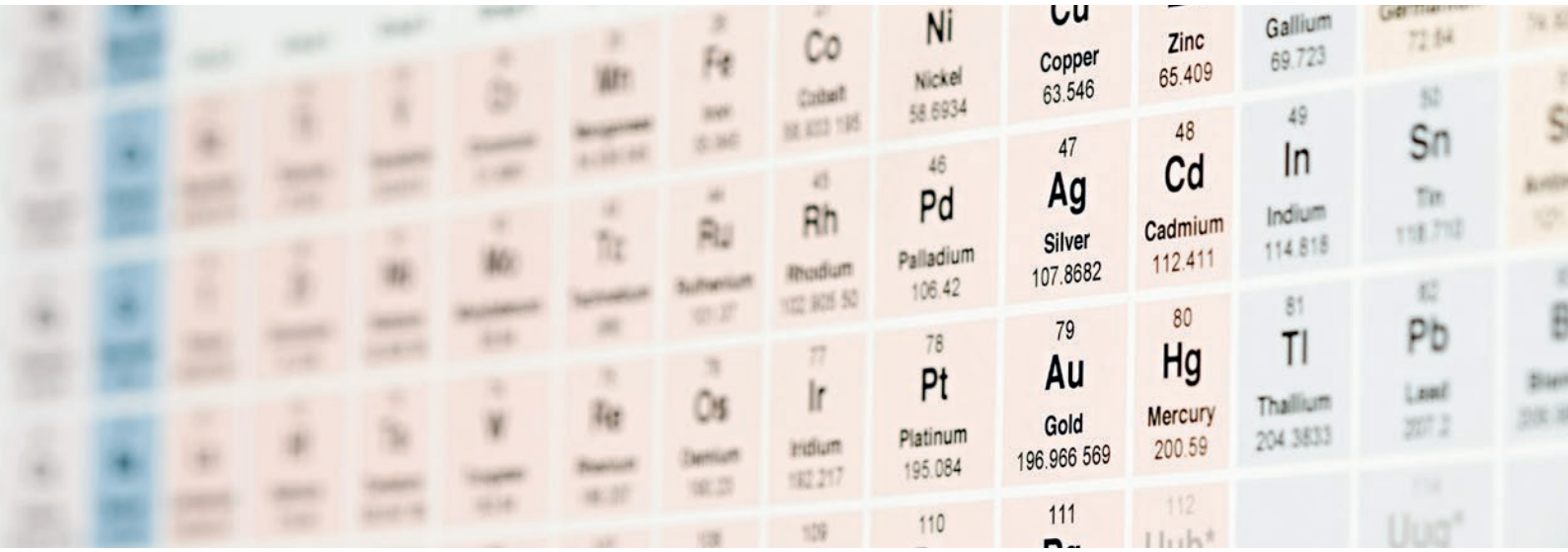
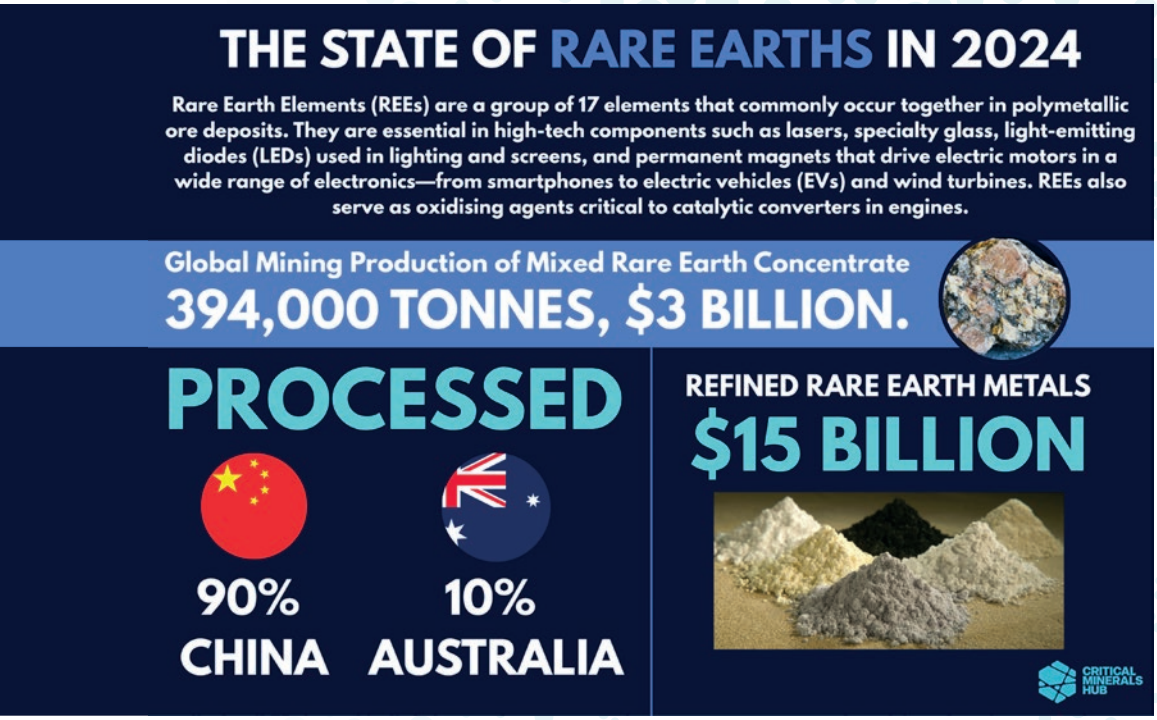
REFUSE, RETHINK, REDUCE, REUSE, REPAIR, REFURBISH, REMANUFACTURE, REPURPOSE AND RECOVER



