Volume 11

# FUTURE TRENDS Key themes for 2025 and beyond

HEPTAGON Capital



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



### Key themes for 2025 and beyond

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elcome to the eleventh edition of our Future Trends compendium. We have been writing about and investing in future trends since 2011, during which time we have published almost 70 dedicated pieces of thematic work.

It's certainly been a journey. We believe that the themes we continue to investigate not only have the power to capture the imagination, stimulate and cause debate, but also matter, since they drive a core part of our investment process. After having offered investors exposure to the Future Trends investment strategy via an equity note since 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 covered the diverse topics of potential cures for Alzheimer's Disease, how artificial intelligence is impacting the cybersecurity landscape for both attackers and defenders, what the house of the future may look like given growing sustainability imperatives, and why warehouses are the unsung heroes of the modern world. Consistent with prior years, all these reports are reproduced in full in this compendium. An adjacent QR code by 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 opportunity take to every available to better understand the future. During 2024, we travelled extensively across the UK, mainland Europe and the United States. Highlights included tasting lab-grown salmon in San Francisco and seeing live salmon in farms in rural Norway. We have stood inside both semiconductor clean rooms and automated warehouses (Oberkochen, Germany and Bradford, England respectively). Robots have served us lunch and

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chatbots have sought to make our lives easier. Many of these events have been captured in the <u>Future</u> <u>Trends Blog</u>, which was launched almost six years ago. Over 250 posts have been published since 2019. A summary of 2024's output can be found on page 78.

Throughout all our work, we have agued consistently, **expect more disruption**. Our first thematic piece – on data – remains as relevant now as it did on release. In brief, the amount of data that are 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.

Time and again, new technologies improve capabilities and decrease costs. Think of them not as replacements for old applications, rather as mechanisms for expanding market size. Innovation is all about creating new demand. Our annual 'bigger picture' essay on pages 10-13 discusses how these debates continue to be reframed within the context of artificial intelligence. We believe that while **the potential for AI is being overstated in the near-term, the longerterm opportunities around this technology are underestimated**.

After this essay, readers will encounter our perspectives on what we see as some of the key future trends changing the world, reflecting new information we have learned recently (pages 32-73). All our theme pieces from the last two years then follow. A summary of our complete thematic output can be found on page 76. 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 80. Looking forward, our aim is to continue researching new topics and publishing our conclusions. The world is never boring, and we are continuing to learn on a daily basis. Read on, and hopefully your appetite will be sated. We are already looking forward to compiling next year's thematic compendium.

#### Alex Gunz

Fund Manager, Heptagon Capital November 2024







# FUTURE TRENDS IN PHOTOS































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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.





### PART TWO: In Brief



# THE BIGGER PICTURE Al and Its Discontents

What can Sigmund Freud teach us about AI? His famous 1930 work "Civilisation and Its Discontents" (which your author first read when at university) explores the important clash between the desire for individuality and the expectations of society. Framed through the lens of AI, the debate is one over whether the technology - or any other for that matter - will promote freedom and creative instincts or accelerate conformity. Even if we might be on the cusp of a genuine revolution, we may have to deal with potential disappointments first, particularly

in the context of currently stillelevated expectations. Most likely, we won't know the answer for some time.

At heart, we are 'techno-optimists', in the words of Marc Andreessen, founder (along with Ben Horowitz) of the eponymous venture capital firm. In order to believe in the future, it is necessary to believe in the power of ingenuity, entrepreneurship, innovation and cooperation. Arguably, **technology is the only source of perpetual growth**, since it enables the world to make more efficient use of scarce resources, particularly in the face of a still-growing global population.

Have no doubt, AI is a game-Jensen Huang, changer. As arguably its biggest advocate, puts it, "AI will bring significant productivity gains to nearly every industry." Think of AI as being a platform shift that allows for computers no longer to be instruction driven. Rather, see them as being intention understanding. Put another way, computers will stop acting like calculators and start acting like the human brain. Intelligence will become a service. The over 800%

rise in the NVIDIA share price over the last two years reflects the optimism that has become embedded in the potential of Al. For another example, consider the implied \$150bn valuation of OpenAl achieved at its most recent funding round, despite reported losses of over \$5bn.

Students of history will, of course, be familiar with the words of Sir John Templeton, written just three years after Freud's work was published. In his view, **the four most dangerous words in investing are "this time it's different."** Beyond the debate over whether investors are currently overpaying to gain exposure to the theme of AI, the more pertinent consideration is that **no technology develops in a linear fashion**. In this context, stock market corrections of AI proxies should only be seen as healthy.

For AI to properly fulfil its potential, firms everywhere will need to buy the technology, shape it to their needs and become more productive as a result. Nonetheless, many corporates appear currently to be struggling to enunciate the tangible benefits of AI. A majority (56% of Fortune-500 companies, per a <u>recent report</u> in the Financial Times) even see it as a risk. How generative AI gets used in practice is still not clear. Doing things you already do, but slightly better, easier or more efficiently can be thought of as necessary, but far from sufficient, especially if it is difficult to quantify the specific gains.

providing basic but accurate summaries of complex information, Al still struggles. **There is no killer app**, yet, nor has a truly original one – forget augmented personal assistants – been suggested. Large language models may know a lot about the world, but still almost nothing about the specific person using them. The incorporation of Al into business processes remains a niche pursuit for now. Efforts to deploy the technology may even be distracting executives from other, more important priorities.

