, and people would swim in the nice warm water. Sorry but no comparison.

2 ★ Recommend Reply

AdamD 17 hours ago

Thorium is the future. Uranium reactors were developed to provide plutonium for bombs, but we could have gone with the safer thorium instead.
My father worked on the magnets for JET. He was always telling me fusion was just on the horizon He retired in 1983. The horizon hasn't moved.

5 ★ Recommend Reply

Graham 12 hours ago

@AdamD That Thorium reactor projects were killed off by need to provide weapons grade plutonium is a myth. Civil reactors are not very efficient and making plutonium, which is why plutonium is manufactured in reactors designed for the task.

The Thorium reactor was killed by economics of the fact we knew more about Uranium reactors from the bomb program and also the same programmes provided the expertise to manufacture fuel for reactors.

The Thorium reactor died because it needed a whole infrastructure to support it and key issues such as reactor corrosion remained unresolved.

2 ★ Recommend Reply

A good piece Rod, but it's a bit more complicated than that.

To get a better understanding of this complex subject I very strongly recommend "Sustainable Energy - Without the hot air" by the late Professor David JC MacKay who, having served for five years as the Government's Chief Scientific Adviser from 2009, sadly died in April 2016. This was a great loss as he had an enormous unfinished contribution to make to the sustainable energy debate.

It is an excellent, very readable primer which puts the the choices on energy in clear focus and perspective. Surprise, surprise, looked at objectively, there are no easy options.

It contains sufficient academic detail for those who want it and a most impressive bibliography should you need further collateral.

It can be downloaded free (an indication of Professor MacKay's altruism) here:

http://www.withouthotair.com/download.html

and a 10 Page synopsis here:

http://www.withouthotair.com/synopsis10.pdf

3 ★ Recommend Reply

YORKY69a 10 hours ago

@Mimir Much as I respect Mr McKay,s work it does not really address nuclear generation and sadly does not address the false arguments of risk from this method of electricity production which still pervade the media and prevent rational planning.

★ Recommend Reply

Mimir 9 hours ago

@YORKY69a @Mimir He devotes an entire chapter to it and includes it in 3 of his 5 hypothetical plan options. He

1 ★ Recommend Reply

David Spence 19 hours ago

I think it is true that safe nuclear is the answer for the future. However that future isn't here yet so we need to face a few unpleasant truths. You could turn the world's oceans into giant wind/wave farms but such green dreams won't cover consumption. I suggest the money wasted on such schemes be invested in cleaning up oil and gas until nuclear is ready and viable. Further, consider too that oil and gas are only the light ends of the hydrocarbon product. We will still need lubricants and greases plus feedstock for various chemical processes.

4 ★ Recommend Reply

Graham 12 hours ago

@David Spence No you could provide all the energy the world needed from the North Atlantic alone. The issue with Oil and Gas is Co2 and carbon capture has failed to prove viable compared with renewables.

http://www.independent.co.uk/news/science/wind-farm-world-renewable-energy-green-deep-sea-india-electricity-power-north-atlantic-a7991326.html

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David Spence 8 minutes ago

Graham, Firstly I have great difficulty in believing articles in The Times. Credulous I may be but The Independent? Perhaps not.
Turning the North Atlantic in to a huge wind/wave farm would have an impact on shipping lanes, not least the huge oil burning carriers transporting wood chips to power the idiotic power stations which will still be needed at low wind/peak load periods. The wood chips hardly have any impact on carbon capture I suppose in much the same way

that are surely just over the green rainbow.
Solar? Great but as more transport systems switch to battery power the largest charging loads will occur at night.
Er.

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Alistair Speirs 1 day ago

Extracting ourselves from the European Union seems to have meant that we are also less pleasantly extracted from the Euratom treaty
Stupid Brexit.

4 ★ Recommend Reply

Ken Barrett 1 day ago

@Alistair Speirs I do congratulate you, Alistair, for reading all the way through this lengthy piece to find a way of promoting your usual mantra. No one could accuse you of indolence.

17 ★ Recommend Reply

Alistair Speirs 23 hours ago

@Ken Barrett @Alistair Speirs
Why, thank you, Ken. I thought it good - a change from Rod's usual apprentice-to-Mad-Mel stuff.

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