How On Earth Did It Come To This?

The Sorry State of Rare Earth Minerals

BY MELISSA COGAVIN, BROADBAND JOURNAL



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$3.5TRN - VALUE OF THE GLOBAL ELECTRONICS INDUSTRY – ALL ELECTRONICS CONTAIN RARE EARTHS

$3.5BN - VALUE OF THE GLOBAL RARE EARTH COMPONENT INDUSTRY

$15BN - ACTUAL VALUE OF RARE EARTH THEMSELVES PER ANNUM

$3BN - VALUE OF THE RARE EARTH MINING INDUSTRY

50X THAT OF GLOBAL RESERVES OF ECONOMICALLY RECOVERABLE RARE EARTHS

394,000 TONS A YEAR OF MIXED RARE EARTH CONCENTRATES

SOURCE: THE MINERAL HUB 2025

Every year that passes words and phrases seep into the general consciousness, amplified by the media, and before long become part of general usage. In the 90s it was 'multimedia', 'Britpop' and 'ozone layer', for example. 'Bird Flu' and 'Credit crunch' were coined in the 2000s and never really left us. 'Brexit' joined the lexicon not long after that, along with 'Remainers', 'Remoaners' and 'Trumpism'. 'Covid' was an uninvited guest and we all remember people suddenly very opinionated – even expert - on the apparent pros and cons of the WHO, a body few of us had given much thought to before 2020. Carbon literacy and net-zero shouldn't be recent additions but are, but the big climber of 2025, straight in at number one is Rare Earth Minerals, also known as Rare Earth Elements. Fortunately, this area is niche enough that your Auntie Doris probably doesn't have strong feelings about Neodymium.

You needn't delve too deeply into the news at present to realise that rare earth minerals are, along with bees, water and sunshine, fairly critical to the future of human life as we know it. What is alarming is the seeming abandon with which these are being employed, the finite nature of rare earths and more alarming still, what is and isn't being done about it. This article investigates why.

[At this point a disclaimer: a quarterly publication such as Broadband Journal can't possibly hope to compete with incredibly fast-moving world events and 24-hour rolling news; any political observations will be obsolete before we even go to print. This article seeks to understand the unavoidable geopolitics of this topic from a distance and trusts your own judgement to fill in the blanks - Ed.]

