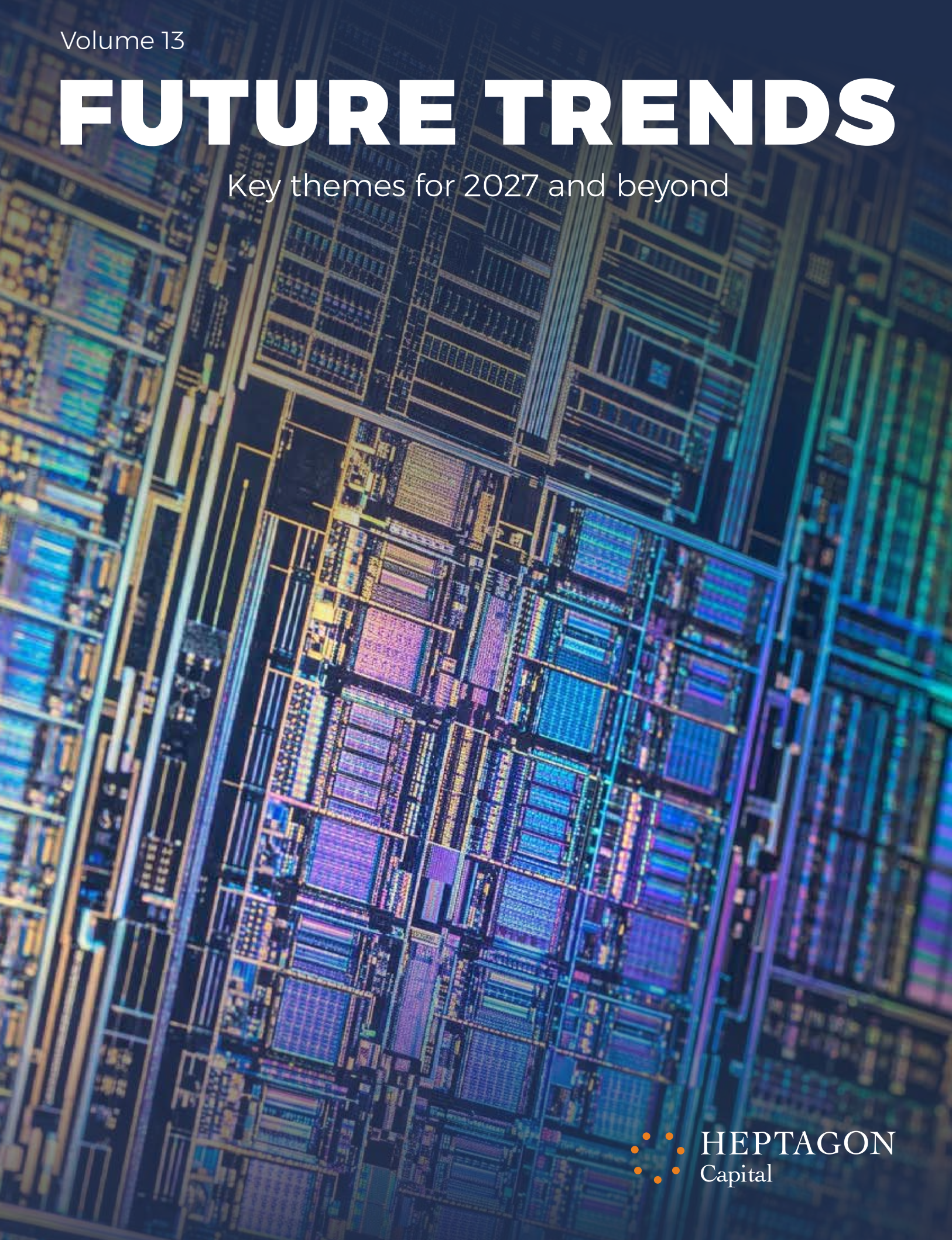
Volume 13

FUTURE TRENDS

Key themes for 2027 and beyond



HEPTAGON Capital



About the Author: Alex Gunz – Fund Manager

Alex joined Heptagon Capital in January 2011. His primary role is managing the Heptagon Future Trends Equity Fund. He is also involved in Heptagon's multi-manager programme for discretionary clients.

Alex started his career in financial services in 1997, working for Hoare Govett as an analyst before moving to Credit Suisse where he became a top-ranked analyst covering European telecoms operators. Following Credit Suisse and before joining Heptagon Capital, Alex held senior roles at JP Morgan and Friedman Billings and Ramsey.

Alex has a degree in Philosophy, Politics and Economics from Worcester College, University of Oxford and a Masters in English Literature from Queen Mary College, University of London. Alex also has an Honours Diploma in Wine and is a published novelist.

"Understanding the future matters and has clear investment implications. We have been researching and investing in future trends since 2011. This constitutes the thirteenth compendium of our latest thinking."

This is a marketing communication and does not constitute an offer to invest and must not be relied upon as such. This material is intended only for persons in jurisdictions where its distribution is permitted. It must not be distributed to any person where such distribution would be unlawful. Please refer to the Prospectus and the relevant Key Information Document before making any final investment decisions.

References to companies and securities are included solely to illustrate the themes discussed. They do not constitute a recommendation to buy, hold or sell any security. The Fund may or may not hold positions in the companies mentioned, and holdings may change without notice.

The value of investments may fall as well as rise and investors may lose some or all of the amount invested.



CONTENTS

VOLUME 13

Key themes for 2027 and beyond

PART ONE: Introduction	**2**
Executive Summary	4
Future Trends In Photos	6
PART TWO: In Brief	**9**
The Bigger Picture: Resource Rush	10
How We See The World Changing	14
PART THREE: Recent Thematic Work	**33**
eVTOLs: Flying Start	34
Agentic Shopping: The Accelerating Ascent Of A-Commerce	40
Autonomous Vehicles: Arriving Soon In Autopia	46
Stablecoins: Mainstream Stability, Finally?	52
Longevity Science: Time To Turn Back Time	58
Space: The Race Is On	64
Geothermal Energy: The Sun Beneath Our Feet	68
Humanoid Robots: The Real Robot Revolution	74
PART FOUR: Appendices	**79**
The Full Future Trends Index	80
The Future Trends Blog	82
The Heptagon Future Trends Equity Fund	84
Disclaimers	86

Heptagon Capital LLP is authorised and regulated by the Financial Conduct Authority (FRN: 403304).



EXECUTIVE SUMMARY

Welcome to the thirteenth edition of our Future Trends compendium. We have been writing about and investing in future trends since 2011, during which time **we have published 75 dedicated pieces of thematic work.**

It remains an exciting journey. We believe that the themes we continue to investigate not only have the power to capture the imagination, stimulate and cause debate. They also matter, since they drive a core part of our investment process. After offering investors exposure to the Future Trends investment strategy via an equity note in 2013, **we formally launched the Heptagon Future Trends Equity Fund in a UCITS format in January 2016.**

Over the past year we published four new detailed thematic pieces. These have all sought to shine spotlights onto different aspects of the future. What seems hard to conceive of today may be commonplace before not long. We may be using stablecoins for our purchases and even getting agents to do the shopping for us. It's already possible to travel by autonomous vehicle in selected cities today. Expect accelerating development. This mode of transportation may soon be complemented by electric take-off and landing vehicles. Consistent with prior years, all these reports are reproduced in full in this compendium. An adjacent QR code for each of these notes will take readers directly to a short video which provides a helpful summary of the theme.

In addition, we have continued to take every opportunity available to better understand the future. During 2026, we travelled extensively across the UK, mainland Europe and the United States. Highlights included trialling an autonomous vehicle on London's chaotic streets, visiting a next-generation Amazon fulfilment centre where robots help pick the goods and travelling to Germany to see one of Europe's greenest (and most technologically

advanced) warehouses. There was also a chance to visit multiple conferences and trade shows. We did everything from debate the future of cybersecurity and venture capital in the UK to seeing pitches for rotating solar panels at the world's leading exhibition for the solar industry. Many of these events have been captured in the Future Trends Blog, which was launched almost seven years ago. Around 400 posts have been published since 2019. A summary of 2026's output can be found on page 82.

Throughout all the work we have done, we have argued consistently to **expect more disruption**. We have always been optimists, advocating for change – however uncomfortable it may appear – as a force for good. Assume that technology delivers productivity gains, then **lower input costs could drive abundance**.

Underpinning all technology are two things: data and physical assets. Our first thematic piece – on data – remains as relevant now as it did on release. In brief, the amount of data that is produced and consumed is growing exponentially, but for these data to have any value, they need to be secured, analysed and stored effectively, creating a range of potential investment opportunities.

This year's thematic essay (see pages 10-13) expands on this notion. *Unlike* previous digital revolutions, artificial intelligence is unusually resource intensive. Against this background, the more successful AI becomes, the greater the demand it creates for scarce physical inputs. **The human-machine era will be shaped by successfully securing resources**. Energy systems, supply chains, infrastructure and national security capabilities are no longer treated as peripheral assets. Instead, they have become strategic and scarce, and increasingly priced as such, creating new geographical tensions and uncertainties.

After our annual bigger picture thought piece, readers will encounter our perspectives on what we see as some of the key future trends changing the world. These reflect the new information we have learned in the past twelve months (pages 14-31). All our theme pieces from the last two years then follow. A summary of our complete thematic output can be found on page 80. Readers can also find every thematic piece available in a digital format on Heptagon Capital's website. More information about the Heptagon Future Trends Equity Fund is provided on page 84.

Looking ahead, our aim is to continue researching new topics and publishing our conclusions. The world is never boring, and we are continuing to learn each day. Read on, and we hope your appetite will be sated. We are already looking forward to compiling next year's thematic compendium.

Alex Gunz

Fund Manager, Heptagon Capital

November 2026







FUTURE TRENDS IN PHOTOS



























In our role writing about and investing in the future, we have had the opportunity to travel extensively around the globe in order to understand better how the world is evolving. The illustrations on these pages provide a snapshot of some of our research activities over the recent past. Much of this work is referenced both in our theme pieces and Blog.

Photos by author























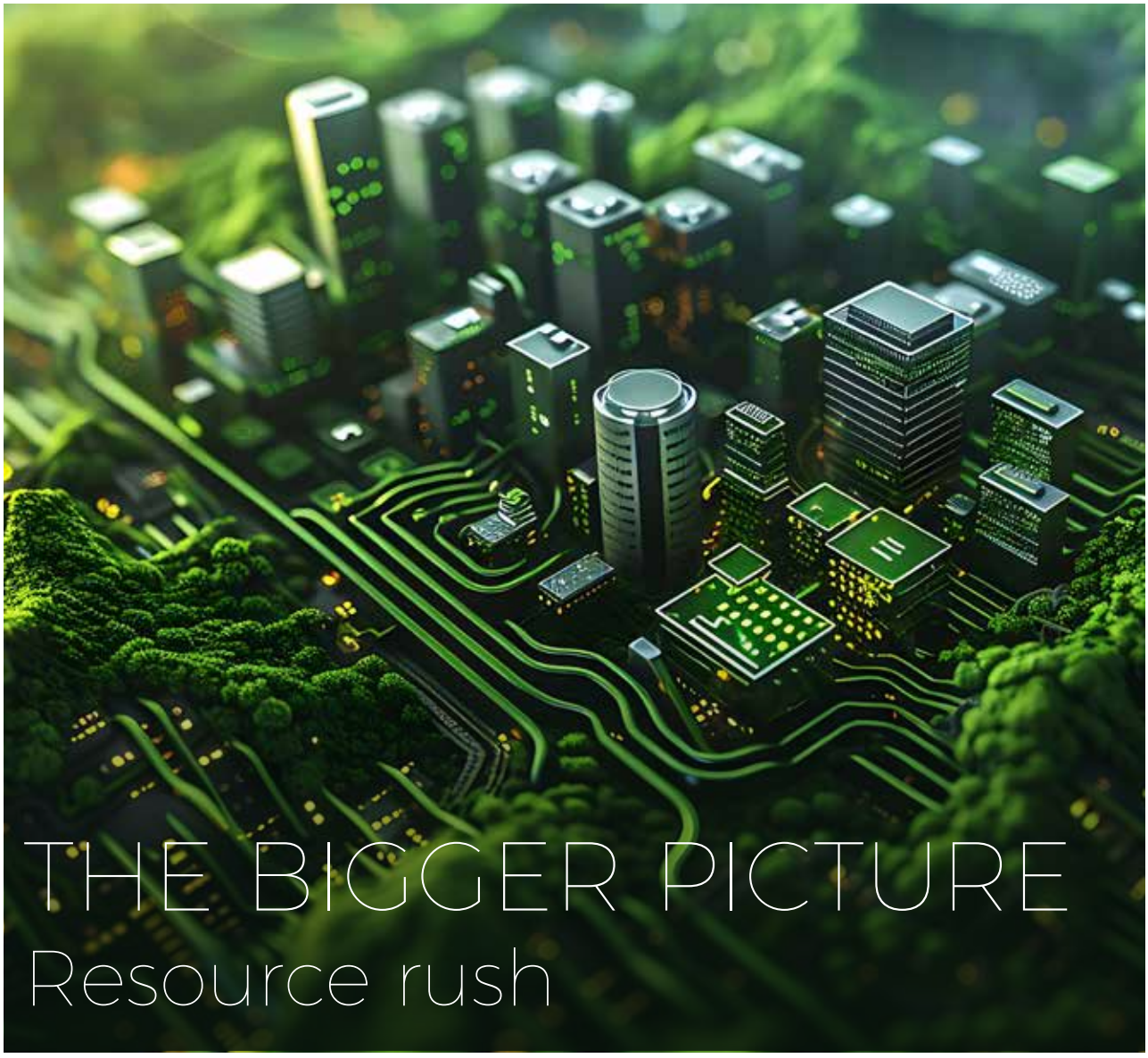


2

PART TWO: In Brief







THE BIGGER PICTURE

Resource rush

Humanity is at an inflection point. Given the speed at which new ideas can be transformed into practical businesses, technology has rarely been more exciting. We are witnessing a broad digital transformation across both corporate and personal lives.

However, **what happens when innovation comes up against economics?** Societies remain governed by the constraints of scarce resources. Add in the further complexities of demographics and geopolitics, and it soon becomes clear that **the human-machine era will be shaped by successfully securing resources**.

National security and artificial intelligence are increasingly being viewed as strategically significant, and in some cases existential. As a result, **international relations now operate under new rules and norms.** These are characterised by state intervention and the geopolitics of resource scarcity. We have moved *away from* a world defined by benign globalisation. Instead, affairs are increasingly shaped by economic nationalism around certain resources. Governments have become more willing to intervene in markets, with clear consequences.

One of the best characterisations of such a world view can be found in Tim Marshall's seminal 2015 work, *Prisoners of Geography* (updated most recently last year). Here, he argues that the physical geography of nations – mountains, rivers, plains, coastlines, climate and access to resources – exerts a decisive influence on their political choices, security concerns and foreign policy. One lens for understanding contemporary

conflicts and power dynamics is to view them as **the predictable outcome of geographical advantages and vulnerabilities**.

These dynamics serve to severely constrain what leaders can realistically do, regardless of ideology or ambition. **Energy systems, supply chains, infrastructure and national security capabilities are no longer treated as peripheral assets**. Instead, they have become strategic and scarce, and increasingly priced as such.

Growth alone is no longer sufficient. In a more uncertain world. **Resilience, reliability and control are becoming equally important measures of success**. The numbers already point to this shift. Global defence spending has risen to a record $2.9tr, approximately 20% higher than before the Ukraine conflict, according to the Stockholm International Peace Research Institute. Likewise, NATO's commitment to allocate 5% of GDP to defence extends beyond traditional military budgets to include wider investment in infrastructure, cybersecurity, logistics networks and strategic industrial capability.

The past year has been the *most visible* reminder of the new normal (the Russian invasion of Ukraine was the precursor). **Conflict in the Middle East demonstrated how the world is still highly dependent on both oil and shipping**. The latter carries 85% of the world's exports by volume and 55% by value (per Clarksons, a global maritime consultancy). Iran's effective control of the Strait of Hormuz continues to give it asymmetric geopolitical leverage, *despite* economic sanctions and conventional military limitations. The country is unlikely to give up this advantage for the foreseeable future. The threat of a renewed blockage will continue to hang over the Strait.

The weaponisation of Hormuz (and, more recently the Bab el-Mandeb Strait in the Red Sea) has changed the world. As Jack Fusco, the Chief Executive of Cheniere Energy puts it, the third Gulf War has "shone a bright light on the criticality of supply and the importance of energy diversity." Against this background, **governments and corporates will seek to stockpile more commodities and energy inputs**.

The shift from a just-in-time mindset to a just-in-case approach that was set in train by the COVID pandemic has accelerated. For decades, globalisation rewarded efficiency. Supply chains were built around minimising cost, irrespective of geography. Now, that calculation has changed. **The result is duplication, redundancy and strategic stockpiling**, all of which require additional capital and resources. Countries will look to build greater inventories of oil, coal and natural gas *at the same time as* massively increasing investments in domestic energy sources (nuclear, solar, wind and geothermal).

There is a new trend at work too. **Unlike previous digital revolutions, artificial intelligence is unusually resource intensive**. Every additional layer of compute requires power, cooling, semiconductors, metals and transmission infrastructure. **The more successful AI becomes, the greater the demand it creates for scarce physical inputs**. Against this background, as economies advance, vulnerabilities will *extend* from tankers and pipelines toward grids, cyber systems, critical-mineral processing, base metals, essential elements and power-electronics supply chains. AI cannot scale without the control of physical infrastructure. Digital infrastructure may be necessary for 21st century success, but it is *not* sufficient. Heavy assets with low obsolescence are in the vanguard – call it a HALO effect.

If **power (and the battle to build the best grid) is integral to winning the AI arms race**, then existing boundaries will continue to be pushed outwards. One useful framework for best understanding this new landscape is to think of the world as four domains. None is mutually exclusive and all are interlinked. To misquote the title of the famous 2022 film, countries will seek "everything everywhere all at once": they will go up (to space), down (to extract resources), in (to make humans stronger) and out (AI and humanoids to make us more productive).

Many of these ideas have already been addressed in our recent thematic work. However, to provide some additional context, **consider the Earth's orbit, the**

Arctic, plus the deep sea and the planet's subsurface layer as the key domains for new resource extraction, geopolitical competition and risk. This is the 'up and down' of our resource rush thesis.

Begin with our planet's orbit. The space between 160km and 35,900km above the Earth's surface (or low Earth orbit to geostationary orbit) constitutes a limited natural resource. It offers a platform for observation, communications, research and defence activities. **Space represents the digital infrastructure in the sky. It is becoming increasingly congested, contested and competitive**. Earth observation alone comprises a $440bn industry today, with a potential of up to $700bn, according to the World Economic Forum. In the future, control of space will be as *important* as dominance on land, sea and air. This has clear implications for the balance of power.

Meanwhile, **the Arctic is home to strategic mineral, energy and biological resources but also commercially and strategically valuable sea routes**. Russia, the US and Norway already extract large amounts of oil and natural gas from the region. In addition, the Arctic holds an estimated 13% of the world's undiscovered conventional oil resources and 30% of its undiscovered conventional natural gas resources (per the US Geological Survey), mainly in offshore basins under the frozen Arctic Ocean. Many countries, including those without an Arctic presence, will also seek increasingly to exploit the literal heat from the Earth. Geothermal energy can represent a key tool in the path to self-sufficiency in a world ever-more focused on energy security, **resource independence may prove as important as resource abundance**.

Going in and out will also matter. **Advances in AI, robotics and neurotechnology are fundamentally transforming how we work and pushing the boundaries of human potential**. Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%. By mid-century, the global population of people aged 60 years and older will double, topping 2.1bn. Furthermore, the number of persons aged 80 years or older is expected to triple, reaching 426m by 2050 (all data from the World Health Organisation).

An ageing population significantly increases the cost of health and social care, putting more burden on already scarce resources. **Longevity science and humanoid advances can make a difference**. We may be able to live both better and longer. "In the future, the line between what is human and what is technology will blur", believe 71% of people interviewed by VML Intelligence.

So, **who wins? It would be naïve to assume that the old order endures**. Most pertinent to the debate is **the rising dominance of China**. Of course, this is not a new notion, but part of a deliberate and institutionalised philosophy. China has been doing central planning (or five-year plans) since the 1950s. Its current one – the 15th – runs to 2030 and emphasises technological self-reliance, an expansion of research and development, and the ambition to strengthen China's position in global technology and supply chains.

China finds itself in a strong position. The country refines 60% of the world's lithium, with corresponding figures of 68% for nickel, 40% for copper, 80% for cobalt, and 68% for graphite. When it comes to rare earths, China's refining capacity is equivalent to an 85% global market share. The country also produces 80% of global solar cells, 70% of the planet's cathodes, and 50% of its computers and smartphones (all data courtesy of Bloomberg New Energy Finance, or BNEF).

Its advantages lie not just in natural resources and manufacturing capabilities. **China overtook the US in 2024 in terms of research and development spend**, measured on a purchasing-power parity basis. China's budget has been rising at the same time as America's has been shrinking. This increased spending has translated into a leading number of patents issued (900,000 last year, three times the level of the US and more than four times that of Japan, according to the World Intellectual Property Organisation).

Furthermore, China has now overtaken the US in terms of the number of articles contributed

to, or published in, *Nature*, a leading scientific academic journal. A report in *The Economist* also suggested that **China has more active AI researchers than America, Britain and Europe combined**. 40% of mentions of open LLMs in AI research papers are for Chinese models, according to data collected on Hugging Face. Although China's advantages are considerable, these do, naturally, need to be weighed *against* the country's challenges around demographics, indebtedness, governance and rule of law.