Similarly, any primary school age child can learn how to clear the dinner table in one or two shots, while a 17-year could drive a car with fewer than 20 hours of training. Alenabled assistants are nowhere close. Human brains continue to massively outperform computers in cognitive tasks, especially when measured in comparable units of effective power required. **A burden** of proof on the extent to which Al can be adoptable at scale across the economy therefore exists.

Might we then have reached a peak of inflated expectations? A trough of disillusionment may come next, should this technology follow the traditional hype cycle, per Gartner. Put another way, what happens if the market decides that there are fewer use-cases and less profit in Al than is currently priced in, particularly should the broader economy start to slow?

**Technological revolutions take time**, often decades rather than years. At this stage another history lesson may be valid. Few readers will likely be familiar with the English economist William Stanley Jevons, born before both Sigmund Freud and Sir John Templeton, in 1835. His most famous work, "The Coal Question," discussed the impact of the Industrial Revolution, a regime change that played out over a long period. In it Jevons observed how improved steam engine efficiency led to much greater coal demand. Economists, at the time, had worried that England was running out of coal. Many of Jevons' peers argued that improved efficiency would temper demand and bring about a crisis. Jevons dismissed this loaic. correctly concluding that improved efficiency would accelerate demand by promoting increased adoption.

From here, to Jevon's Paradox: improved efficiency increases consumption, than rather the inverse. Better efficiency encourages more significant use. Or, as the same input unit generates more output, economic growth accelerates, increasing overall consumption. Set this argument against the discontents of AI. Fear sells, particularly when misunderstanding exists. However, history has proven both Ned Ludd (new technology will result in job losses) and Thomas Malthus (output will fall as population grows) consistently wrong. Ask people if 'technology can make the world a better place', and 83% respond in the affirmative, per a study conducted by VML Intelligence.

Look around and we can see the Jevons Paradox at work in many

At some simple tasks, such as

different industries. We suspect it will be little different when it comes to AI. As vehicles have got more efficient, many have chosen to own larger cars and drive further. The same is true for airlines. Better engines allow us to fly further and more frequently. Farmers have equally found that if the yield of a crop is increased, it will reduce the given area required to produce the same amount. However, improved efficiency could make it more profitable to grow further crops and incentivise farmers to convert more land for crop production, correspondingly increasing land use

The case for accelerated AI adoption should, therefore, be evident: a rise in efficiency in resource use will generate an increase in resource consumption, rather than a decrease. If technology can help workers be more useful, then it could enhance their productivity, and perhaps their job satisfaction too. Higher productivity means serving more customers, leading to more demand elsewhere.

Consider the impact of AI already in terms of customer service. It can help raise performance. A <u>recent</u> <u>study</u> by Erik Brynjolfsson of MIT finds that such workers manage to resolve 14% more issues per hour when assisted by an AI bot, with the lowest performing benefiting most from the tool. A broader OECD <u>study</u> showed how **80% of workers in manufacturing and financial services who use AI report that it improves their output**. A large majority also say that it improves working conditions. Those who work in sales have seen an uplift in lead generation and note taking. Translators have become copy editors, tidying first drafts undertaken by a computer. Al won't take your job. *If* you do lose it, then it will be to someone who is better at using Al than you. This process will likely continue and may speed up. A more productive economy should be a richer one, creating incremental demand for goods and services.

However, the discontents remain. Al will only get better and as it becomes both more self-aware and embedded, it is possible that humans may feel in greater opposition to it. What happens when technology reduces or replaces a previously unique human skill with something that can be replicated by a machine, or a piece of software? A major existential reckoning with AI - the moment of singularity, when the capabilities of machines surpass humans - seems some way off - but it would be naïve to deny that technological change won't bring about some unintended consequences.

Some of these consequences will, of course, be positive. We can envisage how **AI could become a** *public good* **and also usher in an entirely new computing paradigm**. The massive fibre infrastructure boom of the late 1990s resulted in many corporate failures (WorldCom, Global Crossing, Level3 etc.) but also led to a substantial fall in bandwidth costs over the coming years, increasing accessibility and usecases. Cloud computing followed, enabled by companies with the financial resources to build out data centres. People originally did not believe they needed smartphones before they existed. Now, it is inconceivable to most how they ever existed without them. Al is here to stay, and noone will be able to avoid it. It will become as ubiquitous and as necessary as electricity (once, of course, the grid infrastructure to support it has been upgraded which is no easy process).