WHERE IS IT MOST DOMINANT?

"If we stay on the road we're on right now, in less than 10 years, virtually everything that matters to us in life will depend on whether China will allow us to have it or not … They have come to dominate the critical-mineral industry supplies throughout the world."

Marco Rubio, Secretary of State, USA

You could be forgiven for thinking rare earths are most present in Ukraine and Greenland if recent headlines are to be believed, but China absolutely dominates, followed by Vietnam, Brazil, Russia, India and Australia. Ukraine and Greenland don't even feature in the top 20 of the World Population Review's assessment of Rare Earth Reserves.

Rare earths have played a significant part in the US peace/arms deal being inked currently with Ukraine as part of the ongoing peace process, though rare earth minerals expert Jack Lifton maintains there are none of any importance even in Ukraine, and that the motivations from the Trump administration are more likely politically driven, a cynical face-saving exercise possibly and an attempt at dominating the region. "A business case means you're going to make a profit. A return on your investment, in a reasonable time. A better return than making an investment on a secure asset like gold bullion. There's no business case for Ukraine; I don't even want to talk about it, it's so ridiculous," he told Investor Coffee in a recent webinar. Ukraine is eliminated then.

There are mineral deposits scattered all over the planet. Most have been identified as either economically recoverable or not, and these can be due to the sheer difficulties presented by the physical landscape, climate and geopolitics again. China dominates the rare earths market, but only part of that is due to the fact most of the reserves are found and mined in China. China also dominates the processing, manufacture and distribution of the world's electronics market, and this is no accident.

"$3.5trn is the value of the global electronics market. All electronics have rare earths in them. Of that 3.5 trillion, the actual rare earth metals processed are only worth $15 billion. It isn't worth that much. And that, by the way, is one of the major reasons we don't do it. And why China does."

They don't want anyone else to know their secret sauce. That said, it's not that hard. It's not nuclear fission. It's chemistry. It's material science and chemistry.

Amanda Van Dyke is an investment banker based in London who heads up the Critical Minerals Hub which provides analysis and insights on the global market for critical minerals. She has a deep knowledge and understanding of this market and broke down the rare earths market over a coffee.

What is happening with rare earths is only one part of an audacious, far reaching strategy that even now is not especially discussed in the West. Reports and interpretations vary, but not long after the 1949 Communist Revolution a manifesto was developed, laying out a complex 100-year road map that would establish China as the world's economic superpower by 2049. It isn't even clear if this manifesto has been written down, such is its hallowed secrecy. Only parts of it have been translated. Western complacence has largely ignored what was quietly taking place across the landscape as a rural nation developed into a manufacturing powerhouse, creating a dependence on cheap, well-made electronics that according to Michael Pillsbury, whose chilling and prescient 2015 warning on The Hundred Year Marathon: China's Secret Strategy To Replace America as the Global Superpower, "constitutes the US misreading of China's 'hundred-year marathon' as its greatest intelligence failure of the past 50 years." Ouch.

The mining of rare earths began some fifty years into this journey, with China realising early on that dominating the messy and complex processing part of the rare earth supply chain was essential to securing market dominance down the line.

Van Dyke explained further. "China realised a long time ago that the money was in making the electric vehicles; computers and high tech is fine, but the value add is in the big-ticket items. To control the big industry, you need to control the components, so they own the entire supply chain. China owns many of the biggest mines in the world, over 50% of the market. The processing of rare earths is maintained at a deliberately very small margin, basically at cost. Why? So that nobody else is incentivised to develop their rare earth deposits or process the rare earths because there's so little money in it."