Project forward: in the future, advanced robots and AI *may* allow for anything to be built. In this world view, **the owners of the scarcest assets should clearly be the biggest beneficiaries**. These comprise a powerful combination of land, commodities and intellectual property. **The resource rush will only accelerate**. Consider also that over 70 countries accounting for more than 80% of the world's emissions have committed themselves to net-zero targets. Installing just 1MW of capacity in an offshore wind farm requires six times more scarce metal than in a gas-fired plant. Meanwhile, an electric car contains three-to-four times more copper than a petrol-fuelled one (per BNEF). Even if net zero targets fail to be met on schedule, the direction of travel should be clear.

Revolutions, of course, do not happen overnight. For now, America continues to project its dominance across multiple spheres. *If anything*, **the US has become more unilateral and transactional** in its approach to international relations. Although America's share of world GDP has fallen from its 2000 peak of 30%, it is still roughly similar to early-1990s levels, when the Soviet Union collapsed and China had yet to join the World Trade Organisation. The country still outspends all its peers on defence and continues to exploit the privileged role of its currency. The US Dollar is used for over 80% of global trade invoicing, while two American companies – Visa and Mastercard – run more than 70% of all credit card transactions (all data per Bloomberg). In terms of artificial intelligence, the US has the scope to leverage further its advantages in terms of existing capital, infrastructure and applications. A *less reliable* America may still be a preferable global hegemon than any other alternative.

However quickly the resource rush develops, **geopolitics will remain the flashpoint**. The politicisation of the Strait of Hormuz is perhaps a sign of things to come. Other potentially sensitive locations to monitor could include the Panama Canal or the Strait of Malacca. There are also Taiwan's semiconductor manufacturing capabilities, not to mention the expertise of the Netherlands in lithography (without which the semi industry could not operate). **The scope for miscalculation**, especially should incumbent nations seek to exploit domestic leverage, is significant.

Beyond these issues, **do not dismiss a 'tragedy of the commons' scenario**. This economic and ecological concept refers to individuals (or nation states) acting in their own self-interest, *despite* a shared, unregulated resource. Such a course of action ultimately ruins the resource for everyone. **Both the Arctic and outer space could be possible candidates**. We are all, ultimately, prisoners of geography.

A *more optimistic* future forecast might recognise that **exponential acceleration is not only fundamentally challenging, but also exciting**. Humans have always feared the unknown and been resistant to change. However, Darwin and Jevons trump Malthus and Ludd. *If* technology results in productivity gains, **lower input costs could mean more abundance**. Economics would then become less a discipline concerned with managing scarcity and more about how best to harness abundance. If civilisation is the product of human intelligence, then technology can raise our ambitions substantially. **The great question, then, for the coming decades is whether humanity can create abundance faster than it creates new forms of scarcity.**

HOW WE SEE THE WORLD CHANGING



2026 has been a year of records – and it's not over yet. Most readers of this piece will never have experienced a summer as warm as the one just passed. A hotter planet has clear implications for energy infrastructure and policy, increasing strain on already stressed resources. The unceasing boom in artificial intelligence investments only adds to the pressure. Record sums will be spent on data centre infrastructure this year. The reason for this is simple: AI capabilities continue to expand at an unprecedented pace. This has ramifications for all industries. We are already seeing clear benefits within factories, on our streets and in research labs – think humanoid robots, self-driving cars, accelerated drug development and more.

As in our previous compendiums, we present below a summary of how and where we see the world changing most rapidly. Please note, this review is non-exhaustive; think of it rather as a series of interlinked high-level perspectives. Our stance remains that as diverse future trends overlap and intersect, they become mutually reinforcing.

THE GREAT DATA CENTRE BUILD-OUT



Season Eight Blog posts:
Top themes for epic uncertainty (10 April); HALO effect (14 May); Staying cool and chilling out (04 August); Disruption on steroids (21 October).

Relevant Theme Pieces:
The Data Deluge (March 2011); Keep the lights on. Make the grid smarter. (September 2022); Your questions on AI (answered by a human) (March 2023).

"The build-out of AI factories [data centres] represents the largest infrastructure expansion in human history – and it is accelerating at extraordinary speed"
Jensen Huang,
Chief Executive and Co-Founder of NVIDIA

If there is one story that has captured attention throughout the year, then it has been just how quickly the capital expenditure budget of the hyperscalers has continued to grow. **Global spending on AI hardware and software was just over $1tr in 2024. This year it will likely double**, according to Gartner.

A large portion of this spend is accounted for by the hyperscalers – the technology giants that operate massive cloud and data centre infrastructure at global scale. FactSet consensus estimates indicate that **Alphabet, Amazon, Meta and Microsoft will spend over $750bn on new data centre build this year, up more than 80% versus their 2025 spend.** Just ten years ago, these four businesses spent a cumulative $31bn. If Oracle's capital expenditure were included in the 2026 estimate, then it would rise to at least $840bn.

Have no doubt, these are big figures. For context, the global telecoms industry spends roughly $300bn annually on network investments. Meanwhile, oil and gas companies allocate around $1tr to new capital spending. Another way of thinking about hyperscaler capex spend is to consider that **$750bn is equivalent to roughly 2% of US GDP**. Put another way, such a sum is *more than* the combined military spending of Germany, France, the UK, Japan and Italy. Equally, compare it to the

$711bn of net new bank lending that occurred in the US last year (all data courtesy of JPMorgan).

Project out and the direction of spending is heading only one way – upwards. A recent McKinsey study suggested that **the total bill for global data centre buildout and related power infrastructure might reach $7tr by 2030**. This would be greater than the combined GDP of Germany and Japan. On an even longer-term view, cumulative global data spending might reach over $30tr by 2050, based on a recent PwC forecast. If such figures are to be believed, then it will be critical that supply and demand expectations remain appropriately matched. There are clear implications for energy and water consumption too.





WE NEED MORE INFRASTRUCTURE!

Season Eight Blog posts:
The year of water (29 January); Bites from the Big Apple (16 March); Top themes for epic uncertainty (10 April); HALO effect (14 May); Staying cool and chilling out (04 August).

Relevant Theme Pieces:
What happens when the lights go out? (May 2011); Liquid data: digitalising the water sector (February 2022); Keep the lights on. Make the grid smarter. (September 2022); Your questions on AI (answered by a human) (March 2023).

If "data centre demand will keep going into the next decade..."
Maria Ferraro,
Chief Financial Officer of Siemens Energy

...then "we've got to build infrastructure..."
Duke Austin,
Chief Executive of Quanta Services

...because there is an "unprecedented need for new generation capacity"
Dan Shugar,
Chief Executive and Co-Founder of Nextpower

The US has over 4,400 data centres operational – almost eight times the next nearest country (the UK). It is currently *planning* to build another 3,000 (based on figures from Statista and other publicly available information). The tripartite quote above highlights the importance of the infrastructure debate. However, **building new data centres is *non-trivial***. Morgan Stanley estimates that **fewer than 10% of all large infrastructure projects get built on time**. Complexity is typically underestimated and exogenous factors often ignored.

Against this background, readers should perhaps not be surprised to learn that *just* as the capital being spent on new data centres is reaching all-time highs, so is the number of delayed and blocked projects. **Around half of all new proposed buildouts are facing some form of current delay**, according to Axios. The reasons for this are multiple, spanning equipment shortages, interconnection and

generation issues, local land use, and environmental permitting requirements. NIMBYISM (not-in-my-backyard) is a well-known phenomenon, but one recent Gallup survey suggested that **people in America would rather live next to a nuclear power plant than a data centre**.

Winning over local opposition may be one thing, but building a data centre is quite another. Consider that **a 1GW data centre is an extraordinary piece of infrastructure:** running continuously, **it would consume 8.8TWh of electricity a year, roughly equivalent to the annual use of up to 1m homes, while the campus itself could cover the equivalent of over 100 football pitches**. Now imagine these filled with 200,000 tonnes of equipment. Roughly half this might comprise steel. For context, London's Wembley Stadium contains about 23,000 tonnes of steel and the Shard, its tallest building, some 12,000 tonnes (per information from Severfield, a steel manufacturer). The remainder would comprise cables, fibre, pipes, generator sets, transformers, chillers, switchgear.

Another way of thinking about this topic is to consider that **the bill of materials for a 1GW data centre might comprise at least $40bn of expenditure**, according to work conducted by Bridgewater. The majority of this spend (almost 70%) would likely be on IT equipment – mainly semiconductor chips in the form of compute and graphic processing units. Construction accounts for only ~15% of the bill.

Assume then that you can get your data centre built. What many operators are now finding is that **the binding constraint is no longer land or capex, but time to power**. The International Energy Agency (IEA) believes that grid constraints could delay about 20% of global data centre capacity planned for construction by 2030. Almost every piece of critical infrastructure is subject to significant lead times. Siemens Energy – the source for one of the opening quotes in this section – suggests that customers may need to wait up to five years for turbines and as many as seven for grid connections. **Potential winners will be those who secure power early, pre-order long-lead equipment and diversify effectively by geography**.

An equally critical consideration is **can the world produce and deliver enough electricity to sustain the AI and data centre boom?** Data centres globally consumed about 1.5% of total electricity in 2024. By 2030, this figure could double, per the IEA. Most of the demand is clearly in the US, where data centres are projected to consume 12% of the country's power by 2030, and 20% by 2035, on current projections made by Bloomberg New Energy Finance.

Even without AI, there is a critical need to invest in energy infrastructure, given ageing existing equipment combined with increasing constraints. More extreme weather conditions and the growing risks of cyber compromise – both discussed in more detail later – constitute key concerns for utilities globally. Quanta Services, a leading US infrastructure construction business, estimates that **$1.5tr needs to be invested in grids, high voltage transmission and power generation in the US over the five years to 2030**.

Don't forget water. This is a much more complex input than power for two reasons: geography and regulation. You can't easily move water across state lines, and a patchwork of state and local rules implies a highly fragmented industry. Like the electricity grid, the average age of a water pipe in the US is around 45 years. Useful service life is estimated at circa 50 years. AI is forecast to require an additional 31 trillion litres of water per year by 2040 (per Xylem), albeit that the manufacture of semiconductors is markedly more water-intensive than running a data centre.



AI, OR ABUNDANT INTELLIGENCE



Season Eight Blog Posts:
At the AI coalface (11 February); Where technology meets humanity (04 March); How we really feel about AI (09 March); Coffee with the CTO, 2026 edition (23 April) The agentic age (28 April); If everything can be faked… (08 June); Computer says yes (11 August); When agents go rogue (20 August); The good, the bad and the ugly (06 October); Disruption on steroids (21 October).

Relevant Theme Pieces:
Artificial Intelligence: The rise of the smart machine (April 2016); Your questions on AI (answered by a human) (March 2023).

"We see a future where intelligence is a utility like electricity or water and people buy it from us on a meter"
Sam Altman,
Chief Executive of OpenAI

There remains a certain wonder attached to seeing energy transformed into intelligence. **Few innovations in history have advanced as rapidly as modern AI**. In the space of just a handful of years, systems have progressed from making simple mathematical mistakes to designing production-ready software, assisting with advanced scientific reasoning and becoming indispensable tools for many of the world's most capable software engineers. The latest generation of models has taken another step forward, with AI now playing a growing role in the creation, testing and refinement of *future* AI systems.

Listen to tech leaders. Satya Nadella of Microsoft has said that AI already generates almost 30% of code in certain projects, with the share continuing to rise. Meta's Chief Executive, Mark Zuckerberg, has argued that AI could soon undertake around half of the company's software development work. Taken together, these comments suggest that **AI is rapidly evolving from a coding assistant into a core participant in**

the software engineering process.

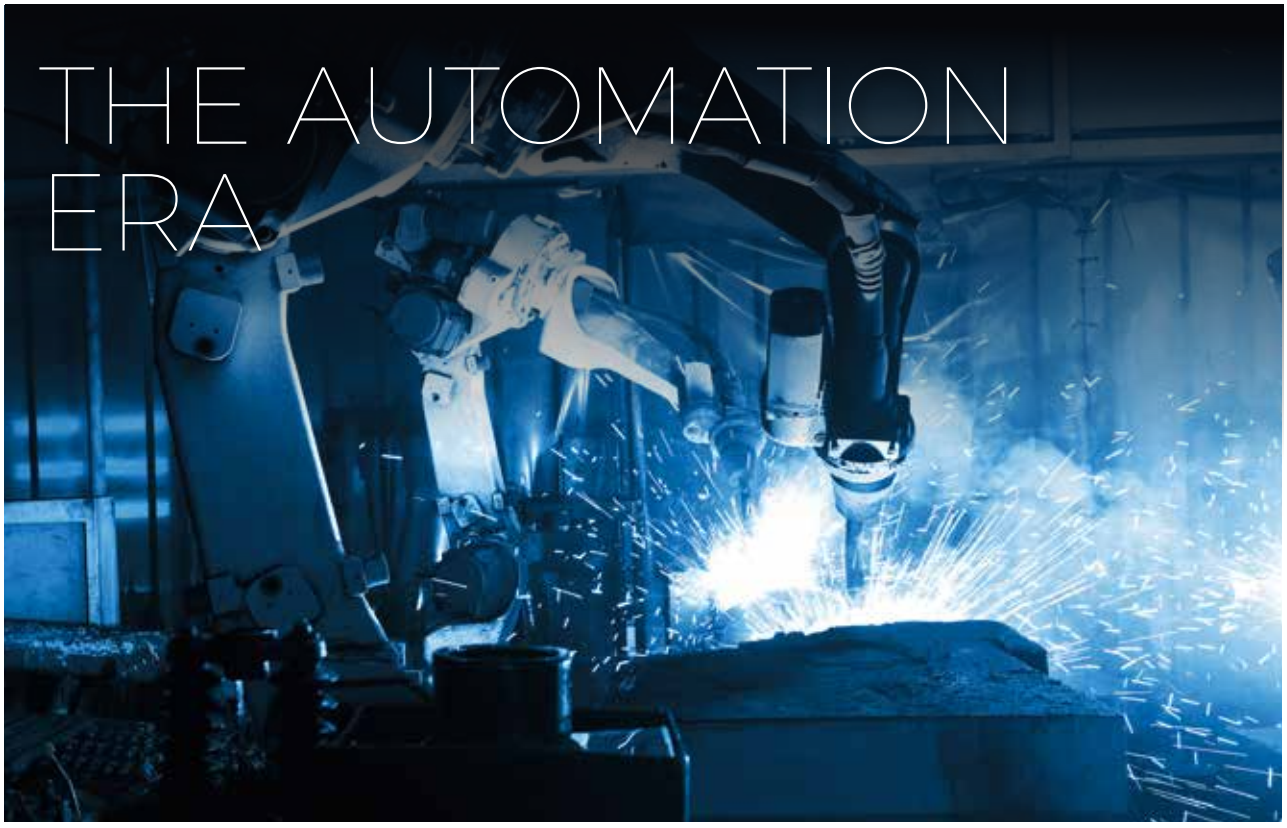
Outside of tech, **many businesses across diverse industries are reporting tangible efficiency gains**. Hasbro believes that AI can reduce toy design – from concept to physical prototype – by 80%. Meanwhile tobacco company, Altria, has said that the technology has helped it cut the time required to create new marketing content by 50%. In the world of logistics, C. H. Robinson has reported a 50% improvement in productivity driven by internal AI agents (measured in terms of shipments per employee), with a ~30% reduction in employee headcount. Bank of America has said that AI means that it needs around 2,000 fewer people now to write code. The challenge, of course, remains translating isolated productivity gains into economy-wide improvements.

No surprise, then, that **of 250 multinationals polled by Gartner, 83% said they expected to spend more in 2026 on AI than in 2025**. This dynamic also helps explain why 86% of all venture capital funding in the first half of this year went to AI businesses, up from 65% in the same period a year prior, according to Pitchbook. Given the speed at which AI reasoning capabilities are evolving, artificial general intelligence (AGI) – or human-level intelligence – may be here closer than many expect, *hopefully* with few adverse effects.

65% of people polled by Pew may worry that AI will reduce the number of jobs available in America. They should, however, bear in mind that roughly half of the country's employment growth in the thirty-year period through to 2020 came from jobs that did *not previously exist*, according to research from MIT. Consider that the roles which are likely to see fastest net growth through to 2030 are big data specialists, fintech engineers, and machine learning specialists, in that order, according to the World Economic Forum.



THE AUTOMATION ERA



Season Eight Blog Posts:
Robots? Yes please! (05 February); Germany's greenest warehouse (06 May); Delivering smiles (and toilet paper) (20 May); The robot coffee test (13 July); Faster, higher, stronger - together? (01 September).

Relevant Theme Pieces:
The robot revolution (July 2012); Robotics 2.0: the rise of the service robot (April 2017); Drones: Now ready for take-off? (October 2022); Warehouses: Unsung heroes of the modern world (June 2024); Humanoid Robots: the real robot revolution (February 2025).

"AI is moving into every device and every physical system"
Rene Haas,
Chief Executive of
ARM Holdings

Listen to Jensen Huang and **the physical AI opportunity could be as much as $50tr**. He did not provide a timeframe, but the World Economic Forum believes that **automation could add $15tr to the global economy by 2030**. Perhaps easier to quantify is the assumption made by Barclays that the industrial automation, humanoid robot, autonomous vehicle and drone markets combined could be worth $1.4tr by 2035. These are big numbers. In each case, the key question is what needs to happen for us to get there?

Begin from the premise that with roughly 8m factories and 2.8bn buildings globally (per Bloomberg), **it is cheaper and far more scalable to adapt robots to human environments than to rebuild the physical world around them**. There were 4.7m industrial robots operating in factories worldwide at the end of 2024 (the last year data was formally released by industry body, the International Federation of Robotics), more than double the number in use a decade ago. This is equivalent to 177 for every 10,000 manufacturing workers. These figures are almost certainly higher now.

Project forward and global robotic

deployments could reach 65m by 2040, according to MP Materials. Another study (by RethinkX) suggests that by this timeframe, more people will either own or rent a robot than a car. 73% of people polled by VML Intelligence believe that "in the future people and digital humans will work side by side." Whether adoption follows this trajectory will depend heavily on economics, regulation and customer acceptance.

The current evidence is encouraging. Consider Amazon. It now has more robots deployed in its warehouses than the rest of America and Japan combined (over 1m, versus ~950,000, according to a New York University study). Amazon has said that at least 40 of its delivery fulfilment centres are equipped with robots, which are generating estimated cost savings of ~$4bn annually, per Morgan Stanley. Further supportive data are provided by Walmart. The retailer has said that more than 50% of its fulfilment centre volume is now automated, resulting in a ~40% reduction in the US of net delivery cost per order.

Expect more industrial robots, but humanoids too. Close on 15,000 humanoids were delivered in 2025, almost five times the level of the year prior. By the end of 2026, the figure could reach 50,000 units, implying a market worth ~$5bn (data from Omdia and Morgan Stanley respectively). As costs fall, volume should scale. China's Unitree R1 humanoid – the current most popular model – costs just $5,900 per unit.



THE CAR OF THE FUTURE



Season Eight Blog posts:
Robo(taxi) wars (13 January); Hands off the wheel (17 June).

Relevant Theme Pieces:
The car of the future: the long road to autopia (April 2015); TAAS: the new transport revolution (February 2017); Autonomous vehicles: Arriving soon in autopia (April 2026).

"The ChatGPT moment for physical AI is here – when machines begin to understand, reason and act in the real world... robotaxis are among the first to benefit"
Jensen Huang,
Chief Executive and Co-Founder of NVIDIA

Waymo autonomous vehicles have now driven over 220m cumulative miles and are logging around 500,000 trips per week, not only in cities (the 11 where it is operational, soon growing to 14), but also on motorways and at airports. These are impressive statistics. Just a year prior, Waymo was doing 876,000 rides a *month*, a sixfold rise relative to 2024's number.

Furthermore, data show that Waymo's vehicles result in 82% fewer injury-causing crashes than human drivers in the cities it serves. There is also a 94% reduction in crashes involving serious injuries or worse and 93% fewer crashes involving pedestrian injuries when Waymo's are involved. According to the Insurance Institute for Highway Safety (the source for the above statistics), **a Waymo is more than ten times safer than the average human driver**.

Do not forget, however, **innovations take time to scale**. Uber estimates that autonomous vehicles *globally* will complete around 50m trips this year. For context, the ride aggregator says that customers will take around 3bn journeys using its services in 2026. In other words, the autonomous vehicle industry is still nascent. **Autonomous vehicles may only account for around 20% of all ride-share trips in the US by the end of this decade**, per the Forecasting Research Institute.

Prospects for autonomous trucking look brighter. While the global robotaxi addressable market might reach $415bn in a decade's time, the equivalent opportunity for autonomous trucks could be worth $560bn, according to Goldman Sachs. Another study (by JD.com, in China) suggests that AI-assisted lorries will result in a 30% reduction in drivers deployed in the industry, generating meaningful savings for businesses' transportation costs. By 2028, it could be cheaper (on a per mile basis) to operate an autonomous truck than a human-driven one.

HEALTHCARE: USE DATA, SAVE LIVES



Season Eight Blog Posts:
Dare to be different (7 January); Breaking the obesity trap (21 January); Why we die (26 May); Just scratching the surface (29 September).

Relevant Theme Pieces:
Fat profit potential: bulging bellies and growing obesity (April 2012); Reinventing healthcare and the coming age of personalised medicine (November 2012) Longevity science: Who wants to live forever? (October 2019); Alzheimer's: The final healthcare frontier (April 2024); Longevity Science: Time To Turn Back Time (September 2025).

"The combination of AI plus analytics will empower healthcare organisations to harness data and unlock unprecedented visibility"

Anurag Mehta,
Chief Executive of
Omega Healthcare

Healthcare is the area where the application of big data and artificial intelligence could make the *biggest difference*. **Populations in the western world are ageing and managing an increasing burden of chronic health issues, resulting in rising costs**. Healthcare spending in the US accounts for 18% of GDP, a figure which could reach 20% by 2030. Keeping costs at this level of GDP in 2050 would require generating cumulative savings of over $2tr, according to Morgan Stanley.

Shifting the paradigm matters, especially since .half of all US healthcare expenditure in any given year is concentrated on roughly 5% of the population, and a fifth on just 1%, based on calculations from a16z, a venture capital firm. Technology can be leveraged across the value chain, from hospitals – the largest category of healthcare costs – through to drug development. Imagine how **AI in hospitals might be used to make operations more efficient, improve scheduling, supply chains, record-keeping, adherence and staffing**.

When it comes to drug development, the benefits could

also be significant. At present, fewer than 10% of all candidate drugs ever make it to market, yet the cost of developing each successful drug might total over $2bn. Robot chemists, however, are scaling drug discovery at ten times the rate of humans, conducting over 1,000 experiments daily. These developments could result in **a fourfold decrease in drug development costs** with new drugs being commercialised at almost twice the current pace (per work from ARK Invest). Novo Nordisk recently announced, for example, that it will cooperate with Anthropic to speed drug development.

Viewed from the other perspective – that **healthcare needs to become more patient-led and pre-emptive** – consider that within the next five years almost 75% of respondents to an EY study believe that they will routinely use technology to self-diagnose healthcare issues before seeing a professional. At the same time, however, survey results also show a significant level of trust remaining with doctors. 89% say their doctor is reliable, compared with 68% for AI tools.



THE DATA DELUGE, REVISITED



Season Eight Blog Posts:
Where technology meets humanity (04 March); Bites from the Big Apple (16 March); Welcome to the Novacene era (24 March); Coffee with the CTO, 2026 edition (23 April); The good, the bad and the ugly (06 October).

Relevant Theme Pieces:
The Data Deluge (March 2011); Drowning in data (October 2012); Ten Years On: The Data Deluge 2.0 (October 2020).

"Data demand is unprecedented... [it] will exceed supply for the foreseeable future"
Christophe Fouquet, Chief Executive of ASML

Whether it's in large language models, factories, autonomous vehicles, medical research or *anywhere else* for that matter, one thing is irrefutable: **the amount of data we produce and consume is only heading upwards**. Humanity now generates around 400 quintillion bytes of data every day (according to IDC). Put differently, every 24 hours we create enough digital information to fill roughly 1.6 billion smartphones.

Take Gen-Z as a case study. Those currently aged 14 to 29 – which would include your author's two teenage children – spend an average of 7 hours and 43 minutes per day looking at screens. Annualise that number and it comes out at 118 calendar days. For context, we spend roughly 122 days of any given year asleep (data from the dcdx Gen-Z Time Screen Report). A typical American might check their phone 186 times a day.

No surprise then that **mobile network data traffic is forecast to grow at a 17% compound annual growth rate through to the end of the decade**. Meanwhile, total data generated over the same period should see an annual growth rate of 25% (figures from Ericsson and IDC respectively).

The AI infrastructure build discussed earlier is just part of the story. Worldwide IT spend is expected to reach $6.3tr this year, up 13.5% relative to 2025's figure, per Gartner. Beyond building data centres, think about semiconductor fabs – the factories that make the chips that power phones, computers, cars and more. **A modern semiconductor fab might typically cost $10-30bn to build, making it one of the most expensive factories on Earth**. There are, according to Dr Wei, the Chief Executive of TSMC, "no shortcuts."

CYBERSECURITY: KEEP IT SAFE



Season Eight Blog Posts:
Top themes for epic uncertainty (10 April); "A polite punch in the face" (16 April); Coffee with the CTO, 2026 edition (23 April); If everything can be faked… (08 June); When agents go rogue (20 August); Disruption on steroids (21 October).

Relevant Theme Pieces:
Watch out! The growing privacy invasion and cybercrime threat (April 2014); Cybersecurity: the next generation (September 2017); Cybersecurity: The more things change… (September 2024).

"In an AI threat environment, there is nowhere to hide… CEOs are waking up to cyber [spending] as the new normal"
Nikesh Arora,
Chief Executive of
Palo Alto Networks

Cyber espionage and warfare are ranked as the fifth biggest risk facing the world, according to the World Economic Forum's annual Global Risks Report. Only the spread of misinformation and disinformation (which may be exacerbated by malicious cyber actors), extreme weather events, societal and political polarisation, and the cost-of-living crisis rank more highly. There are many reasons why cybersecurity ranks highly in studies such as these, for **data have no value *unless* they are secured**.

Global cybercrime costs passed $10tr in 2025, a figure that is *larger* than the GDP of every country on Earth, except for the US and China. No surprise then that **worldwide cybersecurity spending could reach almost $250bn** (figures from Statista and Gartner respectively). 87% of global organisations say that they have experienced some form of cyberattack in the past 12 months, while the comparable figure for consumers is 80% (according to reports from Alpine Macro and Mastercard respectively).

The average cost of a data breach to a corporate is $4.4m, a figure which rises to $10.2m in the US (information again from Alpine Macro), while the FBI's 2025

Internet Crime Report shows that Americans were defrauded of $21bn last year, with losses up 37% year-on-year.

The biggest culprit is, un-surprisingly, artificial intelligence, which has enabled malicious actors to increase both the frequency and the sophistication of their cyberattacks. Palo Alto Networks believes that **adversaries can launch attacks up to 100 times faster with AI**. Research from MIT suggests that **AI now powers around 80% of ransomware attacks**, while a recent study from Forrester suggests that rogue AI agents (non-human identities acting inside a workplace environment without a robust identity access management system to track them) constitute the largest cyber threat. At the same time, do not forget that 88% of security incidents still stem from human error (per ISACA, an industry body).

Two-thirds of organisations globally say that they are planning to increase their investments in cyber risk protection over the next 12 months. Chief Executives are most worried about cyber fraud, with ransomware ranking second (data from the World Economic Forum). While encouraging, it remains a concern that over 30% of business leaders polled in the same report have low confidence in their nations' ability to respond to critical infrastructure attacks. It's time to get spending on cyber.





Season Eight Blog Posts:
The year of water (29 January); Where technology meets humanity (04 March); Welcome to the Novacene era (24 March); Four fun things (30 July); Step on the gas (23 September); The energy trap" (12 October).

Relevant Theme Pieces:
Winds of change: the growing case for renewables (March 2018); Solar Energy: Everybody loves sunshine (January 2020); Winds of change: offshore edition (September 2023); The sun beneath our feet: the growing case for geothermal (April 2025).

"A secure [energy] portfolio must be a diverse portfolio"
Jack Fusco,
Chief Executive of
Cheniere Energy

A combination few would have foreseen at the start of the year of **war in the Middle East** and **record summertime temperatures** has served to refocus attention on energy supply. Security and diversity of supply have moved to front of mind for all governments as well as their national utility operators. Additionally, if evidence were needed for global warming, then 2026 must surely represent a prime case study.

Global temperatures are currently rising twice as fast as they were in the 1980s, with 2026 likely to go down as the warmest year on record (according to the United Nations). 64% of Americans say that they are "somewhat worried" about global warming, while 86% of people polled globally assert that they are concerned about the state of the planet they are leaving for future generations (data from Exploding Topics and the World Health Organisation respectively). These dynamics create **an urgent capital reallocation opportunity**.

Change is already underway. The solar, wind and storage sectors invested a combined record $79bn in new US projects in 2025, with solar and wind installations set to outpace comparable fossil fuel deployments by a factor of 200 to 1 over the three years through to 2027 (per the American Clean Power Association and the Federal Energy Regulatory Commission respectively). Another study (from Ember) suggests that solar added twice as much to global electricity generation last year as any other energy source.

As a result, for the first time in history, renewables have overtaken coal as the largest source of global electricity, with wind and solar covering all growth in the first half of 2026, according to Science Magazine. **By 2032, solar alone is on track to become the world's largest source of electricity**, accounting for a 20.5% share, according to Bloomberg New Energy Finance.

Progress might be encouraging, but **meeting climate goals will require over $4tr of annual new investments through to 2030, according to the United Nations. Current spending levels are three times *below* this level**. Conflict in the Middle East only complicates matters. The good news is that once an economy shifts *away* from crude oil, it rarely shifts back. Beyond renewables, both nuclear and coal (the latter more so in emerging economies such as China and India) will likely get a push. Diversification makes sense, but the battle to save the planet is far from won.



HONOURABLE MENTIONS

There is, sadly, never enough space in this publication to cover all the topics that deservedly merit attention. Prior compendiums have discussed topics as diverse as food innovation, hydrogen, the metaverse, online dating, plastic waste and quantum computing. **Separating hype from reality remains a critical mantra** when it comes to thinking about (and then investing in) the future.

Against this background our bonus topics for this year comprise: space and more power to autonomous AI agents. These themes feed *directly* into the other areas in which we see the world changing: space is more about data than interplanetary tourism, and retail is a prime industry waiting to be disrupted by new technologies.

Space: Digital Infrastructure in the Sky

Space is indispensable for life on Earth. Control of this domain is becoming as important as dominance on land, sea and air. Yet, it is becoming increasingly congested, contested and competitive. The reason why is that **getting a satellite into orbit has become more than 90% cheaper over the past two decades** (per Orbital Radar). What was once the preserve of governments and the largest corporations is increasingly becoming accessible to start-ups, universities and even small nations. **Over the next decade, up to 50,000 new satellites may be launched into space**, representing an almost threefold increase in the number of objects currently orbiting the Earth (per MDA Space). By 2035, the space economy could be worth up to $1.8tr, according to Goldman Sachs. Project even further forward and one day we may have data centres in space, certainly if Elon Musk is to be believed. However, on present costings, an orbital data centre would cost almost three times its ground-based equivalent, according to a report in Tech Crunch. Building communities on the Moon would clearly cost far more.

More Power to Agents

Think of agentic commerce as the **third wave of transformation within the e-commerce landscape**. First, shoppers could buy online via their desktop. Then came mobile shopping. Now, *someone else* can make the purchases. Consumers are getting more comfortable using AI assistants to streamline tasks and receive personalised recommendations. By decade-end, 40% of consumers could be using AI assistants for shopping comparison purposes, even if only half this figure might feel comfortable letting the agent make the purchase, according to a recent PwC study. The lingering concern remains whether agents will act in consumers' best interests. Even so, by 2030, the gross merchandise value realised from agentic e-commerce could reach $400bn, based on research by Raymond James. As more retail moves online – whether consumer-led for convenience, or agent-inspired – it will require more warehouse space. Each percentage point of retail spending that migrates online requires roughly 50 million additional square feet of warehouse space, creating billions of dollars of incremental demand for logistics real estate (according to Prologis). And the **flywheel keeps turning:** more warehouses mean more opportunities for AI and automation.

3

PART THREE: Recent Thematic Work







FLYING START – THE GROWING CASE FOR EVTOLS

Executive summary: Urban transportation networks could soon be transformed by electric vertical take-off and landing aircraft (eVTOLs). A combination of a supportive regulatory environment, improving technology and falling costs has resulted in the emergence of a nascent industry. Trials are underway around the world. The promise of urban air mobility is one of faster and safer transportation, increasing capacity and reduced environmental emissions. As the industry scales, it could be worth $30bn within a decade, and substantially more if freight and logistics are added in. Over time, taking an eVTOL could be as easy as hailing a taxi. The journey won't be linear though, given inevitable regulatory delays, safety issues and other practical concerns. Unit economics are also open to debate. Two US businesses (Archer Aviation and Joby Aviation) have established an early lead, while Uber is positioning itself as a demand aggregator. The eVTOL industry appears to be off to a flying start.

Booking an air taxi could be a lot like hailing a ride on Uber

Watch here

The space between the ground and the next thousand metres up may be **humanity's most under-utilised resource**. But not for much longer, if the sky is soon filled with electric vertical take-off and landing aircraft (eVTOLs). Their scope for revolutionising urban transportation and logistics services could be transformative. Even if a world full of flying taxis may sound like the stuff of science fiction, the vision is already beginning to take shape.

Think of urban air mobility as being an emerging aviation ecosystem that uses highly automated eVTOL aircraft to transport passengers and cargo over low-altitude urban routes. Unlike helicopters that have a single rotor mast, eVTOLs have multiple smaller rotors. This makes them both safer and quieter. Ask people how they feel about them and **98% of US airline travellers say they would consider taking an eVTOL.** An additional 79% say they would travel more often if air taxis were available (data from a 2025 survey conducted by Honeywell).

The concept of flying cars is not a new one. As early as 1917, inventor Glenn Curtiss pioneered the 'Autoplane'. Three years later, Henry Ford began prototyping 'plane cars' as single-seat aircraft, but halted development after a fatal crash in early tests. Beginning in the early 1950s, air operators offered air taxi services via helicopters in a handful of US cities, including New York, Los Angeles and San Francisco. At peak, more than 30 helicopter flights occurred daily between JFK airport and downtown Manhattan. Services were halted in 1979 after a crash in 1977 killed four people on the roof and one on the ground below.

Fast forward to now. A new series of entrepreneurs are in the vanguard. Flying taxis are becoming an increasingly common reality owing to four key factors: **a more supportive regulatory environment, a race for supremacy between the US and China, improving technology, and falling costs**. These have all been accompanied by growing proofs of concept.

For the Trump administration, eVTOLs and advanced air mobility represent **strategic technologies that are tied to national security, supply chain resilience, and military capability**, particularly given their overlap with drones and other autonomous systems. Dominance in next-generation aviation could also influence control over global standards, export markets, and high-value manufacturing jobs.

Against this background, in December 2025, US Transportation Secretary Sean Duffy and the Federal Aviation Administration (FAA) announced the eVTOL Integration Pilot Program (EIPP). This is aimed to accelerate the deployment of eVTOLs in the US. More than 20 projects have already begun. **Formal FAA approval for urban air mobility could follow as early as next year**. As a measure of its ambitions, China declared in March that the low-altitude economy – drones and electric air taxis – had been formally classified as an 'engine of growth', alongside other critical industries such artificial intelligence and quantum computing.

Manufacturers in both countries have benefited from technological advancements. **Better battery performance has been the primary enabler**. The broad industry consensus is that their energy density is now 30-50% higher compared to five years prior owing to the increasing use of nickel and a shift towards solid state cells. At the same time, propulsion and power electronics have also improved. Motor power density has roughly doubled over the last five years. Lighter motors enable better payload and range trade-offs.

AI has been another important factor, driving a massive improvement in simulation capabilities, whether in terms of virtual flights or digital twins. As a result, manufacturers can go through faster iteration cycles with significantly less physical prototyping. Industrial partnerships have also helped spur development of the eVTOL industry. Auto manufacturers such as Stellantis and Toyota as well as airline businesses including Boeing are involved, sharing their knowledge of scaled and automated manufacturing processes. Bespoke eVTOL prototypes cost $5-10m five years ago. Today, **most manufacturers see visibility to a $1-3m price per vehicle range**.

Cast your eyes skyward and

you may even see eVTOLs above you. In November 2025, China's EHang became the first company in the world to obtain aerospace regulatory approval to commercially operate pilotless eVTOLs. These are currently available just for sightseeing in Hangzhou and Hefei. In New York, Joby Aviation completed the city's first point-to-point eVTOL air taxi flight in April, operating between Kennedy airport and a heliport site on Manhattan's West 30th Street.

Similar test flights have run in several US states. Other trials are underway in countries as diverse as Brazil and India. Developments in the Middle East – which had been seen as one of the leading locations for eVTOLs – have been put on hold owing to current conflict in the region. In all locations around the world, journeys are taking place along existing helicopter routes and with pilots (rather than automated computers) operating the vehicles.

The case for eVTOLs versus helicopters ought to be clear. The former are markedly quieter (by up to 100 times, on most estimates), have no single point of failure and are explicitly built with multiple redundant systems. At the same time, **eVTOLs are not trying to compete against multi-hour flights or car journeys**. The idea is that passengers could fly from downtown Manhattan to the airport in less than 10 minutes. By car or train this could take an hour. Alternatively, imagine flying into Newark, taking a drone to JFK airport, and then connecting through to your next destination.



eVTOLs could be transformative in an urban context. Cities are constrained by fixed road and rail capacity. Travel times are non-linear and unreliable – think about rush-hour gridlock. By contrast, **eVTOLs bypass ground congestion entirely, operating point-to-point in the air and delivering predictable, linear journey times**. They effectively unlock a new dimension of capacity. Urban transport today is 2D (roads, tracks) and expanding via new rail routes or road widening it is expensive and slow. eVTOLs add effective 3D capacity without major land use changes. Consider too the potential environmental benefits of increased transport electrification and accompanying lower emissions.

Booking an air taxi could be a lot like hailing a ride on Uber or Lyft (Uber even previewed its 'Uber Air powered by Joby' service at a press event in Dubai in February, just days before hostilities began). Riders simply enter their destination in the *where to*? bar, as usual. If their trip qualifies, Uber Air powered by Joby will appear as an option. With one tap, the app can then book every leg of the journey, including Uber Black pickup and drop-off at Joby vertiports.

98% of US airline travellers say they would consider taking an eVTOL

For many, your author included, taking an eVTOL sounds like an enticing proposition. But does it



eVTOLs could be transformative in an urban context

make economic sense? Today, the effective cost per passenger mile is equivalent to that of a helicopter ride. **Over time, the industry believes that taking an eVTOL will be equivalent to a paying for a premium ride-hailing service** – only five to ten times faster, and at greater safety than in a helicopter or even driving on the ground.

In any discussion over **eVTOL economics** several factors need to be considered. These include utilisation – hours in flight – and load factor, or passengers per flight. Battery life, turnaround and charging time will also play a role, as will whether eVTOLs are piloted manually versus autonomously. The latter can reduce the cost per flight by up to a third, according to most industry experts. Clearly, as the overall eVTOL ecosystem scales (and shifts towards autonomy), payback periods will come down, and unit economics correspondingly improve.

Most forecasts from consultants and investment banks size **the eVTOL industry as being worth up to $30bn over the next decade**. These models typically assume limited fleet sizes, early infrastructure and premium pricing (niche use cases). More optimistic scenarios include substitutions away from other transportation sources. Morgan Stanley believes **the overall market could be worth at least $1.0tr by 2040**, if logistics and freight use cases were included too.

The debate is not *whether a market exists*, but how quickly *adoption broadens*. The critical distinction is between technological feasibility and commercial viability. The former appears increasingly proven; the latter remains open to debate. The industry has had numerous false starts (not to mention several bankruptcies). There are lots of variables and many unknowns. Regulatory certification for eVTOL is unprecedented owing to its novel architecture. One high-profile incident, particularly early in deployment, could materially slow adoption and tighten regulation.

Consider next the economics. What if battery technology plateaus and energy density upside stalls, constraining range, payload and economics? Further, real-world battery degradation rates and life cycles may prove worse than lab assumptions, especially under fast-charging and high utilisation. Imagine what might happen were autonomy delayed or never approved. Ground-based transportation alternatives to eVTOLs may also improve. Better urban planning and more autonomous cars may erode some eVTOL advantages.

Two additional under-appreciated constraints for eVTOLs come in the form of **airspace integration and ground infrastructure**. Remember that eVTOLs are not simply new aircraft – they introduce high-frequency, low-altitude urban traffic into airspace today that is lightly used (helicopters, drones)

and not designed for dense point-to-point flows. Scaling the eVTOL industry implies a potential move to thousands of flights per day per city. Current manual air traffic control systems would need to be automated. *Without* automation, controller workloads become the bottleneck long before demand.

At the same time, vertiports (dedicated eVTOL take-off and landing sites) are not trivial. A functioning network would require not only take-off and landing pads, but passenger handling, charging infrastructure and safety zones. Integration into urban transport nodes also matters. Location scarcity constitutes a key constraint, for vertiports must sit close to demand centres such as central business districts and airports. However, in dense cities, land is scarce and planning permissions are difficult, implying high costs, accompanied by potential political friction. Even if eVTOLs are quieter than helicopters, community acceptance may be another issue. Vertiports may end up being a scarcer asset than new aircraft.

Given current constraints, the eVTOL industry has consolidated from around 250 companies five years ago to fewer than 10 meaningful businesses today. The two main listed players are **Joby Aviation** and **Archer Aviation**. Both are US-listed, capitalised at around $5bn and remain loss-making. **Uber Technologies** was arguably the original commercial developer of urban air mobility, developing the modern air taxi network concept before selling its Uber Elevate division to Joby. Today, Uber is positioning itself as a *platform*, seeking to act as a demand aggregator, whereby eVTOL rides are booked via its app and integrated alongside its cars.