Meanwhile, what about everywhere else? India, Australia and the US were mining at scale, but without the government support China lavishly supplied to its own industry, their outputs were eclipsed during the 90s, at a point that digital revolution was starting to gain traction. "Mining is expensive and dirty, it's bad for the environment; we don't want that kind of industry in the west," Amanda said. Around this time a leak in a processing plant in California made locals nervous and it was closed down, at which point all American mined rare earths (rated 7th in the league for highest level of rare earth reserves, not insignificant) were shipped to China, in the misguided belief doing business with the US was a benign effort by China to continue propping America up as the world's dominant superpower. Intelligence officials now admit they were naïve.

Van Dyke added, "The Chinese have realised that all you need to do in commodities is slightly overproduce to keep the price down. If you just produce one or 2% more consistently than the market needs, you keep a total lid on the prices."

The Chinese business model is unlike anything we operate with in the West. Investors expect a return quickly and won't invest if that isn't possible. The West operates on election cycles of 4-5 years, maybe they can look forward to 8-10 with a comfortable majority, but where no democracy operates, China has no such barriers to contend with. They can afford to take the long view. In China, Van Dyke explained, "they've mastered the commercialisation of the entire process. They have understood that they need rare earths to develop an electronic components and electronics industry. They told the mining companies, 'we will lend you lots of money to build these factories and you don't have to have a normal rate of return 10-15 percent. In fact, we'll let you run at a loss for the first five years. If you just scrape by with a two or three percent like one or two percent margin, we're ok with that. We'll fund lots of you so that you're slightly overproducing. That way prices never go up and we're okay with doing that because that means we own global rare earth production, and we own the markets that come from it."

One critic on Reddit was particularly scathing about the imbalance of power. "None of this is new. It's decades-old information that yellow-bellied politicians have been ignoring since the 90s. Enriching Communist China would set us on this path. You'd have to live with your head in the sand to not realise what China would do with that newfound power and money."

"They don't want anyone else to know their secret sauce. That said, it's not that hard. It's not nuclear fission. It's chemistry. It's material science and chemistry. China started with sweatshops, but it went into mining, then into energy. China builds more nuclear power plants every year than we've built in the West in the last 10."

Van Dyke was firm on this point. "I don't blame China for what they've done. They have a long-term, intelligent business plan that was economically rational, and invested and worked hard. They built the factories, and they built the relationships. They learned how to be good miners, and they learned how to process materials. They spent the money over long periods of time without expecting immediate returns in order to build a solid, secure industry. And the rest of the world is having a serious problem competing with that."

Broadband Journal turned to Chris Miller for some perspective. Chris detailed the semiconductor supply chain and the West's reliance on China and Taiwan in his excellent book on the subject, Chip War – The Fight for the World's Most Critical Technology (Simon & Schuster, 2022). "Tech companies are beginning to focus on China's dominance of rare earth processing as well as processing of other important minerals like gallium and germanium," he said. "However, China benefits from several factors. Energy prices are low. Environmental rules are lax. And because it dominates global production, the Chinese government can reduce the world price of these materials whenever it likes, making foreign production unprofitable. Without action from Western governments, it will be difficult to reduce China's market dominance."

All of the above means Mr Trump's determination to bring manufacturing back to the US begins to make some sense. Van Dyke raised her eyebrows. "I know it's basically sacrilege in Europe to say Trump's right about anything, but on this, Trump's been right for a very long time." This didn't happen in a vacuum; Trump's policy was the result of years of hard lobbying by Silicon Valley and Elon Musk in particular, all of whom saw the writing on the wall well before the rest of us and certainly before US Intelligence by the looks of it.

However, the damage is done. Fifty years of strategy, massive investment and operating at a loss means China has the advantage and debate continues whether the US can be the hare to China's tortoise. Time will tell.

CIRCULAR ECONOMY

It isn't all about mining and processing, however. Victoria D'Arcy and James George are both UK-based economy experts concerned with the finite nature of the rare earths left on the planet, and what we are doing with the amount of existing rare earth minerals. Those will be already mined, processed and languishing in obsolete hardware in kitchen drawers, charity shops and landfill all over the planet in staggering quantities; it remains a persistent worry, as well as a gigantic, lucrative, missed opportunity.