Both Joby and Archer benefit from strong **partner ecosystems**. The former has a manufacturing partnership with Toyota and investments from Delta Airlines and Uber, with a view to integrating eVTOLs into their respective ecosystems. Equally, Archer's investors include Stellantis, Boeing and United Airlines; United has placed an order for 200 eVTOLs. The two businesses have said on recent conference calls with the investment community that they hope to begin commercial eVTOL flights in the next 6-12 months. Archer has also been selected as the Official Air Taxi Provider of the LA28 Olympic Games. These begin in less than two years' time.

Other smaller listed players include **Vertical Aerospace, Eve Holdings, Beta Technologies** and **Lilium**. The first of these benefits from partnerships with Honeywell and Rolls Royce, while Eve is working with Embraer to develop eVTOL services in Brazil. China's leading eVTOL business, **EHang**, is NASDAQ-listed (and also loss-making).

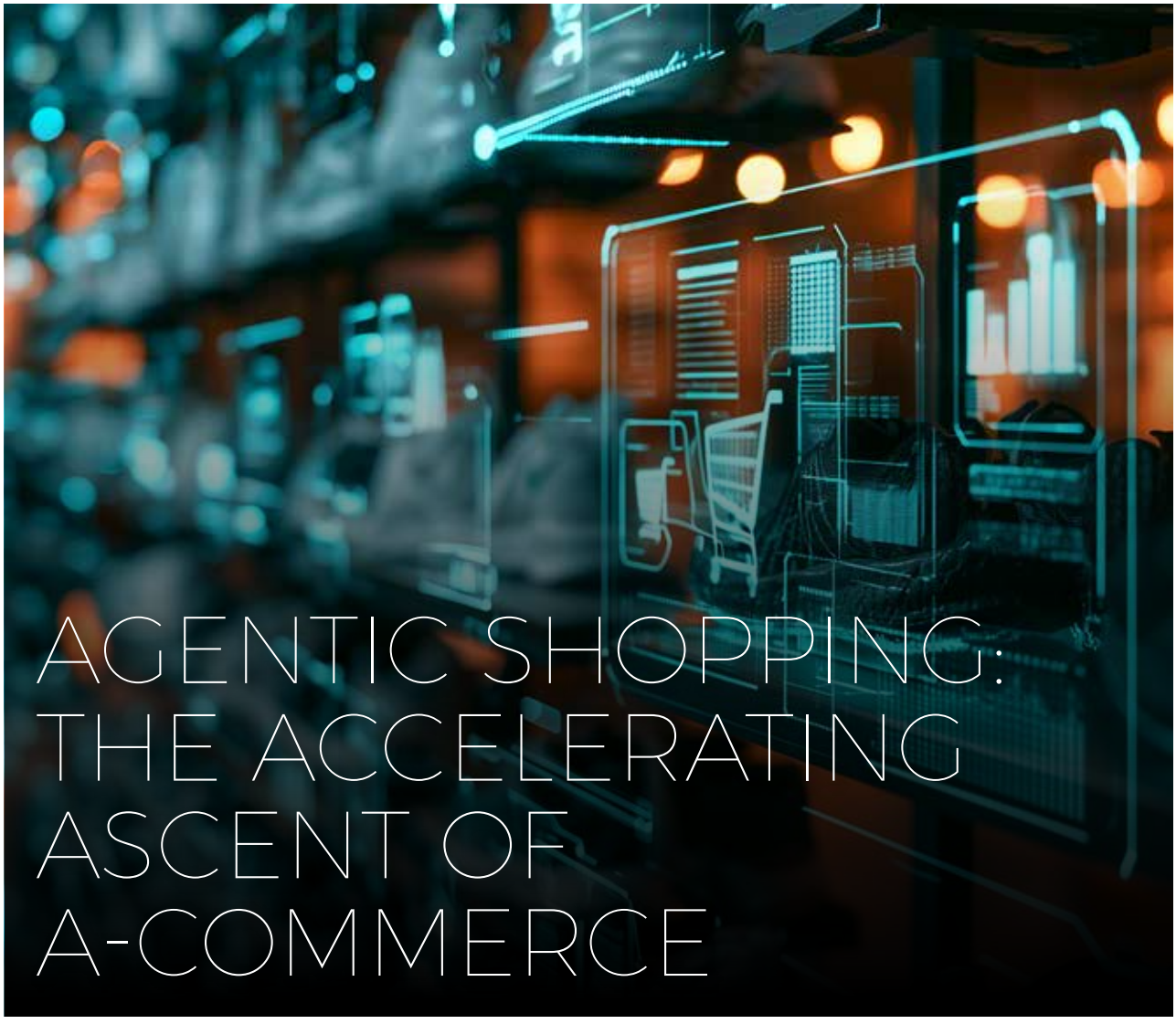
An entire ecosystem will develop around eVTOLs creating potential investment opportunities in related adjacencies in areas such as component manufacturing, electrification, batteries, dedicated materials, simulation software and even infrastructure and air traffic control systems.

Your author is awaiting take-off with excitement. Are you?

22 September 2026







AGENTIC SHOPPING: THE ACCELERATING ASCENT OF A-COMMERCE

Executive summary: The agents are coming. With the emergence of software tools that can make decisions and transact purchases, shopping will be revolutionised. In the new world of agentic a-commerce, there will be a shift in power. Value will move from consumer attention and branding to data quality, pricing transparency and fulfilment reliability. Agents will optimise for value and not impulse. Revolutions do not happen overnight. Building trust and familiarity take time. Delegating purchasing authority to software is both psychologically and operationally hard. Nonetheless, by 2030, the US agentic commerce market could be worth up to $400bn in gross merchandise value, and China's substantially more. Leading retailers such as Amazon and Walmart in the US as well as Alibaba and JD.com in China have already successfully launched agentic shopping assistants. More will follow. The ultimate winners, however, may be the *enablers*, or the providers of payments and financial rails as well as logistics and fulfilment leaders.

All consumers could have their own personalised digital interactive shopper

Watch here

For many people – your author included – shopping is a chore. Agents will make it less so. **Think of agents as representing the third wave of how commerce will be transformed**. Beyond bricks and mortar, first we had desktop e-commerce, then mobile purchases and now the emergence of agents. Call it **the agentic revolution**, or a-commerce. The debate is moving from *where* we shop to *who does the shopping*.

The promise of a-commerce is that **all consumers could have their own personalised digital interactive shopper**. Give it specific instructions and the agent will carry them out. Agentic transactions herald "a new era of commerce", according to the Chief Executive of American Express. Andy Jassy of Amazon believes that agentic commerce solutions will "expand the amount of shopping done online." In the words of Mastercard's CEO, "the [agentic] train is leaving the platform." If so, then **both consumers and businesses will need to adapt**.

An agent, in its most mundane form, can be thought of as simply a piece of software that can understand what you want and take decisions. Agentic commerce, then, **is a form of retail where AI agents do the buying on behalf of consumers or businesses**. This could include discovering products, comparing options, negotiating terms, executing payment and managing reorders with minimal human input. A-commerce represents a practical application or use case for artificial intelligence, unlocking a new vector of growth for the industry.

Today's non-agentic e-commerce shopping journey is fragmented and complex. Imagine instead of having to browse Amazon or book travel, an AI agent could be given an objective and constraints (such as price, brand, delivery time, sustainability, policy rules). The agent would then search for and evaluate options across merchants, make selections and complete the purchase autonomously. AI agents would have the ability to draw upon users' preferences and their history combined with existing reviews and live merchant data feeds.

Agents can perform tasks as mundane as real time and continuous price comparisons, or making automated recurring purchases, such as grocery orders. There would be no longer any need to wait in long online queues to purchase sought-after tickets for a concert or sporting fixture – you could instruct an agent to buy them on your behalf; stipulating things such as seating preferences and maximum spend. Planning a holiday? Not only could the agent help arrange your travel plans, but it could also source hotel stays, book restaurants, buy tickets for major attractions and so on – and all from different merchants. In all the above cases, **complexity is removed for the user**.

Agentic commerce is very different to traditional e-commerce. In both, the *customer* is still human, but **in an a-commerce world, the *decision maker* and *transactor* are software**. Agents should not be thought of as super-concierges – which are often reactive and advisory. They do not (need to) recommend, but simply act, with delegated authority and at machine speed.

In the new world of commerce, four big changes look set to occur. There will be **a shift in power**. Value will move from consumer attention and branding to data quality, pricing transparency and fulfilment reliability. There will be **lower friction** too. Purchase decisions will become faster, more frequent and more price-rational. Since **agents will optimise for value and not impulse**, this will impact retailer margins. Marketing budgets would suffer in favour of scale and efficiency. **New toll collectors will emerge**. Platforms that host agents, control identity, payments or procurement rules can stand to capture meaningful economics.

None of this will happen overnight. Consumers may have become more comfortable with using AI assistants to streamline tasks and receive personalised recommendations. However, **even by 2030, only 40% of consumers globally say they expect to use AI for comparison shopping** according to a PWC survey conducted last year. But when it comes to making purchases, there are still some barriers. **While 33% of respondents say they are comfortable with an AI agent planning their grocery shopping, only 25% would let AI place the order**. Just 22% state that they

would allow an agent to make a purchase. Many consumers still need reassurance on safety or that AI is prioritising their interests.

For agentic commerce to work practically a full tech stack needs to be put in place. This comprises not just an **agentic commerce surface**, or user interface, but also several mutually supporting protocols. Think of these as rails upon which agents operate and rules that govern communications and messaging between systems, asking whether the agent can be trusted, whether it is allowed to pay, and how it checks out.

The front-end will capture user intent, apply user-defined rules and orchestrate the shopping and checkout journey on the user's behalf. A **trusted agent protocol** will then help merchants to identify who the agent is and whether it is legitimate. An **agent payments protocol** will help prove what the agent is authorised to do financially, within defined user mandates. Finally, an **agentic commerce protocol** will execute the payment over existing rails, handling authorisation, clearing, settlement and operations.

China is arguably ahead of the US in practical adoption of agentic commerce, albeit framed less as a standalone concept and more as an extension of super-apps. Agent-like functionality exists in the form of automated re-ordering, smart recommendations, one-click execution. Adoption has been fastest in **low-friction, high-frequency categories** such as food delivery, local services, travel, in-app retail and financial services. **Compared with the US**, China benefits from tighter platform integration, ubiquitous digital payments, weaker consumer resistance to automation and fewer legacy intermediaries.

In the western world, younger digital natives are likely to be the earliest adopters. First purchases may be utility-like products and then more emotional transactions. **The gross merchandise value (GMV) of American a-commerce purchases is set to grow from 1% of digital purchases in 2026 to 10% by 2030**, according to Morgan Stanley. GMV grows from $8bn to $192bn over this period, equivalent to a compound annual growth rate



of over 100%. Other forecasters believe **the market could be worth up to $400bn by the end of this decade**. For context, China's a-commerce GMV is already estimated to be over $1tr.

Consumers are experimenting already. Amazon and Walmart, America's two largest retailers, are in the vanguard. Around 300m customers used Amazon's Rufus agent last year. Rufus is an AI shopping assistant that helps customers research products, compare options and decide what to buy directly within the Amazon app. Amazon says that shoppers who engage with Rufus are 60% more likely to complete a purchase than those who do not use it. The retailer estimates that Rufus generated $10-12bn of incremental annualised sales in 2025. Last month, Amazon took the decision to fold Rufus into Alexa to create a single, unified AI assistant across its platform. All the AI models underpinning Rufus have now been embedded into Alexa.

Walmart launched a similar agentic assistant, called Sparky, in June last year. Around half of its customers have tried it, per the company and those who do generate c35% higher average order value than non-Sparky users. Elsewhere, Macy's has said that users of its new AI-powered 'Ask Macy's' chatbot are spending 400% more relative to non-users, early testing suggests.

In Europe, Zalando Assistant has led to at least a 20% increase in product clicks and more than a 40% increase in items added to customer wishlists, according to the retailer. Other businesses including CarMax, Carrefour, DoorDash, Instacart, Kroger and Lowe's are also trialling agentic services. Alibaba's Wenwen service and JD.com's Jingyan smart shopping assistant are among the most successful examples of agentic services in China, although limited public disclosure is available.

All the above are critically being supported by robust protocols such as UCP and ACP Mechanics. The Universal Commerce Protocol is an open standard developed by Google that it describes as **a "common language" that allows AI agents and merchant commerce systems to work together across the full consumer shopping journey**. Multiple payment processors (including Adyen, American Express, Mastercard and Stripe) and retailers (Best Buy, Shopify, Target, Walmart) are adopting UCP. Individuals can use the protocol to check out on eligible Google listings in Search AI Mode and Gemini using Google Pay. ACP Mechanics, developed by OpenAI and Stripe, follows a similar approach that powers 'instant checkout' by letting AI agents complete purchases inside ChatGPT. Microsoft has also launched Copilot Checkout feature.

At the same time, the **major payment processors have launched B2B enterprise offerings aimed at building, testing and deploying fit-for-purpose agents**. Mastercard's Agent Suite combines technical support with customisable AI agents, leveraging Mastercard's extensive payments expertise, data-fuelled insights, proprietary technology platforms, and 4,000 global advisors. Visa has a similar offering called Intelligent Commerce, while American Express has released its ACE (Agentic Commerce Experiences) developer kit.

By 2030, only 40% of consumers globally say they expect to use AI for comparison shopping

Everything, however, is nascent. "We're not even in the first innings" said the Chief Executive of American Express in April, while "it's such early days" with a "big change processes" required, noted Rene Haas, the Chief Executive of ARM Holdings, the chip designer, last month. Think of agentic commerce (or agents more generally) as being arguably where the web was 30 years ago. Lots of bold ideas and acronyms are being thrown around, but **building trust and familiarity take time**.

The delegation of purchasing authority to software is both psychologically and organisationally hard. For many the perceived loss of control – allowing an agent to commit spend without human review –

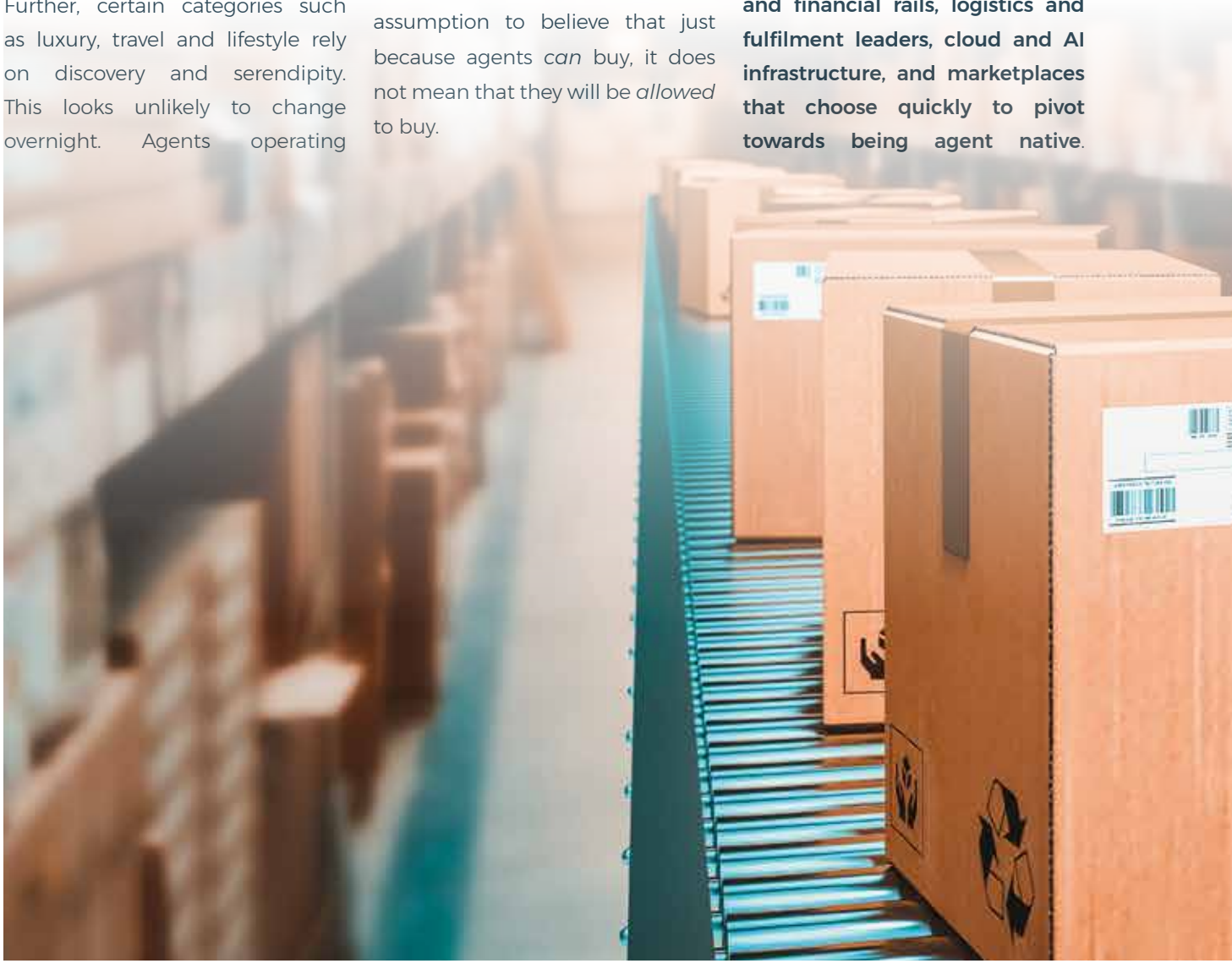
may be uncomfortable. Consumers may legitimately wonder what happens were an agent to make a poor decision. With whom does the accountability lie: the vendor, the platform, the model or the user? Equally, consider the issue of auditability. If agent decisions are probabilistic and non-deterministic, then they may be hard to explain.

Real world complexity will continue to exist, even in a world of agents. Factors such as product attributes, delivery reliability and after-sales services are often inaccurate and non-standardised. Agents may therefore struggle. Further, certain categories such as luxury, travel and lifestyle rely on discovery and serendipity. This looks unlikely to change overnight. Agents operating in *any* retail category are also high value targets for attackers. Credential abuse constitutes one consideration. Equally, malicious actors could adversely influence agent behaviour via data poisoning or adversarial inputs.

Ultimately, consumer behaviour may prove stickier than expected. Practically for a-commerce to be a success, **there needs to be multi-sided adoption by consumers, merchants, platforms and regulators simultaneously**. Against this background, **progress may be incremental rather than disruptive, and only in narrow categories**. It is an incorrect assumption to believe that just because agents *can* buy, it does not mean that they will be *allowed* to buy.

The rise of agentic commerce will create inevitable winners and losers. However, the story will be *less about agents themselves* and more about a **reweighting of value towards infrastructure, execution and trust**. Do not forget that **agents will optimise for reliability over brand, predictability over optionality and certainty over choice**. Agents will need confidence in merchant legitimacy, inventory accuracy, fulfilment performance and recourse if something goes wrong.

Against this background, likely beneficiaries could emerge from one of four major areas: **payments and financial rails, logistics and fulfilment leaders, cloud and AI infrastructure, and marketplaces that choose quickly to pivot towards being agent native**.



Think of the former – companies such as Mastercard and Visa – as being de facto toll collectors. Agents should increase transaction velocity and frequency rather than disintermediate payments processers. Card payment networks benefit from volume growth *regardless* of who initiates the transaction. Embedded controls such as identity and fraud management should only become more valuable in an agent-driven world. Both major payment networks currently enjoy 99.9999% uptime on their core platforms with less than 0.1% fraud rates.

If agents optimise for reliability, speed and cost, then scaled, high-quality fulfilment networks such as Amazon, DHL and UPS as well as the owners of critical adjacent infrastructure (Prologis, for example), should benefit. Last-mile execution may become more important than brand storytelling in an agentic world. At the same time, since agents are compute-intensive and require persistent inference, orchestration and data access, then the major cloud and AI infrastructure players (AWS, Google, Microsoft, and NVIDIA by default) also look well-placed.

As the world becomes increasingly agentic, some businesses will clearly face challenges. If we accept that agents can reduce the value of brand awareness and impulse-driven discovery, then advertising-led consumer brands – whether Nike and Adidas or Unilever and Procter & Gamble – may be at risk. Marketing spend becomes less effective, since agents ignore persuasion. Similarly, retailers that are reliant on browsing and footfall – department store owners or general retailers – may suffer. Inventory and fulfilment trump store experience in the agentic age. Price opaque intermediaries such as traditional travel agents or comparison sites could be at risk too.

Even if agentic adoption does take time, the agents are coming. It is up to both retailers and consumers to embrace them. Watch this space. In the future, you may never have to visit a shop or waste time on a website again.

23 June 2026





AUTONOMOUS VEHICLES: ARRIVING SOON IN AUTOPIA

Executive summary: Autonomous vehicles (AVs) are here and more will arrive in 2026. Over 500,000 weekly rides are being currently taken in Waymos across America. With both technology and safety levels improving rapidly, scepticism towards driverless cars is diminishing. They can help save both time and lives as well as improving urban environments. Greater AV supply should fuel increased demand. By 2035, the overall autonomous vehicle market could be worth up to $400bn. The journey forward will not be linear. Inevitable accidents, increased regulatory scrutiny and fears of potential cyber-compromise may delay progress. Regardless, significant sums of (often private) capital are being ploughed into the industry. Waymo appears to be an early leader, but many other players are developing rival businesses, while companies such as Uber are seeking to position themselves as platforms for demand aggregation. Buckle up for an exciting journey.

"The ChatGPT moment for physical AI is here – when machines begin to understand, reason and act in the real world... robotaxis are among the first to benefit."

Watch here

The road to autonomous driving, or autopia (a phrase we first coined in 2015), has been long and winding. However, the foot is now truly on the accelerator. **2026 is shaping up to be the year of the robotaxi**. With their emergence, cities globally may soon start to be reshaped. **The industry is now at an inflection point**. Expect more autonomous vehicles on a street near you soon.

Your author first took a ride in a Waymo in San Francisco last September. Users must rely entirely on technology to get them safely to their destination. It was both **an exciting and unnerving experience**. One ride led to more, in different conditions too (at night, when raining, and so on). In the short period since then, the industry has evolved rapidly. Indeed, such is the rate of progress that many of the statistics cited below may already represent a backward-looking perspective.

Waymo trials began in San Francisco in late 2022. The service formally launched in June 2024. The company reported that its vehicles had undertaken 14m trips in 2025, triple the levels of the year prior. By March this year, Waymo was seeing over 500,000 *weekly* rides across the ten US cities where it is currently operational, **a tenfold increase since launch**. There are currently over 3,000 Waymos in service across the States. The business has announced plans to enter at least a further ten cities before the end of 2027 including several outside the US. Your author hopes to be using Waymo in London shortly.

Not to be outdone, **multiple other players have begun trials and services**. These span a range of locations (further US cities, Europe, the Middle East and Asia) and formats (partial versus full autonomy, partnerships with ride hailing businesses, OEM rollouts and so on). In China, more than 10 commercial companies are currently operational, with testing underway in 50 cities across the country. Dubai has said that it aims to have 25% of all road transportation trips undertaken by autonomous vehicles by 2030.

Major improvements in technology and corresponding vehicle safety levels have helped win over the sceptics. Although the tech stack will vary by autonomous vehicle operator, most AVs are equipped with a **complex array of hardware and software**. These would typically include LiDAR (i.e. laser-driven detection sensors), cameras and radars, as well as AI and deep-learning, high-definition mapping and GPS positioning. Fear not, **redundant systems are built in for safety**, so if one sensor breaks, the car can still pull in data from others. Humans also typically oversee AV fleets and can intervene if needed.

Crucially, **AVs benefit from a constant learning, or reinforcement environment**. The vehicles use artificial intelligence in both the car and the cloud to mimic the way in which human drivers process (new) information and react to it. Logically, as robotaxi services expand, the algorithm becomes self-reinforcing. This explains why NVIDIA's Jensen Huang said in January at the Consumer Electronics Show that **"the ChatGPT moment for physical AI is here – when machines begin to understand, reason and act in the real world… robotaxis are among the first to benefit."**

When robotaxis first launched in San Francisco, two-thirds of residents were opposed to them. Two years on, the ratio had flipped. A November 2025 poll (reported in *The Economist*) suggested that more than **65% of San Franciscans were now in favour of unmanned vehicles**. A separate study, by JD Power (a consumer research firm) found that **confidence in AVs generally was 56 percentage points higher among those who had ridden a robotaxi** versus those who had not. More use-cases in different conditions – say, snowy cities such as Denver, or those with old and narrow streets, like London – help further legitimise the technology.

The advantages of using a robotaxi ought to be clear: they are **time- and lifesaving. Driving should become safer, more convenient and more enjoyable**. Unlike humans, robotaxis do not get distracted, text, or drink and drive – and they have a 360-degree field of vision. Globally, car accidents result in around 1.2m annual fatalities and are the leading cause of death among people aged 5-29, based on data from the World Health Organisation. Furthermore, it is estimated that around **90% of accidents involve human**

error (this latter figure relates to the US market, and is according to information provided by the NHTSA).

Waymo reports that its autonomous vehicles have now driven more than 200m miles cumulatively without human assistance. During this period, the company notes that there have been **92% fewer serious injury (or worse)-causing crashes compared with a human driver over the same distance, and 81% fewer injury-causing crashes**. Another study, by Waymo and Swiss Re, a reinsurer, finds that Waymos are involved in 88% fewer property-damage claims and 90% fewer bodily injuries per mile than humans.

Consider the other benefits. **Since autonomous vehicles are in almost constant use, the more popular they become, the more they will free up space and make urban life more comfortable**. With fewer cars and parking spaces needed, in time, cities could be redesigned to be more pedestrian-friendly and to have more green spaces. Uber has reported that Waymo AVs operating on its network complete more daily trips than 99% of the company's human drivers. Vehicle arrival time is typically 25% faster in cities where present, relative to a trip undertaken in a conventional taxi. For context, the average working American spends just under an hour commuting each day, versus eight hours on the job.

The cost of both taking and operating an autonomous vehicle continues to fall. This is a function of **scale economics and improved vehicle design**. At present, self-driving vehicles cost about $7-9 a mile to operate, compared with $2-3 a mile for traditional ride-hailers and $1 a mile for personal cars, according to data from consultants BCG. At launch, Waymo's vehicles were said to cost ~$150,000. However, its latest generation of AVs will likely see a more than 50% cost reduction. Not only do they use fewer sensors – since they have become more efficient – but the cost per sensor continues to drop. As with other technologies that start to reach maturity, sensors have seen a marked decrease in cost, equivalent to around a 100-fold fall over the last five years.



The cost of both taking and operating an autonomous vehicle continues to fall

Unlike regular cars, robotaxis do not sit idle for most of the day, meaning that their main cost – the investment to build them – can be spread over many journeys. The key, then, is to **deploy robotaxis in areas where there is demand, and cars can be kept occupied for long periods of time**. Furthermore, as time goes on and the experience improves, AV companies will also need to rely less on remote vehicle operators. For a ride-hailing business, human drivers are estimated to account for 50-70% of the cost of a traditional taxi journey, so **with no-one at the wheel, costs should fall rapidly**.

Assume robotaxis become sufficiently safe and *no more*

expensive than a human-driven cab, then demand should accelerate rapidly. **More vehicle supply should also drive increased customer demand**. Uber reports that in both Atlanta and Austin, following the launch of initial AV services, there was a 9 percentage-point year-on-year growth acceleration in first-time riders relative to pre- its AV launch, and an additional 3 percentage-point year-on-year increase in trips per rider, using the same parameters.

Project ahead and there could be **up to 100,000 driverless taxis on the road by 2030**. By then, they may have captured 30% of the US ridesharing market and be generating $7bn in revenues (data from Wood MacKenzie, Morgan Stanley and Goldman Sachs respectively). **The overall autonomous vehicle market could be worth up to $400bn a decade from now**, according to McKinsey. China alone could be a $180bn market by 2040, says UBS.

Many factors could, of course, undermine the journey to autopia. The market is still nascent. **AVs still struggle with unpredictable scenarios** (road conditions as well as human behaviour). **Operating robotaxis *at scale* is untested**. *For now*, the industry may be just one high profile accident away from being taken off the road. Consider, for example, the negative media coverage that accompanied the power outage experienced by Waymo's fleet in San Francisco last December, and also the recent systems failure of Baidu's robotaxis in Wuhan. Reputational risk remains significant.

Furthermore, **governments almost everywhere have been cautious about approving *fully* autonomous vehicles due to safety and liability concerns**. Self-driving cars are only currently permitted in around half of America's states. The Governor of New York State blocked AVs in February 2026. Other major cities such as Boston and Seattle are currently considering whether to permit them. In Germany, all AVs today must be always monitored by a human.

There remain further **legal, ethical and cyber concerns**. The general rule that underpins AVs at present is *collision avoidance at all costs*. However, who decides the ethical rules: car manufacturers, governments or consumers? Further, were an AV to kill someone owing to a programmed decision, who would be liable: the developer, the owner or the algorithm? Embedding ethics into code inevitably creates accountability issues. Different cultures and legal systems have different moral priorities (such as minimising total harm, protecting passengers or following the law).

In addition, a fully autonomous car relies upon (as well as generating) huge amounts of data. There remain major uncertainties about the legal ownership of such data as well as the risk of it being corrupted or hacked. If AVs were compromised, this could lead to catastrophic and fatal failures.

The most likely reality is that **the pace and scale of adoption will be uneven**. Many people enjoy driving (or being driven, especially if they value the company) and others may resist giving up control. All vehicles – whether shared or personal – will increasingly embed greater levels of autonomy. The near future may be a **hybrid model**, where conventional and autonomous vehicles coexist.

Given the size of the prize, many players are seeking to gain exposure to the expanding autonomous vehicle market. There are **also multiple (and overlapping) elements to the AV value stack**. These comprise self-driving technology or software platforms; demand aggregation solutions (the role currently fulfilled by the likes of Uber and Lyft); asset ownership and financing; and vehicle manufacturing plus other adjacent hardware. Assume the AV industry follows others, then **more value should accrue higher up the stack**.

From a *practical perspective*, **only one operator – Waymo – has been currently approved by US regulators for multiple use cases:** both supervised and unsupervised operations, running 24-7, permitted on highways and at airports, and allowed to operate in rain and snow. Waymo, then, *may* have an **early mover advantage**, partly enabled by its safety positioning (with redundant sensors). It is also gaining major insights from continued real-world driving experience. Notably, Waymo has pursued partnerships in several geographies, including working with Uber in Nashville and

Avis in Dallas.

Have no doubt, **a lot of private capital is going into the autonomous vehicle industry, even though the ultimate winners may not yet be known**. Consider the precedent of AOL's dominance at the start of the dotcom boom and where the business is now (essentially defunct). Waymo's January 2026 funding round implied a $110bn valuation for the business. For context, however, this is equivalent to less than 5% of its parent company, Alphabet's market capitalisation, and so is unlikely to be a major driver of share price performance in the near-term.

Tesla is perhaps Waymo's closest challenger from a tech stack perspective, although its approach to autonomous driving is very different. Whereas Waymo has moved straight into L4 autonomy (i.e. no driver required), Tesla has opted for an approach that requires less up-front investment. Using only cameras and no LiDAR, its vehicles currently permit less autonomy and so can be used in more limited circumstances, although Tesla does win out in terms of **cost per mile and production advantages** (from having vertically integrated manufacturing). The business has said that it hopes to be launching fully driverless services shortly. However, Elon Musk has a poor track record of meeting deadlines.

Amazon, via its Zoox subsidiary, has taken a different approach. Its driverless vehicles, active in San Francisco and Las Vegas trials currently, have been **purpose-built** (Tesla's existing vehicles are being adapted, whereas Waymo uses cars provided by Jaguar and Hyundai) and are **vertically integrated**. They contain no steering wheel, no pedals and no driver controls at all. The seats face inward. The system *is* the driver. Such a model *may* be the future, even if there is little visibility on the economics of Zoox at present.

Major technology businesses such as **NVIDIA, ARM Holdings and Western Digital also look well-placed**, *irrespective* of which players ultimately claim the top positions in the AV market. The former is positioning itself as an essential supplier to the industry. NVIDIA's Alpamayo-R1 model (launched in December 2025) allows vehicles to interpret their surroundings, explain their observations and outline their planned actions using natural language. ARM's IP architecture will also be essential for many AV players. It already has long-standing partnerships with several auto businesses including Tesla and Nuro (a US AV tech company). Meanwhile, since every mile driven by AVs will need to be stored for model training and safety purposes, storage companies such as Western Digital should benefit.

The role that **Uber and Lyft** will play in the development of the AV could also be crucial. Both businesses see themselves as **demand aggregators** that benefit from being technology agnostic. Uber (the larger of the two) aims to be "the largest facilitator of AV





Up to 100,000 driverless taxis could be on the road by 2030

trips in the world," per its Chief Executive. The company has signed partnerships with over 20 companies and sees itself as a platform business, acting as the intersection between hardware players (Lucid, Stellantis, Mercedes, VW etc) and self-driving technology businesses (Baidu, Motional, Nuro, NVIDIA, Pony, Waymo, Wayve etc).

Uber and Lyft clearly hope to leverage their network of riders to provide **higher AV utilisation** as well as fleet management capabilities, and in turn drive **better returns for AV tech companies and AV fleet owners**. Such a strategy is inevitably self-serving, since removing the driver could be seen as an existential threat to these businesses. Neither Uber nor Lyft has an interest in the market narrowing to just two players (Waymo, Tesla), hence why they are supporting so many self-driving tech companies.

In the near-term, a hybrid mix of humans and AVs will be beneficial to consumers, minimising pick-up times and maximising coverage. The road forward for the autonomous vehicle industry will not be straight, but it will certainly be exciting.

20 April 2026.



STABLECOINS: MAINSTREAM STABILITY, FINALLY?

Executive summary: Stablecoin's time may be now. Processed transaction volumes now surpass those of Visa, yet they still represent less than 1% of global financial transactions by value. With advances in technology, supportive regulation, and growing acceptance from established players, the stablecoin market could expand more than fivefold by 2030, reaching up to $3 trillion in value. Stablecoins promise enhanced speed, cost, transparency, availability and inclusivity for users. Forget trading for crypto accounts – stablecoins will increasingly be used in retail transactions and cross-border payments, bypassing traditional intermediaries. Although there are no shortage of stablecoin advocates, stablecoins remain unproven and subject to the credit and liquidity risks of their issuers. The path forward will be uneven but the emergence of stablecoins represents a major shift both for incumbents and disruptors. It may still be too early to call the winners, but the established payment processors (Visa and Mastercard) look potentially vulnerable.

Technological progress and supportive policies have driven the growth of stablecoins

Watch here

Remember memecoins or non-fungible tokens? **Digital assets have come and gone, often in spectacular style**. The crypto space has been marred with scandals and scams throughout its short history. Yet the value of bitcoin has continued to increase, enjoying a greater than 90-fold rise over the last decade, albeit with several bumps along the way. Despite – or maybe because of – this move, there remains a high degree of scepticism. The championing of crypto by the Trump administration only adds to both the euphoria and the confusion.

However, nothing arguably marks crypto's emerging maturity more than the rise of stablecoins. They have become the fastest and cheapest way to send a dollar – in less than one second for less than one cent – almost anywhere in the world. **Think of a stablecoin as a type of cryptocurrency designed to maintain a stable value by being pegged to a reserve asset, such as a fiat currency like the US dollar or a commodity like gold**.

Stablecoins can be likened to **digital tokens that run on existing blockchains** (or secure, decentralised digital ledgers). These blockchains automatically handle transactions and track ownership using built-in rules and algorithms. **Popular stablecoins run on multiple blockchains, much like cash can be printed by different Central Banks and stored in separate vaults**. When a customer sends money to the issuer, a digital token is created and the funds are held in reserve. To redeem, the token is destroyed ('burned'), and the original currency is returned.

There are good reasons why the time for stablecoins may now be right. Their growing ubiquity demonstrates how new technologies can help address some of the current and pervasive inefficiencies in modern financial systems. What stablecoins offer is the promise of a cheap and broadly accessible means of domestic and cross-border payments. Stablecoin adoption will accelerate as network effects spread across financial institutions, merchants and consumers.

Technological progress and supportive policies have driven the growth of stablecoins. These have been accompanied by increasing transaction volumes and incumbent responses. By contrast, early attempts, such as BitUSD, faltered because they were under-collateralised and lacked sufficient liquidity. Tether and Circle both launched in the mid-2010s but average daily stablecoin volumes remained negligible until recently. Daily flows have increased 400,000-fold in the last decade (albeit from a low base) and more than doubled in the last year. In 2025, approximately $30tr of stablecoins were processed, according to Bloomberg. For context, Visa processed $16.7tr of volumes across its network in its most recent financial year (ending 30 September 2025).

Technological advancements in blockchain, e-wallets and on-chain analytics have enhanced the robustness of the stablecoin ecosystem. Performance (speed of transactions) has improved, reducing network congestion and improving reliability. On many crypto exchanges today, stablecoins are offered one-to-one in exchange for cash with a single click. Meanwhile, enterprise payment platforms such as SAP and PayPal now offer native stablecoins to their business customers.

At the same time, **the policy environment has become increasingly supportive**. The GENIUS Act (or Guiding and Establishing National Innovation for US Stablecoins) was signed into law in July last year. It legitimises stablecoins for mainstream use and clarifies issuer eligibility, regulatory oversight, definitions, and permitted collateral types. The Act also requires stablecoin to comply with strict marketing rules to protect consumers from deceptive practices. Other geographies have sought to follow suit. The European Union is in the process of developing its Markets in Crypto-Assets rulebook. The UK, Switzerland, Japan and Singapore are accelerating developments too. China has been more reluctant, preferring to prioritise its Central Bank Digital Currency project.

The industry is responding. Banks including JPMorgan and Citi already operate tokenised deposits (a traditional bank deposit represented as a digital token on a blockchain issued by a regulated bank). Customers of Goldman Sachs, JPMorgan

and UBS can make stablecoin purchases via credit cards. The payment processors – Mastercard and Visa – have integrated support for stablecoin-routed payments. Visa announced in November a pilot that will allow businesses and platforms to send payouts directly to recipients' stablecoin wallets. This was followed by a December announcement that it had launched stablecoin settlement on its network in the US for both issuer and acquirer partners.

SWIFT, the global messaging network that enables banks and financial institutions to securely exchange information about financial transactions, has begun its own blockchain to facilitate transactions between global banks. It plans a blockchain-based ledger for asset-based transactions. Meanwhile, a consortium of nine European banks has said it intends to jointly launch a euro-denominated stablecoin in the latter part of 2026. Other projects underway include Project Guardian and Project Helvetia, which involve the Monetary Authority of Singapore and the Swiss National Bank respectively.

Despite rapid growth and increasing adoption over the past year, **stablecoins currently account for fewer than 1% of global financial transactions by value**. Their total circulating supply was equivalent to at least $300 billion at the end of 2025, based on reports from multiple sources. However, look ahead and the stablecoin market could grow at least fivefold to $2tr by 2028, and reach $3tr by 2030, according to McKinsey.

Speed, cost, transparency, availability and inclusivity comprise the main reasons why stablecoin adoption should grow. Think of stablecoins as de facto digital Dollars that can move at internet speed, 24-7, every day of the year. They transcend traditional banking hours and global borders. Ownership is registered instantaneously on digital ledgers, allowing for near-instant settlement. This allows for increased transparency and control. Payments can be tracked in real-time. Future business innovation could see smart contracts, automated portfolio rebalancing, tokenised assets as payment vehicles.

Today, stablecoins are mostly used within crypto markets, where traders use them to move funds quickly between exchanges and to buy other digital assets without converting back to traditional currency. **Crypto trading accounts for around 90% of stablecoin volumes**, according to Alpine Macro. The remainder currently comprises remittances and settlements.

However, the number of potential use cases is significant. Consider that retail payments are currently dominated by credit and debit cards. Merchant costs are generally 1-2% of transaction value (bank acquirer and issuer fees add further costs). **Using stablecoins would cut out firms such as Mastercard and Visa and address a major pain point for both consumers and retailers**. Major businesses such as Amazon and Walmart are also reportedly considering their own coins. To consumers, these might work like a gift card, providing a balance to spend with the retailer, perhaps at lower prices.

Cross-border payments represent another area for stablecoin growth. Legacy systems rely on correspondent banking, which is slow and costly for small values. Middlemen can again be disintermediated. Interestingly Western Union, a major incumbent in the space, announced last October that it would seek to launch a dollar-backed stablecoin. This would let its 100m customers send money internationally detached from local currency fluctuations and risks. The US Dollar Payment Token (USDPT) is expected to launch in the first half of 2026.

Since stablecoins are *wallet-based* as opposed to account-based, **access is opened to anyone with an internet connection**. The unbanked and underbanked now have enhanced access to a global payment network. This could be a particularly important dynamic in emerging markets, where local fiat currency is volatile and/or where consumers do not have easy or affordable access to Dollars. Stablecoins enable non-US based internationals to hold a Dollar proxy without needing to use a multi-currency bank account. Equally, in countries experiencing high inflation, individuals and businesses might use Dollar stablecoins as a hedge against



local currency depreciation.

A much broader, longer-term vision would embrace **full tokenisation**. In this world view, ownership rights to an asset (whether cash, stocks or even private equity stakes and debt) would be converted into a digital token on a blockchain. With instant settlement, this dynamic could unleash significant capital.

There are **no shortage of advocates** for this vision. Most have a vested interest. Larry Fink, the Chairman of Blackrock, believes that **"one day… tokenised funds will become as familiar to investors as ETFs."** Meanwhile, Vlad Tenev, his counterpart at Robinhood Markets believes that the changed financial environment is **"laying the groundwork for crypto to become the backbone of the global financial system."** Scott Bessent, the US Treasury Secretary has also been an ardent supporter. For many in the Trump administration, leadership in stablecoins can represent a mechanism for reinforcing Dollar hegemony.

Stablecoins currently account for fewer than 1% of global financial transactions by value

However, the path forward will be uneven. The IMF warned in its 2025 financial stability report that **the stablecoin market could pose a systemic threat to the global financial system**. Since stablecoins are relatively new, they may face usability errors, systemic shocks, and periods of volatility. **Stablecoins carry the credit and liquidity risks of their issuers**. They may therefore face runs (like banks), creating possible contagion risks. *At present*, since most stablecoins are currently used to transact in crypto rather than outside it, implies that bear markets in riskier crypto assets could drive outflows in stablecoins.

More broadly, **for any currency to become a general-purpose payment tool, it needs to be not only seamless and predictable but also have significant reach, distribution and global merchant acceptance**. Add in to this the importance of multi-level security and fraud protection as well as compliance with local laws and regulations across multiple geographies. Consumer habits take time to change. Banks may also face operational challenges, needing new technologies and infrastructure. Intermediaries



The US Government stands to be the biggest beneficiary of stablecoin growth

may be reluctant to cannibalise lucrative payment revenues unless competition forces it. For as long as stablecoins are employed mostly as an intermediary, they will require abundant liquidity and off-ramps (venues for exchanging digital assets) to traditional fiat currency.