James George told Broadband, "A survey has just been completed on electronic waste just in the US, and they had calculated that in the legacy equipment in our homes - phones and laptops and electronics - in the US alone there was enough lithium ion in the batteries and components sitting in our cupboards,

attics garages to provide lithium to the EV industry for the next 70 years."

Victoria maintains that the demand for rare earth minerals far outweighs the rate we can mine and process them, resulting in not only a shortfall but a point in the not-too-distant future where there will no more economically recoverable rare earths left. In 2021, Goldman Sachs announced that copper was the new oil, highlighting the urgency of the matter. D'Arcy agrees. "The demand for copper is likely going to double in the next 10 years," she said. "That shortfall equates to about six million tons." Compared to rarer earths than this, copper is abundant, she added. "So why don't we just open up a new mine? There's plenty of copper in Chile. But it's in the Andes at around 5000ft, so there are logistical challenges, and it takes roughly about 16-20 years to open up a mine." Added to that, accessible, recoverable gold is likely to run out in 18 years and there will be no more silver or platinum by 2050. Don't put off that engagement for too long will you?

RECYCLING

"It's the fundamental piece that has to change."

Victoria D'Arcy, Circular Economy Strategist, Podcast Host, All Things Circular

There are two issues preventing movement in this area – attitude and technology.

Recovering copper and other rare earths that have already been produced from existing hardware is possible, but difficult, expensive and not happening at any kind of scale to incentivize consumers to do it. For some time now Apple have been offering a low-key incentive to return old handsets for a discount on new ones, promoting Liam and Daisy, disassembly robots that access the rare earths that powered your phone, but efforts like this have yet to really move the needle.

The 2018 YouTube promo featuring Liam and Daisy at work generated some very creative feedback in the comments about eliminating waste, demonstrating again there is no shortage of creative solutions. Progress in large companies stalls because of process, rarely because of a lack of good ideas, for example:

"Given US value chains, I doubt Apple makes any money from this. The ABB machines are expensive and the volumes are small. I see a couple million dollars in these specialised robots in the video. Worse, they take only the most valuable components, leaving the same toxic waste disposal problem. This is nowhere near the scope and scale of what's needed. I would humbly suggest that the public or governments demand an eco-phone. The phone would be made from high recyclable materials with a design for disassembly and reuse. And we might need a refundable disposal tax at the time of sale."

An incredible idea and a golden opportunity for both government and the tech industry to collaboratively do the right thing.

Recycling is a two-pronged approach, argues James George. "The consumers have got to be part of this solution as well. Do you incentivize them? Do you plead with their moral compass? Do you let consumers offload this stuff in a kind of digital amnesty? What is the mechanism that allows you to get it all back? All of that requires effort, because we're challenging the current status quo." A status quo in the west that goes all the way back to colonial mining outposts in c19th Africa and Asia and the establishment of powerful supply chains that still exist – and thrive - today. Supply chains that are being invested in heavily by China (and until lately, the US) as foreign aid projects, building up soft power overseas. Breaking such supply chains, with millions of people and dollars invested and dependent on their success won't be easy.

However, we are at a generational

inflection point in 2025 – recycling hasn't seemed attractive for Generation X and arguably as consumers we are the worst offenders; Generation Z sees the opportunity, appeal and crucially, value in platforms like Preloved, Vinted, Facebook and Ebay which has rubbed off on Gen X. Ownership of CDs and DVDs is meaningless in 2025 – we are all used to consuming online now – a shift few imagined would be possible in the 90s. This shift will percolate through to hardware, another generation of execs will retire, a younger generation will be motivated to implement a business model that works. The fear of cannibalisation will ease off, and we will begin to see a greater adoption of second-hand iPhone and laptops etc as the circular economy begins to take hold.

James George details the unexpected consequences. "When you chat to people who have cornered a market about remanufactured and re-conditioned goods, traditionally the initial response is always, no, I don't want to cannibalise my primary market. That's logical, but what actually happens is brands end up accessing part of the market that they never captured previously. Neither do they lose their primary customers, who then want to buy reconditioned handsets. They've created a secondary and tertiary markets to their primary market."