Nonetheless, the growth in stablecoins represents **a major shift both for incumbents and disruptors**. Stablecoin payments are unlikely to lift *total* transaction volumes, but they promise efficiency, and those **gains come at incumbents' expense**. The growing use of stablecoins will pressure transaction and payment service providers. Stablecoins may divert deposits away from banks, resulting in fee compression. Banks may simply become less relevant. Payment networks would suffer via disintermediation, since direct peer-to-peer payments bypass card networks.

Visa and Mastercard *may* be at particular risk owing to their elevated profit margins and valuations. Both businesses generate operating margins above 50% and have consistently traded at a clear premium to the broader market. Unsurprisingly, the businesses have a vested interest in stating that stablecoins represent a *complement* rather than a substitute to their existing solutions. Visa has described stablecoins as "an opportunity" and has already supports a tokenised asset platform on its network. Mastercard calls it "an attractive and growing offering." Only time will tell. Stablecoins might also render parts of other fintechs' infrastructure obsolete unless they adapt quickly. Businesses such as Adyen and Fiserv may be exposed.

At this stage *it may be too early to identify the beneficiaries*. Ease of use and acceptance will drive adoption. Payment scale and network effects will be key. The two *current* market leaders are **Tether** and **Circle**, which command ~80% of the stablecoin market. The former is privately owned. The latter listed in June 2025 on the New York Stock Exchange. Circle (owner of the USDC stablecoin) was valued at $20bn at the end of 2025, down from a peak market capitalisation of $50bn. **Coinbase** is the co-issuer of USDC and operates the Base blockchain for stablecoin settlement. It earns fees from stablecoin trading, custody and infrastructure and is capitalised at $68bn.

Other businesses that have begun to establish a presence in the space include Figure, PayPal and Robinhood. All are listed. **Figure** has launched YLDS, a stablecoin designed for institutional-grade use in lending and settlement. Its Provenance Blockchain supports stablecoin transactions and tokenised lending. The company has collaborations with BlackRock, Microsoft and NVIDIA. Meanwhile, **PayPal** is the issuer of PYUSD, a dollar-backed stablecoin integrated into PayPal and Venmo. It has exposure through direct stablecoin issuance and payment infrastructure. **Robinhood** supports stablecoin trading and USDC payment solutions. It also has a retail crypto platform with growing stablecoin integration and has over 100 tokenised products currently available for its customers. Do not forget **JPMorgan**. As America's largest bank, it is positioning itself to be a leader in compliant, bank-issued stablecoins. It is also the issuer of the JPM Coin for institutional payments.

Ultimately, **the US Government stands to be the biggest beneficiary of stablecoin growth** because most stablecoins are pegged to the US dollar, reinforcing its role as the dominant global reserve currency. As stablecoins expand into cross-border payments and digital commerce, they effectively export dollar usage into new markets, **deepening dollarisation** worldwide. This increased demand for dollar-backed assets also **boosts liquidity for US Treasuries**, since stablecoin issuers typically hold large reserves in short-term government securities. America's financial influence will strengthen globally.

10 February 2026



LONGEVITY SCIENCE: TIME TO TURN BACK TIME

Executive summary: The appeal of living a healthier and longer life is clear. It's also becoming an increasing reality. Think of the human body as just another piece of hardware to be hacked, optimised and upgraded. Longevity science is a developing discipline that embraces genetics, biology, medicine and technology. It matters since an ageing population with growing chronic conditions raises the cost of health and social care. Advances in longevity science are helping to shift the healthcare paradigm from reaction to pre-emption, improving the capabilities of already healthy people. Multiple moonshots are underway. Many will fail and others will encounter practical, scientific and ethical issues. However, over $8bn of venture capital flowed into the sector in 2024. Businesses want even a small share of the $600bn longevity-focused healthcare market. Equity investors have multiple ways of playing this theme, which we expect only to grow in importance.

As time passes our bodies become worse at replacing faulty or mutated cells

Watch here

Your author is getting older. This phenomenon is unquestionable. In the six years since we last wrote on longevity science as a future trend, more grey hairs have appeared, as have several facial lines. Nonetheless, your author *feels* at least as healthy as he did back in 2019. This may just be luck, although lots of exercise and a good diet have probably helped.

Death is one of life's very few certainties. Think of it as a common enemy, but one that unites humanity. To counter this, mankind has always looked for ways to boost its powers. This may be mentally – via education – or elsewhere. Consider basics such as clothing and glasses, or, more recently, wearables to monitor health. **Ageing is one of the toughest biological problems to crack – but it won't stop people trying**.

Very few people live beyond 100. In America and Britain, centenarians currently make up around 0.03% of the population (per the United Nations, or UN). The reason: **as time passes our bodies become worse at replacing faulty or mutated cells**. This weakness allows damaged cells to build up, compromising healthy tissue and helping to accelerate disease process. Ageing is a key risk factor for the diseases common in high-income countries: cancer, heart disease and neuro-degenerative diseases such as Alzheimer's and Parkinson's.

The *good news* is that UN data show **that the average life is likely to be ten years longer by the end of this century than currently, on a global basis**. With technology and science, it is now possible to conceive more easily of living beyond 100, perhaps to 120 and beyond. The idea of genuine elixirs is now gaining credence. When polled, 74% of people say that they like the idea of living a long and healthy life beyond the age of 100 (according to VML Intelligence).

The caveat to this discussion is what's the point in extending life if it's going to be spent suffering in ill health? More remarkable is the idea not only of ageing, but of *ageing healthily*. Any debate about longevity needs to disintermediate *lifespan* with *healthspan* – for the two are different. Put another way **better health can mean longer life**. Whereas lifespan refers to the total number of years a person lives, healthspan is a concept that focuses on the number of those years that a person remains free of significant illness or disease.

The gap between lifespan and healthspan is growing. At the turn of the century, it was 8.5 years. Now it has risen to 9.6 years (per 2019 data – the last available – from the World Health Organisation, or WHO). For women, the gap is typically 2.4 years longer than for men. A more recent UK study conducted by the National Health Service shows that 20% of men's lives and 23% of women's are currently spent in poor health. Reframe the debate: most people agree that **an improved healthspan is the priority.**

The medical profession would describe **longevity science as the ability to live a long life beyond the species-specific average age at death**, *practically*, it is a multidisciplinary field that investigates the biological and physiological processes of ageing to potentially extend lifespan and improve healthspan. The burgeoning field of longevity science embraces genetics, biology, medicine, and technology. Some think of the human body as just another piece of hardware to be hacked, optimised and upgraded.

Crucially, the quest for longer, healthier lives is not merely a pursuit of individual aspiration but has broader societal implications. **Advances in longevity science matter since an ageing population significantly increases the cost of health and social care**. The pace of population ageing is now much faster than in the past. Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%, according to the WHO.

A higher prevalence of chronic conditions in this ageing population would not only increase healthcare and social costs but also have a clear impact on public finances. By way of example, a study in the British Medical Journal shows that US healthcare spend is forecast to grow at an average annual rate of 5.6% between 2027 and 2032, in contrast to a projected 4.1% p.a. rise in GDP over the same period. Add into this burden **increased welfare spending and the pressures only rise**.

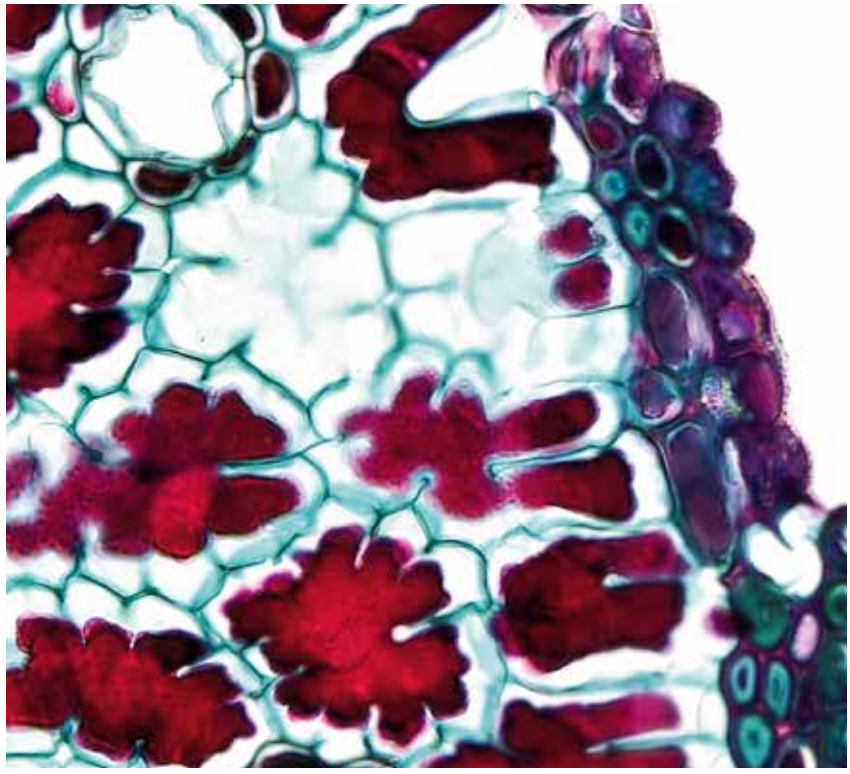
Longevity science can help address these challenges through a range

of mechanisms. The field is broad and nascent and would include at least the following five areas. These comprise **understanding the biological mechanisms of ageing, identifying potential interventions, exploring the role of genetics and lifestyle, developing technologies for life extension and focusing on healthy longevity.**

If there is an overarching principle, then it could be seen as changing the paradigm in healthcare. Think about longevity science as trying to shift emphasis *away from* treating debilitating afflictions *towards* improving the capabilities of people who are already healthy. Another way of viewing the discussion is to **think about solutions being aimed at pre-emption rather than reaction**. Longevity science can become the toolkit for allowing humans to live better.

Such a broad opportunity implies that there are **multiple different (and sometimes overlapping) moonshots underway**. Not all will be successful. However, **as developments in adjacent fields overlap, they should become mutually reinforcing**. Below follows a *non-exhaustive* list of some of the areas where research is underway.

Begin with medicine. **Genomics and regenerative medicine are at the forefront of biotech solutions**. The falling cost of decoding the genome has produced a swathe of genetic data, which can be augmented and optimised via the power of AI. Emerging solutions could involve CRISPR or mRNA.



The former is a gene-editing technology that allows scientists to make precise changes to DNA.

CRISPR technology (which we first discussed in 2017) offers a promising avenue for improving longevity by addressing the root causes of cellular ageing and age-related diseases. By precisely targeting and editing genes, CRISPR can repair damaged cells, enhance cellular regeneration, and correct genetic defects associated with ageing. Meanwhile, think of mRNA as acting like a messenger, delivering the blueprint for a specific protein to the cellular machinery that builds it. Studies in organisms such as roundworm have shown that alterations in mRNA splicing and translation can extend lifespan.

Elsewhere, work is underway in fields such as **personalised stem cells, regenerative medicine and senolytics**. Think of stem cells as *a repair system for the body*. Personalised stem cells involve using a patient's own stem cells to create tailored therapies or disease models. This approach allows for treatments that are specifically adapted to the individual patient's unique genetic makeup, disease presentation, and cellular environment.

Personalised stem cell, regenerative medicine and senolytics can all make a difference

An alternative approach involves using regenerative medicine as a mechanism for replacing, engineering or regenerating



The links between health and diet have never been clearer

human cells, tissues, or organs to restore or establish more normal functions. Recent advancements in this space are making the prospect of 'manufacturing' human organs a reality.

In the field of senolytics, scientists are developing a class of drugs that selectively target and eliminate senescent cells. Senescent cells have permanently stopped replicating but continue to live and secrete molecules that can contribute to inflammation and tissue damage. Senolytics selectively target and eliminate senescent cells, potentially improving overall health and potentially slowing or reversing age-related declines. In preclinical studies, senolytics have shown promise in delaying, preventing, or alleviating frailty, cancers, and other age-related conditions. They have also been shown to improve physical function and increase lifespan in mice.

At the same time, significant work is underway in respect of lifestyle choices and solutions. **The links between health and diet have never been clearer**. Data from the World Health Organisation show that almost 75% of all deaths globally occur owing to chronic diseases. Crucially, 80% of those deaths arose from cardiovascular disease, cancers, prolonged respiratory diseases and diabetes – all of which are impacted by unhealthy diets.

Against this background, significant work is underway in the overlapping fields of **nutraceuticals, sirtuins, calorific restriction, peptide injections and ozone therapy**. The first of these combines the terms 'nutrition' and 'pharmaceutical' and relate to products that can provide medicinal effects. Common examples include vitamins and minerals, omega-3 fatty acids, probiotics, and herbal extracts like turmeric or ginseng. Like many nutraceuticals, sirtuins are naturally occurring with sources of sirtuin-activating compounds including green tea, red wine, kale, and dark chocolate. These enzymes have been implicated in extending lifespan in yeast, worms, flies and mice by helping to regulate metabolic processes and DNA repair.

Other studies have shown that reducing calorie intake can extend lifespan in various organisms, though its effects in humans are still being investigated. Such an approach can slow metabolism and reduce oxidative stress. Another approach involves peptide injections to promote immunity and improve other functions such as gut repair. Think of peptides as short protein chains that deplete with age. One high-profile example is semaglutide – known to many as Ozempic or Wegovy – which has been shown to promote weight loss in some individuals. Some in the medical profession believe that GLP-1s (glucagon-like peptides – per the above) may replace

diet and exercise as the first line of defence for preventing heart disease in the future.

Project further out and there may be a role for ozone therapy. The approach of administering ozone gas causes reactions that form more proteins and red blood cells, which in turn increases oxygen supply. It has been used in the treatment of infections and viruses. Other benefits may include improved circulation, lower inflammation, potentially higher energy levels and sharpened brain function.

Moonshots are also underway in respect of **brain-computer interfaces** (or BCIs). Think of these as mechanisms that pass signals directly between biological brains and semiconductor chips. Such interfaces could not only help restore movements after accidents but help in areas such as rehabilitation and cognitive function improvement. AI will likely play a major role in how quickly BCIs develop. *More extreme* longevity solutions could include widespread organ printing, cryonics (the practice or technique of deep-freezing the bodies of people who have just died, in the hope that scientific advances may allow them to be revived in the future) and even mind-uploading (where humans exist in perpetuity in a metaverse).

The only problem with all the above is that advocates naturally radiate optimism. **The history of longevity science contains multiple defunct ideas**. Innovators (and investors) need to battle against multiple scientific, ethical and practical concerns. Begin with the most basic: it may be both naïve and hubristic to assume that we can defeat death. *Something* will kill you eventually. Natural selection has no interest in longevity per se. An individual is simply a means to make copies of itself, as opposed to being an end in itself.

Even with advances, **we still don't fully understand how or why the body ages**. Extensive research, testing and regulation is therefore required before many proposed solutions can hit the market. Not all drug-approval agencies recognise old age as a treatable condition, making trials harder to register. Further, by their very nature, trials must follow thousands of people over many years, adding to their cost and complexity. One solution may be multiple small-scale trials running in parallel. However, these may encounter the additional challenges relating to cost (and eventually reimbursement). Do not forget the Trump administration's current plans to restrict university funding.

Advocates may also run into **challenges relating to population growth and resource allocation**. How might we share scarce resources such as food, water and energy (not to mention housing) among an ever-growing population? Then there is the debate about inter-generational equity and the impact of longer life in one cohort at the expense of the younger population. Consider too whether a world that grows older would become trapped in stasis, lacking the fresh ideas of the young that characterise progress.

Fear of the unknown is not uncommon and Malthusian concerns about over-population have not come to pass thus far. **Short-term scepticism needs to be balanced against medium-term open-mindedness**. Scientists have, of course, hacked our biology successfully in the past. Whereas test-tube babies were once seen as not only impossible but also unnatural, assisted reproduction is now readily accepted. Over 10m IVF babies have now been born globally. Small gains in extended healthspan can make a difference – especially for those who care.

Venture capital investment into the longevity sector has continued to grow, reaching $8.5bn in 2024. This was more than double 2023's figure ($3.8bn) according to lifespan.io, a data provider. Over 300 deals occurred in the space last year. Although the sector has often been a posterchild for manias and overshoots, the available opportunity is significant. Even a small slice of the longevity-focused healthcare market would be meaningful. Consultants (such as Oliver Wyman) value the broad market at $600bn today and estimate it could be worth over $1tr by 2050.

Many start-ups have evocative names such as **Blueprint, New Limit, Rejuvenation Technologies** and **Shift Bioscience**. Several tech billionaires are involved in the space. Perhaps, if you already have everything, then you may be keen to try and 'buy' eternal youth. **Altos**



Labs, a biotechnology company focused on cellular rejuvenation, secured a recent $3bn valuation in a Series D funding round backed by Jeff Bezos. Elon Musk is involved actively in the space (via **Neuralink**, his BCI project) as are the founders of Google via various projects.

From a listed equity perspective, there are multiple ways of gaining exposure to the theme. These could include **investing in biotechnology and therapeutics, healthcare diagnostics, healthcare services and tech infrastructure**. Other approaches may involve focusing on **wellness and lifestyle or beauty industry businesses** such as Galderma that are involved in developing anti-ageing solutions. Companies involved in the development of **life science tools** may be other beneficiaries. An ageing population may also mean the need for more **seniors housing and medical premises**. Several ETFs such as AGNG and IDNA also exist. Watch this space as the theme looks set only to run from here. We're not getting any younger any time soon.

22 September 2025

SPACE: THE RACE IS ON



Executive summary: Space is a hot topic, the next frontier for both defence and data. Space is becoming an increasing military priority but crucially the digital infrastructure in the sky that is being created will be inherently dual use. The importance of space centres around big data. Satellites can help connect the unconnected and play a crucial role in mitigating world challenges. Falling launch costs mean enhanced access to data and increased use cases. As a result, the global space industry is already worth over $600bn and is set to roughly double in value over the next 20 years. However, the path forward for the industry is unlikely to be linear given its technological complexity and accident-prone nature. The geopolitics of space are highly contested too. Nonetheless, investors remain keen to gain exposure, with venture capital deals hitting a record level last year. With SpaceX still private, there are few major listed plays at present beyond Rocket Lab. Ultimately, the data providers of content and services may be the biggest beneficiaries. For now, the race is on.

We are on the cusp of a new golden age in space

Watch here

Space exploration and the study of outer space have fascinated humans for centuries. We last wrote on this topic almost seven years ago, but since then advancements in our understanding have skyrocketed. **We are on the cusp of a new golden age in space**, enabled by AI-driven software, hardware, materials science and private sector entrepreneurs.

Crucially, **space can help solve some of the most pressing problems facing the world**. Accurate data allows for the efficient monitoring of the planet. Space technology offers the potential to connect every individual, progressing human development. Expect then, the commercialisation and digitalisation of space. At the same time, **space is becoming increasingly congested, contested and competitive**.

You may not be aware of it, but **space has become indispensable for life on Earth**, even if much of this is not visible to your average individual. Space is essential for terrestrial capabilities such as weather forecasting, remote sensing, navigation (GPS), long-distance communications and missile defence and detection. This last point is *crucial*. It is important to recognise that space is not just a place for peaceful exploration, but an arena for future combat. **Control of space has become as important as dominance on land, sea and air**. It has clear implications for the global geopolitical balance of power.

Have no doubt, space and defence are hot topics under the Trump administration. In 2016, when initially in power, Donald Trump became the first President since Ronald Reagan to increase NASA's budget during his term. Globally, defence spending has risen for nine consecutive years and reached a new record in 2023 (the most recently available data) at $2.44tr, per the Stockholm International Peace Institute. Defence budgets are rising everywhere. Anecdotally, **space now accounts for up to 10% of military spend**, versus just a few percentage points at the start of the decade.

A much more optimistic world view would assert that **space will play an increasingly crucial role in mitigating world challenges**. At the least, almost all forms of space-tech are (or will become) *dual*-use, with applications in both defence/government alongside a wide array of commercial use cases. The two main scenarios relate to disaster forecasting and mitigation through continuous monitoring, and improved prosperity. Direct-to-device data technologies can help accelerate access to education and drive broader economic activity.

The commonality in all the above is that **the importance of space centres around big data**. Think of space as **digital infrastructure in the sky**. In this world view, satellite constellations provide part of the solution for how to store, secure and transmit data. In a world where around 200 subsea cables are cut annually (per the United Nations), satellite connectivity can be key to providing communication, particularly in disaster-stricken areas. Furthermore, **space can provide (part of) the solution to connect the unconnected**. Some 2.6bn people lack access to the Internet and the opportunities it brings, according to the International Telecommunications Union.

Space is becoming increasingly relevant as satellite launch costs fall. These have fallen by a factor of 10 in the last 20 years (per McKinsey) reducing barriers to entry. Put simply, **more launches mean more access to data and increased use cases**. Innovations in reusability, manufacturing and competition have helped to lower launch costs from ~$55,000/kg in the Apollo era to less than $1000/kg currently, the equivalent of a 99%+ reduction.