As we have seen many times now across Long Reads from cyber-security to data centres, prevailing attitudes from Gen Xers and Baby Boomers have often stymied change; our generation and those before us grew up before the Internet, before the Digital Revolution, and while we flatter ourselves we are the force of change that heralded this revolution, it won't be us that will see it through the next evolution to a circular economy. That requires a younger generation that grasps the urgency and sees little value in the ownership of consumer products, that is perfectly happy with a second-hand iPhone or a reconditioned laptop if it means a sustainable future.

However, incentivizing consumers is only part of the issue. D'Arcy pointed out that "Nobody is investing in recycling; less than 1% is extracted, it's miniscule. The rest of these rare earths is just shredded, because they are in such small amounts, and because of the chemical structure of them they are very difficult to separate."

It is possible we are just not there yet with the means to make it happen. Like retrieving an egg from a baked cake, Chris Miller points out that "Recycling products with hundreds of thousands of components is often not cost effective. There are many firms trying to change this, but it requires new technology." Fortunately, as we are seeing elsewhere in this piece, technology moves extremely quickly and with a bit of luck and a following wind, may not be an issue for long.

SCARCITY ISN'T NEWSWORTHY

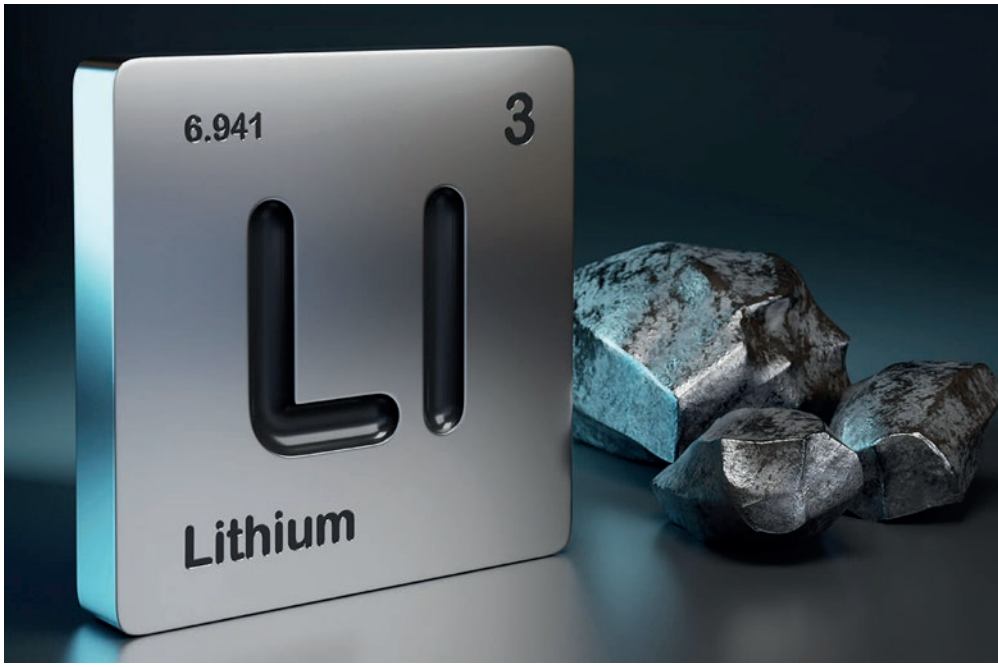
"We're reaching a point where businesses will suddenly say, what are we going to do? And I can't get them almost to listen to me yet, because the problem isn't here yet. It's like we're sleepwalking into it."

Victoria D'Arcy, Circular Economy Consultant

All of this has become urgent at a point where we have rarely seen such explosive, geopolitical instability, with wars and/or tension on every continent, unparalleled migration, climate change, stagnating growth and rising populism everywhere. There is only so much oxygen available for another existential crisis; we are all suffering from crisis fatigue as it is. Social media and 24-hour rolling news cycles tend not to focus on a threat 18 years away either.