Several factors have been responsible for reduced launch costs. **Reusability** has been the most significant. Each Falcon 9 (the current launch rocket used by SpaceX) booster saves as much as 70% of the launch cost, which equates to around $40m per flight, according to the company. **Mass production and manufacturing efficiency** have also helped. Rocket costs have come down from over $1bn when Saturn V launched in the 1960s to ~$70m for a Falcon launch, even when adjusted for inflation. This reduction has been a function of better materials, more streamlined production and increased automation. Lower propellant costs and better engine efficiency have also contributed.

Increased launch cadence and

market competition have been additional important factors in driving the commercialisation of space. *Prior* to this decade, the launch industry was dominated by a few government-backed providers. More recently, the presence of more (private sector) players has helped bring about cost reductions. A Falcon 9 launched roughly every 4 days in 2024 (with SpaceX responsible for over 80% of all launches). This improved to a rate of every 2.5 days in the first quarter of 2025, according to the company. With economies of scale and new learnings from each flight that result in improvements to the next, costs continue to drop.

As a result, there has been **a marked step-up in the numbers of objects launched into space**. Just under 3,000 objects (which include satellites, probes, landers, crewed spacecrafts, space station flight elements and more) were launched into space in 2024. This compares to an average figure of less than 200 recorded annually between 1955 and 2015, according to the Space Industry Association.

Most of these satellites have been launched into low-earth orbit (LEO) and are used for commercial purposes. With a closer proximity to Earth, at ~2,000km distance, such satellite systems offer lower latency than traditional geostationary satellites. The latter, which orbit at higher altitudes of up to 30,000km, have been historically used for broadcasting and observation. LEO satellites in lower orbit provide fast internet speeds and improved communications, with their growing number accelerating more widespread coverage.

Although the US has the most space assets, **more than 90 countries have some form of presence in space**. Russia and China follow the US in terms of space dominance, with the UK and Japan next (per Our World in Data). The rate of change is perhaps fastest in China, with the country planning to launch a 12,000-strong constellation of satellites by the end of the decade. India has clear ambitions too and hopes to become the fourth country (after the US, Russia and China) to send astronauts into space. The UAE has recently created a space agency and countries as diverse as Peru, Saudi Arabia and Thailand are all investing in space initiatives.

The global space economy was worth at least $630bn in 2023, according to McKinsey. Almost every estimate suggests that **this figure will comfortably surpass $1tr in the next 15-20 years**. Morgan Stanley has identified 200 different space use-cases and projects a $1tr addressable market by 2040. The US Chamber of Commerce arrives at a $1.5tr figure over the same period. Meanwhile, McKinsey provides a range of scenarios for the space economy, valuing it at between $1.4tr and $2.3tr by 2035. Over this time horizon, the number of LEOs could increase tenfold to around 100,000.

Several factors could, of course, undermine this outlook. The space landscape has already changed rapidly so far this decade and will likely evolve quickly in the coming years. At the same time, in any nascent and technologically complex industry, **things can and will go wrong**. Not all launches are successful. Failed launches can have a significant reputational impact. In a worst-case scenario, the Federal Aviation Administration (or other comparable body) may rescind launch licences, slowing the development of the industry.

Space now accounts for up to 10% of military spend

Another concern is that there remains **a lack of consensus on how many satellites can be safely parked in LEO**. This could become a geopolitical flashpoint. Add into this the risk of geopolitical miscalculations, particularly around the *governance* of space. The 1967 Outer Space Treaty devised by the US and Russia currently determines what can and cannot be done in space. It forbids any country from claiming sovereignty over any part of space. Not all countries (including China) have signed up to the Treaty, while the issue of 'property rights' in space is highly contentious.

The rapid rise in satellite numbers has raised further concerns about space debris and the potential for collisions in space. NASA estimates that over 8,000 metric tonnes of

defunct satellites (a LEO satellite has an average asset life of 5-7 years), spent rocket stages and broken components reside in space. Fewer than 50% of objects present are actively used for communications, navigation, scientific missions or military surveillance. Efforts are underway to develop international frameworks and technologies to manage space traffic and the long-term sustainability of space activities.

None of these concerns, however, have stopped money flowing into the sector. *Practically*, **governments are outsourcing much of the commercialisation of space to the private sector**. The latter's presence can help reduce bureaucracy and improve complex procurement processes, allowing governments to focus on other priorities. PWC estimates that **~$50bn of private capital has been invested across the global space sector since 2015**. Another study (by Seraphim Space) highlights that global venture capital deals for space start-ups hit a new high of 595 in 2024, up 75% year-on-year.

Although these figures are impressive, investors should be mindful of the fact that **the space industry is highly capital intensive and still in a state of flux**. It is also important to consider that there is a complex value chain comprising rockets (to use space, first you must get there), tools (satellites and software) and end-uses (data and analytics). At the same time, there remains only a finite number of orbital positions and radio frequencies currently available in space.

SpaceX is the most visible play on the space industry. It was last valued at $350bn (in December 2024, per Crunchbase) and remains private. It is hard not to be impressed by its progress. The company was responsible for 5 out of every 6 launches in 2024 and owns ~60% of satellites in space. Per its website, SpaceX has conducted 500 completed missions, 462 total landings and 29 reflights.

With **launch being the hardest capital barrier and very difficult to get right**, it helps explain why there are few scaled launch and satellite plays beyond SpaceX. **Rocket Lab**, a US-listed business capitalised at ~$12bn is the leading public business in the space sector. It has launched more satellites into space than any entities other than SpaceX and the Chinese Government and surpassed 50 successful launches more quickly than SpaceX. Beyond launch capabilities, Rocket Lab also sells space systems and satellites. The business is set to remain loss-making for at least the next two years, per Bloomberg. **AST Space Mobile** (with a ~$12bn market value) may be one company that benefits from Rocket Lab's launches. It is seeking to build the first space-based cellular broadband network designed to connect directly with standard, unmodified mobile phones.

Elsewhere, the listed industry comprises legacy providers of satellite services (**SES, Eutelsat** and **Viasat**) and start-ups (such as **Intuitive Machines, Exail** and **Spire Global**). Many private players are also visible including **Blue Origin** (backed by Jeff Bezos), **Firefly** and **Voyager Technologies**. The latter is planning to list in 2025. China also has its own private plays including **Land Space Technology** and **Deep Blue Aerospace**. From a broader perspective, consider who may benefit from the commercialisation of space. If space is about improved access to (big) data, then the main *providers* of it such as **Amazon** and **Meta Platforms** look well placed given the content and services they offer. For the industry as a whole, the direction of travel looks clear: to infinity and beyond.

24 June 2025

GEOTHERMAL ENERGY: THE SUN BENEATH OUR FEET



Executive summary: Geothermal's time has come. The heat from the earth may be the world's most overlooked energy source – but not for much longer. A compelling combination of growing demand and improving supply means that there could be a 20x jump in geothermal energy production over the next 25 years. By 2050, geothermal may be generating 10% of our electricity needs. Advancements in drilling technologies mean that geothermal is becoming increasingly available. Given that the energy source is virtually unlimited, releases few emissions and occupies just a fraction of the space required by other sources, geothermal represents a perfect source for baseload energy. It can help fulfil AI-driven data demand and pave the way for countries to increase their energy independence. If growth projections are correct, then the industry could see $1tr of cumulative investments in the next decade. There are few listed pure-play businesses currently, but VC interest in the space is significant, while existing oil and gas businesses (and their supply chains) are also getting actively involved.

The world cannot rely on conventional energy sources to fulfil all its needs

Watch here

We need more energy. This fact is indisputable. Before even considering the impact of AI and data centres, **population and income growth are driving demand only one way**. If history is any gauge, energy demand will typically run at double the rate of global GDP. Then add in the impact of new technologies. A simple ChatGPT request consumes nearly 10x the power of a traditional Google search. Given the pace at which AI is currently developing, **the computational power required to meet new data demands is doubling roughly every 100 days**.

Now add into the mix geopolitics. Combine the acceleration in reshoring with the growing importance of energy independence. What should become abundantly clear is that **the world cannot rely on conventional energy sources to fulfil all its needs**. Irrespective of net zero-commitments, wind and solar alone cannot sustain domestic demands. It is against this background that **geothermal can fulfil a critical role**.

Geothermal is far from a novel idea. Indeed, **ancient civilisations used geothermal energy to preserve food and bathe before the resource was later harnessed and leveraged to heat buildings and generate electricity**. Geothermal heating, using water from hot springs, has been purposed for bathing since Palaeolithic times; and for space heating since Roman times. The *Aquae Sulis* in Bath (which it is still possible to visit today) exploited the hot springs beneath the city to supply public baths and underfloor heating. The admission fees for these baths probably represent the first commercial use of geothermal energy.

Think of geothermal as a renewable energy heat source that is found under the surface of the earth. The clue is in its name: geo meaning 'earth' and thermal meaning 'heat.' The literal heat from the earth is **an essentially inexhaustible supply of energy**. This heat is continually replenished by the decay of naturally occurring radioactive elements such as uranium, thorium and potassium beneath the subsurface. None is in short supply.

Fast-forward from the Roman era. Modern-day geothermal power plants operate by drawing fluid or steam from underground reservoirs. Geothermal stations pump cold water underground where it is heated up by the Earth's temperature. The resulting steam turns turbines and produces electricity. Geothermal energy can be extracted at various depths, temperatures, and energy types. It has multiple applications, including home and industrial heating and electricity generation.

Although geothermal forms part of the energy mix in around 30 countries currently, it accounts for just 0.8% of total energy supply. Among clean energy sources, modern bioenergy makes up almost 7% of global energy supply, while the shares of others such as hydropower, nuclear, wind and solar range from 1% to 3% each (all data per the International Energy Agency, or IEA). Today, **geothermal is the second *least-used* clean energy source after ocean energy**.

However, **there are multiple reasons why geothermal's share of the energy mix will grow considerably from current levels**. Geothermal has faced historic issues relating to high upfront costs, notable well failure rates and challenges attached to scaling. To drill one 4 kilometre well costs about $5m; at 10 kilometres, the drilling cost quadruples to $20m per well. The high upfront cost and associated exploration risks have deterred development capital and limited the geographic reach of geothermal.

Today the geothermal industry stands at a critical juncture: **drilling technologies and the power of AI are revolutionising its potential**. Conventional geothermal technologies operated by exploiting high-temperature resources where the permeability of the subsurface allowed for high water flow rates. This meant traditional drilling could only occur in sites that were both hot and permeable – attributes that are usually considered mutually exclusive in the world of geothermal. In contrast, the latest enhanced geothermal systems (EGS) and advanced geothermal systems (AGS) can be used far more widely. In EGS, hot, dry rock is fractured to create permeability. AGS uses a closed-loop system drilled into the rock and is ideal to repurpose end-of-life oil and gas wells for heat and power production.

Progress at field demonstrations in the last two years have **reduced estimated project development costs for enhanced and advanced geothermal systems by almost 50%** according to the US Department of Energy (DOE). At the same time, AI-powered models can now accurately simulate the earth's subsurface at a specific geographic location. This inherently reduces the risk of drilling a well that fails to reach adequate geothermal heat. Risk of failure has historically accounted for between 20-30% of the cost of capital in early-stage geothermal projects. In addition, minimising exploration risk **shortens project development timelines from a typical 7-year time horizon to around 2 years**.

These developments serve only to enhance the investment case for geothermal. As an energy source, it is **commercially feasible and ready for expansion today**, unlike technologies not commercially viable at scale, such as long-term battery-based energy storage, hydrogen, and carbon capture. Geothermal overcomes the limitations of other renewable energy sources. It does not suffer from intermittence, as do solar and wind, nor does it rely on the supply of water, required for hydropower. Consider that **geothermal plants can run at 90% availability or higher** (i.e. power is produced 90% of the time or more), compared to less than 30% for wind or below 15% for solar, per the DOE. Even coal plants typically achieve only a 75% availability rate.



Geothermal installations are characterised by low operational costs. This is because unlike fossil fuels and nuclear, plants do not depend on the supply or price of a commoditised fuel. Therefore, the cost is largely concentrated on the technology and power plant. On a levelised cost of energy (i.e. like-for-like) basis, geothermal's cost per unit range of $64-106 puts it in-line with solar and wind depending on exact category and compares favourably with $68-166 for coal or $115-221 for natural gas, per June 2024 analysis from Lazard. In contrast to many other energy sources, **geothermal power plants tend to have a lower profile and smaller land footprint**, and they do not require fuel storage, transportation, or combustion. Work from the US Global Change Research Programme show that number of square kilometres required for a geothermal plant is equivalent to 10% of the land of a wind farm and 20% of a solar farm. Further, unlike nuclear, geothermal energy creates minimal issues at the point of decommissioning.

Geothermal could meet up to 15% of global electricity demand growth to 2050

An additional positive when making the case for geothermal istransferability. Many industry sources suggest that **up to 80% of the investment required in a geothermal project involves capacity and skills that are common to the oil and gas industry**. Skills and drilling technologies developed in the

areas of fracking and liquefied natural gas have considerable transferability to and commonality with geothermal.

Today, around 140,000 jobs are associated with geothermal power development and operations worldwide, with the industry worth $64bn in 2023 (data from the International Energy Agency and Global Market Insights respectively). Project ahead and most **consultants expect the geothermal industry to grow at least at an 8% CAGR over the next decade**. In the US – the world's largest market – the Department of Energy forecasts **a 20x increase in geothermal energy production by 2050**, generating 10% of the country's electricity, and creating an industry worth $250bn.

The IEA is even more optimistic and believes that with continued technology improvements and reductions in project costs, **geothermal could meet up to 15% of global electricity demand growth to 2050**. To reach this objective, the Agency predicts that, globally, **total investments in geothermal could reach $1tr cumulatively by 2035 and $2.5tr by 2050**. At its peak, geothermal investment could reach $140bn per year, which is higher than current investment in onshore wind power globally.

Recent case studies point to the potential of geothermal. Major pilot projects include Fervo Energy's Project Red in Nevada and Eavor's AGS project in Geretsried, Germany. Project Red has a capacity of 3.5MW and is already operational. Eavor's facility has a capacity of 8.2MW and is due to go into operation in 2026. Both will involve a total investment of over $200m. Fervo announced in October 2024 that it had achieved record-breaking commercial flow rates at its first test well site, with electricity production almost three times ahead of output at its prior pilot.

Even the UK has ventured into geothermal generation. Located near Redruth in Cornwall and funded through a joint state-backed and private venture, the United Downs Deep Geothermal Power Project marks the country's first initiative. The project features two wells. The first reaches to 5.3km, making it the deepest in the UK. It is set to begin operations during 2025, with the venture currently forecast to deliver 2MW of electricity.

In theory, all you need is dry, hot rocks for geothermal to be a success. Practically, **geothermal makes most sense in geographies where four factors are present: no nuclear** (for this energy source constitutes the only other sustainable and effective source for baseload energy), **high wholesale electricity prices, high data centre demand** and **supportive regulation**. Against this background, the logic for further geothermal project developments in countries such as the US, the UK, Australia and Ireland looks high. The recent appointment of Christopher Wright to run the US Department of Energy is encouraging, given his background in fracking and board membership at Fervo.

Arguably, **the main barrier to growth for geothermal is cost**. Novel technologies do appear compelling, but there remains a burden of proof in terms of how they are scaled. Wood Mackenzie, a consultant, estimates that to compete with other flexible low-carbon power generation technologies, geothermal capex costs would need to fall by 30-60%.

Given the relative nascence of the industry, **exploring, discovering, developing, and managing geothermal resources can have greater risks and upfront costs than other renewable energy technologies**. The geological uniqueness of each development may make it more difficult to transfer learnings from one site to another. At the same time, internationally recognised technical standards have not been established for geothermal technologies. **Geothermal may face barriers in respect of land access, permitting, and project financing**. There is also the practical consideration of matching energy demands (particularly in terms of where the hyperscalers' data centres are located) to where geothermal resources lie (or governments offer access to licences).

Put another way, **geothermal projects may be subject to long timelines** driven by complex permitting processes and multiple points of contact with permitting and licensing agencies. Logically, then, **if geothermal is to realise its**

potential, then governments need to move it up the national energy policy agenda. While more than 100 countries have policies in place for solar and/or onshore wind, fewer than 30 have implemented policies for geothermal, per the IEA.

For investors, geothermal's potential should be clear. **Scaled geothermal energy projects have the potential to offer stable and predictable income flows, with power plant lifetimes spanning 80 years or more**. Oil and gas companies have long recognised the potential of geothermal energy, but today pure-player geothermal developers and utilities own most installations.

Capitalised at over $4bn and listed in the US, **Ormat Technologies is the largest geothermal owner and operator globally,** based on installed gross capacity, per data from the consultancy ThinkGeoEnergy. It has built over 200 geothermal wells in the US, Italy and Chile and has other projects underway in geographies as diverse as Turkey and Indonesia. Ormat says that it makes a 13-15% post-tax IRR on a typical project. Also listed, albeit in the Philippines, is **Energy Development Corporation** (EDC), which ranks number two globally in terms of installed capacity. EDC is followed in capacity terms by CFE, a state-owned entity in Mexico, and then Star Energy, an Indonesian business.

Many oil and gas companies are already making efforts to harness geothermal energy. Using its experience with traditional geothermal electricity in Indonesia and the Philippines, Chevron is leading next-generation projects. Equinor and Shell have worked together on conventional geothermal projects like Lithium de France. While new to geothermal energy, BP is a partner in Eavor's AGS project and the Texas Geothermal Alliance, assessing EGS potential in the state.

Geothermal energy start-ups attracted over $650m in venture capital funding in 2024, the largest value ever recorded, according to Dealroom. Highest profile among these is Fervo (referenced earlier), which raised $250m of new funding last year and is currently considering a potential initial public offering, per Bloomberg. Founded in 2017, the business counts Google, Devon Energy and Mitsubishi as partners. **Sage Geosystems** is another significant private US player, which claims to have developed a proprietary geothermal system and has filed over 200 patents. Meta has partnered with Sage, which will provide power for its data centres. Elsewhere, **Eavor Technologies** in Canada, **Quaise Energy** (an MIT spin-out), **Bedrock Energy, Geothermal Anywhere** and **Solution Energy** include other start-ups to watch.

Don't forget the metaphorical shovel makers. **Fuji Electric** is one of the world's largest equipment suppliers and engineering-services providers for geothermal-energy plants. It has delivered roughly 60 geothermal turbines. Other players active in the geothermal space include **Toshiba, Mitsubishi, Sumitomo, Schlumberger and GE**. If the geothermal industry does develop in a fashion similar to fracking or liquefied natural gas, then the spoils for the leading industry participants will certainly be significant.

08 April 2025





HUMANOID ROBOTS: THE REAL ROBOT REVOLUTION

Executive summary: Take robots and add artificial intelligence. The result: a new generation of humanoid robots with radically improved capabilities relative to more traditional robotic models. We will increasingly need such humanoids to support both an ageing population and a shrinking workforce. Already, humanoids can be found working in car factories and warehouses. As underlying technologies only improve and costs correspondingly fall, their number and the use cases in which humanoids can be deployed will only grow. By 2035, the market for humanoid robots could be more than 20 times its current size, equivalent to almost $40bn in value. Progress, of course, will be non-linear and today's leaders may not end up being tomorrow's winners. Regardless, more than $10bn of venture capital has flowed into humanoid robot start-ups in the last year. Large tech businesses and existing robotic players are also keen to get in on the act. Expect a swathe of product launches in 2025.

Think of the next wave of AI as being physical AI

Watch here

The robots are coming is a refrain we have heard many times. However, progress has been slow. Today there are about 3.5m units in operation, primarily in industrial applications. **Globally, there are around 1,000 people employed for every robot**. Even in South Korea, which has the world's highest robot density, there are still roughly 100 times more humans as robots in the workplace, according to McKinsey. Robots may be present, but they have had little impact.

Forget robots. Instead, think of humanoids, or robots that increasingly resemble humans in their capabilities. **Historically, the fields of robotics and AI have been separate. Their convergence is driving the real robot revolution**. In the future, robots will look, act and think much like people. Owning a robot may be as commonplace as having a mobile phone or a car today. Listen to Elon Musk (admittedly an innovator who does not shy from making bold predictions) and robots will "far outnumber" humans by 2040.

For humans, activities such as walking across a busy room or picking an item are routine, requiring little mental effort. Yet these actions are remarkably complex, requiring the body to sense and respond to a mix of visual and haptic cues. Programming a machine to achieve human-like movement in unstructured environments is difficult with conventional methods. Now, with the rapid emergence of generative AI, manufacturers have been able to dramatically improve robots' ability to perform these tasks.

Think of the next wave of AI as being physical AI, or an artificial intelligence that "understands the words of physics and can work among us", in the words of NVIDIA's Jensen Huang. 'Embodied AI' could be another apt description. Take sensors, actuators, batteries, power electronics, sophisticated 3D printing and *now* add in advanced software. The humanoid robot is on its way. **AI has the potential to be transformational in terms of the way in which robots learn to move and navigate environments**. They are picking up skills faster than ever before and adapting in ways previously thought impossible. Robots now have the ability to learn from direct observation and experience in the field. Put simply, perception and action are derived from data collection.

Several large-language training models (or VLAMs – 'vision-language-action-models') have already been developed. Expect more. Take the RT-X Model. This is the world's largest open-source robotic data set. It includes over 1m robot trajectories (or potential paths that a robot might follow while performing a task) covering over 20 different robot types. Apply these learnings to any new robot model, and it can achieve up to a 50% improvement in task completion relative to more conventional training methods. Or consider NVIDIA's Project GR00T, a general-purpose foundational model. It is specifically designed to facilitate humanoid robot learning in the real world. The model empowers robots to replicate human movements through observing action and videos. The benefits are improved coordination, dexterity and task completion. Similar to how iPhones receive new over-the-air software updates, so can robots, enabling more tasks and activities.