Plus, scarcity doesn't sell papers. Drought and famine do. Nobody wants to hear that things might run out, although this sort of thinking will help nobody in the longer term, and Victoria D'Arcy is right in pointing out, "Scarcity is just going to show up unannounced, it's just going to happen. It will start off as delays, then it'll affect costs, and then it will hit the margin." The moment you flush your iPhone down the toilet, you'll no doubt find scarcity borderline fascinating. D'Arcy went on, "We're reaching a point where businesses will suddenly say, what are we going to do? And I can't get them almost to listen to me yet, because the problem isn't here yet. It's like we're sleepwalking into it."

Our consumerist society is like no other period in history; in the West we haven't ever suffered shortages, apart from toilet paper in the first heady weeks of the pandemic which was largely a media construct anyway. We aren't prepared for what this means nor how to cope when it happens. As it seems a long way off, we are indulging in the Ostrich Effect, a way of avoiding bad news by ignoring it, negating its importance, interpreting it



deliberately obtusely. Climate deniers like telling you it's 'just weather', for example.

UNINTENDED CONSEQUENCES

In levying tariffs worldwide in early April the Trump administration caused significant alarm in global markets, and the President's idiosyncratic habit of issuing orders via social media first, ignoring Congress then often rowing back has not helped stabilise relationships or the global economy. Everyone remains on high alert; those with weak hearts should probably look away for the duration of this administration. However, whatever the methodology, Mr Trump's tariffs have shone a glaring light on the over-reliance on Chinese exports worldwide, exposing an uncomfortable level of complacency and forcing industries to look for a workaround, and quickly.

While rooted in a sensible objective to bring the control of processing and manufacture of rare earths back to the US and ease the reliance on China, such action has also prompted urgent action from territories worldwide, who have galvanised quickly in response. Processing mines are being developed in Saskatchewan, Canada, Angola, with plans for more in Australia, South Korea, Norway, Sweden, Texas and even Teesside in the north of England. In doing so, Mr Trump has unwittingly accelerated innovation, forced countries spooked by his erratic behaviour to pull back on reliance with an unpredictable US and a dominant China and prompted a strategic rethink about how to approach a future that is hurtling towards us faster than any of us would like.

REASONS TO BE CHEERFUL

While AI is being offered as the panacea for most modern problems (unless you're editing a magazine, in which case it causes more than it solves), AI is also responsible for a gigantic surge in energy consumption, ten times as much, as well as ten times more hardware required in data centres. AI is likely to aid as much as hinder, and we should be cautious. While none of this is good news, innovation – much of it employing AI and quantum computing - continues at an incredible pace. We should take comfort from the fact in the last year alone, blood tests to detect Alzheimer's have been developed, carbon-capturing microbes have been engineered to remove CO^2 from the atmosphere, weight loss drugs are changing the lives of millions, private space travel is now a reality and lung cancer can be detected through a person's breath. Read that back again – that's in the last year alone.

We must remain optimistic. The technology that is currently missing in recycling rare earth minerals will doubtless emerge and the cost of it will fall. Likewise, the prevailing attitudes towards it will soften as the issue of scarcity and rising costs for tech producers becomes more real.

Victoria D'Arcy is relentlessly positive. "I'm whale hunting with these big tech manufacturers to say, I'll build you a programme, I'll show you how to do it, how to make money from it. It's margin rich. Look at your iPhone, you've already paid to mine it, put it together, you've got sunk costs, and you've actually achieved a margin on that when you sold it the first time. So, the second time, if you just put a license on it, that's pure margin.

"Now where tech manufacturers can't get over is they want to make margin on the second sale on the hardware. If you realise the margin on the hard-earned purse sale, and accept that when you relicense it, then it's pure margin, you will create a wonderful business model."

Attitudes will probably soften quite a bit hearing news like that.