Have no doubt, **we need humanoid robots**. By mid-century, the global population of people aged 60 years and older will double, topping 2.1bn. Furthermore, the number of persons aged 80 years or older is expected to triple, reaching 426m by 2050, according to data from the World Health Organisation. 29% of the US workforce is comprised of boomers (born between 1946 and 1964) that will soon retire. Goldman Sachs estimates that there is expected to be a 4% shortage in US manufacturing labour and a 2% shortfall in global elderly care provision by 2030. Robots can fill the gap. Humanoids will not only work in factories but also care for the elderly.

The potential for humanoids to revolutionise a broad swathe of industries should be clear. **Humanoids should be able to work lengthy days, or potentially non-stop** (were they to have swappable battery packs and/or tethered power). Further, **they require only a tiny fraction of supporting workplace expenditures required** by humans, such as bathrooms, food, parking spaces, insurance, healthcare, pensions and so on. Apart from minimal downtime for maintenance, they should

work without vacation, illness or complaint. In theory, they could be deployed instantly to perform any new task, with significantly reduced administrative costs. Even today, they can also speak (and translate from/to) any language.

Look around and you will see **humanoids increasingly visible in multiple diverse workplaces**. Current models are typically bipedal with five fingers, creating some similarities with humans and requiring minimal workplace reconfiguration. The latest models are capable of movements as precise as of 0.001mm, which give them the skills required in most high-performance jobs (according to the Bureau of Labor Statistics) and provide them with adaptive control to navigate unpredictable environments.

Visit many car factories (admittedly the among the earliest adopters of conventional industrial robots) and you will see humanoids at work. BMW's newest autoworker (made by Figure and profiled above) is 167cm tall, weighs 59kg, walks on two legs, uses five-fingered hands to assemble machines – and takes a break every five hours to stroll to a charging station and plug itself in. Mercedes and Magna International are also using robots, as is Tesla, unsurprisingly. Anecdotally, 90% of its Model 3 is now made by robots.

Take fulfilment centres as another clear use case. Both Amazon and GXO Logistics have started to trial robots (and deploy, in the case of Amazon) in a handful of the warehouses they operate. Robots, such as those made by Reflex, can pick 15kg bins and lift them onto conveyer belts more quickly and safely than their human counterparts. If weight is a consideration, then think of how humanoids could operate on construction sites. Here, they could perform better than humans in more dangerous environments, such as operating at height. Window-cleaning skyscrapers? Skyline Robotics has it covered. Equally, humanoids could be deployed to monitor and maintain remotely distributed assets such as power, water and telecoms infrastructure that are currently difficult for humans to oversee safely.

Healthcare constitutes another major end-market that could be potentially disrupted, particularly in terms of caring for the elderly, not to mention the company that they could provide too. Humanoids could be designed to assist healthcare professionals in physical tasks such as lifting and moving patients, as well as aiding with mobility and retrieving and delivering equipment. Such outcomes would not only help reduce the strain and potential injuries on healthcare workers but can also enhance the overall quality of patient care. Elsewhere, the Perceptive robot is said to be able to perform dental procedures faster and more accurately than its human counterparts.

Project even further ahead and humanoids could, *theoretically*, be deployed in a military capacity or even be deployed to help build new worlds on other planets (Mr Musk is an advocate of the latter scenario). Consider that **today's humanoids are the most expensive and least capable than they will ever be**. Unit costs can vary between $30,000 and $150,000 depending on the model but have already fallen by over a third in the last year, according to research by Goldman Sachs. Payback periods will clearly improve with lower costs. Equally, humanoid capabilities should only grow from here. Against this background, **as the industry scales, the marginal cost of adding one additional robot to the workforce should move close to zero**.

Humanoids are increasingly visible in multiple diverse workplaces

The humanoid robot market is currently worth $1.3bn, but it is currently growing at three times the rate of the conventional robotics market, based on analysis by Goldman Sachs**.** On its projections, **the market could be worth $38bn in a decade's time**. Humanoid robotic manufacturers are, unsurprisingly, more bullish. Given that labour compensation typically accounts for around 50% of a nation's GDP, then the *potential* addressable market for humanoid robots could be as much as $50tr (using a 2023 world GDP figure of $105tr). It will, of course, take a long time to get there.

Herein lies the problem. Advocates would argue that humanoids are productivity enhancers, or complements, rather than replacements. They should allow humans to perform more value-added tasks. Humanoids can also alleviate strains on an ageing population. None of this, however, may prevent an inevitable backlash in some quarters. Beyond the risk of job losses, concerns have been raised about the risk of potential robotic 'hallucination', leading to tasks being performed incorrectly or with disastrous consequences. **Any LLM that powers a humanoid robot will only be as good as the data on which it is trained**. Then there are legal, ethical and security considerations that will need to be combined with the extent to which humans may be comfortable with robots having access to personal data, particularly should it relate to healthcare.

None of these issues is novel. Luddites often make the crucial mistake in failing to appreciate fully that **humanoids will disrupt *tasks* more than *jobs***. Similarly, the risk of robots getting out of control is based on a misperception around their sentience. For us, **the more critical debate should be centred around the alignment of expectations**. Make clear what robots can do at the outset so as to minimise the scope for potential disappointment. Do not anthropomorphise or over-generalise about what humanoids can do. There is also the more practical and mundane consideration that most humanoids can *currently* only work for limited periods of time before requiring recharging. This may constrain their abilities, although improvements are occurring at an exponential pace.

Given the secular challenge of an ageing population and a shrinking workforce, it is appropriate to pose the counterfactual: **what might be the (next) best available alternative to having humanoid robots? In our view it behoves countries logically to be addressing these challenges now rather than before it is too late**. Early adopters could see clear productivity gains to both their business and the broader economy. Expect also a potential race between different countries (especially the US and China) to develop technological standards and to seek to roll their robots out to other regions.

Investors need to pay attention now. Although the industry may be some way off reaching scale, it is clearly preparing for lift-off. **Over $11bn of venture capital funding flowed into the humanoid robot industry during 2024**, according to Pitchbook. Beyond the multiple start-ups present in the field (some were referenced previously in the report, and others would include Agility, Apptronik, Engineered Arts and 1X Technologies as well as Unitree in China), major tech businesses such as Amazon, Microsoft, NVIDIA and Samsung are involved in various robot projects. Existing players in the robotic market such as FANUC, Hyundai, Keyence and Toyota are also seeking to expand into the humanoid arena. Other potential beneficiaries could include enablers, or the providers of critical components such as actuators, sensors and LIDAR (vision) systems.

The analogy of the horse and the car may be a salutary one. Project back to 5th Avenue in 1900 and 95% of all transportation was provided by horses. Less than 15 years later it's almost impossible to spot any horses. The robots may finally be coming.

10 February 2025



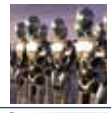
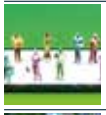
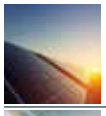
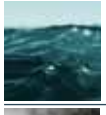
4

PART FOUR: Appendices





THE FULL FUTURE TRENDS INDEX

Date	Thematic Papers Published		
2011	 **Data** The data deluge	 **LNG** A 'natural' solution to the world's energy needs	 **Power Shortages** What happens when the lights go out?
2012	 **Obesity** Fat profit potential: bulging bellies and growing obesity	 **Robotics** The robot revolution	 **3D-Printing** Coming soon to a printer near you
2013	 **Healthcare IT** Healthcare transformed: how IT can help save lives	 **Cashless Society** Cash dethroned	 **Smart Lighting** The lightbulb moment
2014	 **Online Retail** Just the tip of the iceberg	 **Cybersecurity** Watch out! The growing privacy invasion	 **Internet of Things** Connecting the unconnected
2015	 **Digital Currencies** At the tipping point?	 **Car of the Future** The long road to autopia	 **Peer-to-Peer Lending** The P2P revolution
2016	 **Sharing Economy** Get sharing!	 **Artificial Intelligence** The rise of the smart machine	 **Virtual Reality** Time to get real?
2017	 **Transport as a Service** The new transport revolution	 **Robotics** Robotics 2:0 – the rise of the service robot	 **CRISPR** Time for a DNA upgrade?
2018	 **Blockchain** No more middlemen	 **Wind Energy** Winds of change	 **Microbiome** Gut feeling
2019	 **Agriculture** We're all hungry for some agtech	 **Smart Cities** Livin' for the city	 **Cannabis** Green rush: the current investor high in cannabis
2020	 **Solar Energy** Everybody loves the sunshine	 **5G** Gee-whizz: the hype and the reality	 **Hydrogen** The missing element
2021	 **Telemedicine** The virtual doctor calls	 **Micromobility** Disrupt the car, and rethink the city	 **Pet Economy** Digitalising dogs: the long-tail opportunity
2022	 **Water Shortages** Liquid data: digitalising the water sector	 **DeFi** Demystifying DeFi	 **Smart Grids** Keep the lights on: make the grid smarter
2023	 **Circular Economy** In the round	 **Artificial Intelligence** Your questions on AI (answered by a human)	 **Quantum** On the edge of the quantum age
2024	 **Future Housing** Home! Sustainable Home!	**Alzheimer's** The final healthcare frontier	**Warehouses** Unsung heroes of the modern world
2025	**Humanoid Robots** The real robot revolution	**Geothermal** The growing case for geothermal	**Space** The race is on
2026	**Stablecoins** Mainstream stability, Maybe?	**Autonomous Vehicles** Arriving soon in autopia	**Agentic Commerce** The accelerating ascent of a-commerce

We have published 75 dedicated pieces on future trends since 2011, covering at least 50 unique themes (several have seen subsequent update notes, owing to their growing importance and evolving dynamics). Below follows the complete list, sorted chronologically. Every piece since inception is accessible via Heptagon Capital's website.



Water Shortages
The curse of Coleridge



Data Deluge
Drowning in data



Nanotechnology
Get ready for nanotechnology



Food Innovation
You are what you eat



Energy Storage
What if the sun always shone?



Implantable Technologies
The man-machine merger



Cybersecurity
The next generation



Plastic Pollution/ Waste
Winning the war on waste



Alternative Meat
Beyond impossible



EdTech
New school rules



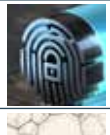
Metaverse
Welcome to the metaverse



Drones
Drones: now ready for take-off?



Wind Energy
Winds of change: offshore edition



Cybersecurity
The more things change...



Longevity Science
Time to turn back time



eVOTLs
The growing case for eVTOLs



Future Housing
How the house of the future may look...



Molecular Diagnostics
The coming age of personalised medicine



EdTech
Back to school



Synthetic Biology
Food for thought?



Quantum
A leap forward



Space
To infinity and beyond?



Longevity Science
Who wants to live forever?



Data Deluge
Ten years on: the data deluge 2.0



Food Innovation
Food's future; how to feed the world more intelligently



Fracking
What you need to know



Rail
Full steam ahead!

THE FUTURE TRENDS BLOG

The *Future Trends Blog* was launched at the start of 2019. Since then, we have published almost 400 posts including around 40 so far in 2026. Our approach to thinking about Future Trends has always been premised on consistently seeking to uncover emerging themes, tracking their evolution and identifying businesses which could be well positioned to benefit from such trends. Our Blog posts typically come out once a week and can be accessed via Heptagon Capital's website and also via LinkedIn.

The Blog provides a platform for sharing some of the original thinking we are doing with a broader audience. 2026 posts encompassed topics that included drones and data as well as longevity and logistics. Underpinning almost all of them was the ever-pervasive topic of AI. Artificial intelligence has been the primary subject in over 15 posts year-to-date, while the term has appeared more than 200 times in our Blog so far in 2026 (according to Copilot, our favoured large language model).

The posts that have provoked most interest from our readers have been those that have asked the question *what happens when humans are no longer the smartest participants in the system?* These would include "Coffee with the CTO, 2026 edition" (post 14), and "Computer says yes" (post 28). Many found the idea that people trust AI more than politicians genuinely unsettling. Personal favourites of your author were "I just want a new pair of trainers" (post 24) and "ROE for Gen-Z" (post 23). The former discusses the problems with agentic shopping, while the latter discusses how human behaviour is changing.

Below follows a complete index of the pieces we have posted to the Blog so far this year.

Season 8

#01: Dare to be different (7 January)
#02: Robo(taxi) wars (13 January)
#03: Breaking the obesity trap (21 January)
#04: The year of water (29 January)
#05: Robots? Yes please! (05 February)
#06: At the AI coalface (11 February)
#07: The airport of the future (24 February)
#08: Where technology meets humanity (04 March)
#09: How we really feel about AI (09 March)
#10: Bites from the Big Apple (16 March)
#11: Welcome to the Novacene era (24 March)

#12: Top themes for epic uncertainty (10 April)
#13: “A polite punch in the face” (16 April)
#14: Coffee with the CTO, 2026 edition (23 April)
#15: The agentic age (28 April)
#16: Germany’s greenest warehouse (06 May)
#17: HALO effect (14 May)
#18: Delivering smiles (and toilet paper) (20 May)
#19: Why we die (26 May)
#20: If everything can be faked… (08 June)
#21: Hands off the wheel (17 June)
#22: Same sun, more energy (25 June)
#23: ROE for Gen-Z (29 June)
#24: “I just want a new pair of trainers” (07 July)
#25: The robot coffee test (13 July)
#26: Four fun things (30 July)
#27: Staying cool and chilling out (04 August)
#28: Computer says yes (11 August)
#29: When agents go rogue (20 August)
#30: How much do you love your pet? (24 August)
#31: Faster, higher, stronger - together? (01 September)
#32: “AI, sophistication and personalisation” (09 September)
#33: Eyes to the skies (15 September)
#34: Step on the gas (23 September)
#35: Just scratching the surface (29 September)
#36: The good, the bad and the ugly (06 October)
#37: The energy trap (12 October)
#38: Disruption on steroids (21 October)
#39: Living in a TUNA world (28 October)

View Heptagon Future Trends on LinkedIn

RECEIVE THE UPDATES
Sign up to our email newsletter for the latest fund updates, webcasts and insights

RECEIVE THE UPDATES

THE HEPTAGON FUTURE TRENDS EQUITY FUND

We believe that investing in businesses exposed to future trends represents an investment opportunity. Against this background, **the Heptagon Future Trends Equity Fund was launched in January 2016** and is led by Portfolio Manager Alex Gunz.

The Fund is managed in-house at Heptagon Capital, a London-based boutique investment firm, founded in 2005 with 47 employees and over $18bn of assets under advice and management across various strategies.

- **Fund launch: January 2016**
- **Fund AUM: $76m**

Strategy: We seek to identify and invest in a diverse range of businesses offering exposure to the key trends which we believe will help shape the future. These naturally align with the **United Nations Sustainable Development Goals**, which we believe will sustainably grow in importance regardless of the economy and regulation. The Fund has been classified as an Article 8 for the purposes of the EU's Sustainable Finance Directive. The portfolio has always been **highly concentrated** (20-25 names since launch) with **low levels of turnover** (typically ~25% a year). The Fund is sector, size and geography agnostic, with **high active share** (typically over 95%).

For further information on the Heptagon Future Trends Equity Fund please refer to Heptagon Capital's website.

- **Signatory of:** PRI Principles for Responsible Investment
- **Sustainable Investment - Low Carbon/Fossil Fuel Free**

All data as of 30 September 2026. **Past performance does not predict future returns, the value of investments and income from them can fall as well as rise.**. Our monthly factsheet and commentary for the Fund are available on Heptagon Capital's website. Please contact your representative at Heptagon Capital for additional information. The ISIN for the Heptagon Future Trends Equity Fund is IE00BYWKMJ85.

The value of investments may fall as well as rise and investors may lose some or all of the amount invested.

Important Information

This communication is for information purposes only. It is not an invitation or inducement to engage in investment activity.

The document is provided for information purposes only and does not constitute investment advice or any recommendation to buy, or sell or otherwise transact in any investments. The document is not intended to be construed as investment research. The contents of this document are based upon sources of information which Heptagon Capital believes to be reliable. However, except to the extent required by applicable law or regulations, no guarantee, warranty or representation (express or implied) is given as to the accuracy or completeness of this document or its contents and, Heptagon Capital, its affiliate companies and its members, officers, employees, agents and advisors do not accept any liability or responsibility in respect of the information or any views expressed herein. Opinions expressed whether in general or in both on the performance of individual investments and in a wider economic context represent the views of the contributor at the time of preparation. Where this document provides forward-looking statements which are based on relevant reports, current opinions, expectations and projections, actual results could differ materially from those anticipated in such statements. All opinions and estimates included in the document are subject to change without notice and Heptagon Capital is under no obligation to update or revise information contained in the document. Furthermore, Heptagon Capital disclaims any liability for any loss, damage, costs or expenses (including direct, indirect, special and consequential) howsoever arising which any person may suffer or incur as a result of viewing or utilizing any information included in this document.

The document is protected by copyright. The use of any trademarks and logos displayed in the document without Heptagon Capital's prior written consent is strictly prohibited. Information in the document must not be published or redistributed without Heptagon Capital's prior written consent.

For all definitions of the financial terms used within this document, please refer to the glossary on our website: https://www.heptagon-capital.com/glossary.

Risk Warnings

The Fund is subject to special risk considerations including geographic concentration risk, portfolio concentration risk and operational risk. The investment return and principal value of an investment will fluctuate so that the investor's shares, when redeemed, may be worth more or less than their original cost. Any investor should consider the investment objectives, risks and charges and expenses of the fund carefully before investing. Where an investment is denominated in a currency other than the investor's currency, changes in rates of exchange may have an adverse effect on the value, price of, or income derived from the investment.

SFDR

This Fund has been classified as an Article 8 for the purposes of the EU's Sustainable Finance Disclosure Regulation ('SFDR'). The Fund promotes environmental and/or social characteristics but does not have sustainable investment as its primary objective. It might invest partially in assets that have a sustainable objective, for instance assets that are qualified as sustainable according to EU classifications but does not place significantly higher importance on the environmental objective of each underlying investment. Please see prospectus for further information on the Funds environmental and/or social characteristics and relevant sustainability risks and principal adverse impacts which may impact the Fund's performance.

Disclaimers

Source: MSCI. The MSCI information may only be used for your internal use, may not be reproduced or redisseminated in any form and may not be used as a basis for or a component of any financial instruments or products or indices. None of the MSCI information is intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such. Historical data and analysis should not be taken as an indication or guarantee of any future performance analysis, forecast or prediction. The MSCI information is provided on an "as is" basis and the user of this information assumes the entire risk of any use made of this information. MSCI, each of its affiliates and each other person involved in or related to compiling, computing or creating any MSCI information (collectively, the "MSCI Parties") expressly disclaims all warranties (including, without limitation, any warranties of originality, accuracy, completeness, timeliness, non-infringement, merchantability and fitness for a particular purpose) with respect to this information. Without limiting any of the foregoing, in no event shall any MSCI Party have any liability for any direct, indirect, special, incidental, punitive, consequential (including, without limitation, lost profits) or any other damages. (www.msci.com)

The Global Industry Classification Standard ("GICS") was developed by and is the exclusive property and a service mark of MSCI Inc. ("MSCI") and S&P Global Market Intelligence ("S&P") and is licensed for use by Heptagon Fund ICAV. Neither MSCI, S&P, nor any other party involved in making or compiling the GICS or any GICS classifications makes any express or implied warranties or representations with respect to such standard or classification (or the results to be obtained by the use thereof), and all such parties hereby expressly disclaim all warranties of originality, accuracy, completeness, merchantability and fitness for a particular purpose with respect to any of such standard or classification. Without limiting any of the foregoing, in no event shall MSCI, S&P, any of their affiliates or any third party involved in making or compiling the GICS or any GICS classifications have any liability for any direct, indirect, special, punitive, consequential or any other damages (including lost profits) even if notified of the possibility of such damages.

Heptagon Capital (DIFC) Limited, an affiliate of Heptagon Capital Limited, is registered in the Dubai International Financial Centre ("DIFC") with registration number 7480 and regulated by the Dubai Financial Services Authority ("DFSA"), under reference number F008730, for the provision of the Financial Services of Advising on Financial Products and Arranging Deals in Investments. Heptagon Capital (DIFC) Limited's registered office is Unit 512, Level 5, Index Tower, DIFC, Dubai, United Arab Emirates. This material is intended only for persons in the DIFC who meet the criteria to be classified as Professional Clients under the DFSA Conduct of Business Rules. It is not intended for Retail Clients or for any person who does not meet the applicable DFSA client classification requirements. The financial promotion to which this local disclaimer relates has been issued and approved by Heptagon Capital Limited licenced to conduct investment business by the Malta Financial Services Authority, and Heptagon Capital (DIFC) Limited, and has not been approved by the DFSA. Heptagon Capital (DIFC) Limited is providing this local disclaimer only for the purposes of distribution in or from the DIFC

Financial Conduct Authority, 12 Endeavour Square, London, E20 1JN (FRN: 403304)

FOR ALL GENERAL ENQUIRIES

Tel: +44 207 070 1800

Email: london@heptagon-capital.com

ADDRESS

63 Brook Street
London W1K 4HS
United Kingdom

Heptagon Capital LLP is authorised & regulated by the Financial Conduct Authority.

Registration No: 403304
Registered in England and Wales No: OC307355
Registered office as above