The real value for AI will likely come from invention. Back to Freud: civilisation depends on creativity. Technology has been, and will remain, an enabler. Improved learning has the potential to turbocharge every industry, boosting trend growth and corporate profitability. With AI, production will become cheaper and easier. It is hard not to be a techno-optimist when the **promise of applying** Al to scientific breakthroughs in healthcare, energy, material science and other industries seems so tantalisingly close.



# HOW WE SEE THE WORLD CHANGING

2024 has another been fascinating year for anyone interested in understanding future trends. AI has remained front of mind but the debates around this topic have encouragingly broadened to include cybersecurity implications and whether existing grid infrastructure is robust enough to support growing data demands.

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The second fill

Better grids need more inputs, particularly from a diverse range of alternative energy sources. Elsewhere, drugs to treat obesity continue to be a hot topic in the healthcare sector. How the food industry responds and evolves is also highly relevant.

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 nonexhaustive; think of it rather as a series of interlinked highlevel perspectives. Our stance remains that as diverse future trends overlap and intersect, they become mutually reinforcing.



Red-hot innovation (13 February); The transition mission (21 February); California Dreaming: Notes from the Valley (19 March); AI and Its Discontents\* (9 April); "There's never been a better time to be a builder" (25 April); Coffee with the CTO, 2024 edition (29 May); Live from London Tech Week (11 June); 27: "Humanlike decisions, but better" (17 July); Postcard from America (21 August); "Embrace change" (15 October)

#### **Relevant Theme Pieces:**

Artificial Intelligence: The rise of the smart machine (April 2016); Your questions on AI (answered by a human) (March 2023) "The next industrial revolution has begun... Al will bring significant productivity gains to nearly every industry and help companies be more cost- and energy-efficient, while expanding revenue opportunities" Jensen Huang, Chief Executive of NVIDIA

Investment in AI has become an arms race, with a potential risk of serious over-spend in the nearterm. The longer-term dynamics have already been discussed in our introductory essay. Consider for now that the four largest hyperscalers will spend around \$200bn in 2024 on data centres, chips and other related equipment for training and developing AI models, a 45% increase versus 2023 levels, based on consensus Bloomberg data. Much of this spend may go on NVIDIA's latest Blackwell GPU architecture, which promises AI training at 4 times the speeds and inferencing 30 times more rapid than the prior generation.

Given all the excitement around the technology's potential, it should also come as no surprise to readers that **AI is driving the venture capital ecosystem**. The average AI funding round anecdotally exceeds a non-AI one by a factor of six, with an implied valuation up to five times higher. AI has accounted for over 40% of all new unicorns (unlisted businesses worth at least \$1bn) formed in the first half of 2024, per Coatue and Pitchbook respectively. The US now possesses over 5,500 AI start-ups and China more than 1,400. Even the UK has some 700, according to Visual Capitalist. The biggest challenge for the industry remains how to translate infrastructure and ideas into practical products. Consultants, at least, seem to be benefiting, with Accenture detailing a sixfold increase in generative AI bookings in its last reported quarter, versus a year prior.

The C-suite, however, remains more sceptical. 71% of industry leaders polled by BCG earlier this year said they were "pursuing limited experimentation and small-scale pilots" while the same study showed that a majority of executives felt that it would take "at least two years" to move beyond the hype. A study by the US Census Bureau (admittedly conducted in February) showed that only 5% of American firms of all sizes said they had used AI. Just 7% then said they planned to adopt it over the

next six months.

Microsoft. however, paints a somewhat different picture, albeit from the perspective of its vested interest in the success of the technology. At its last earnings report, the company said that over 65% of the Fortune-500 businesses now use its Azure service lts interface allows companies to build their own generative AI applications and personalised Copilots. Some large companies have disclosed positive use cases. L'Oréal, for example, has reported that an AI diagnostics machine uplifts the sales conversion rate of its products at retail counters from 10% to 73%. Al for advertising and promotion at L'Oréal is generating productivity gains of up to 15%. In a different industry, payments company Klarna revealed that its Al assistant is effectively doing the equivalent work of 700 full-time agents and has helped reduce repeat inquiries by 25%.

The hope remains that as AI evolves, scales and matures that it can impact both growth and productivity positively. Optimists argue that AI could drive a 15% rise in GDP over the next 10 years (the view of Goldman Sachs) or that it could add contribute 0.3-0.7pp to annual productivity growth in the US through to 2040 (McKinsey's perspective). Given the significant Dollars and intellectual capital invested to-date in the industry, were such gains not to materialise, then investors may need to prepare themselves for some disappointment.





The future starts here (4 January); Red-hot innovation (13 February); California Dreaming: Notes from the Valley (19 March); James Bond, for a morning (22 May); New governments, more data centres (9 July); Two ends of the data spectrum (24 September)

#### We are continuing to create huge – arguably unprecedented – quantities of new data *even without* the upside that AI is set to generate. Consider that **90% of all the world's data was created in the last 18 months**. The total amount of data created and replicated in 2024 is set to reach 163 zettabytes (or 21 zero's worth), up 80 times since 2010, according

to IDC.

If Al's revolution is to further facilitate human connections with computers, then think of the Internet's revolution as communication with any person. We do still 'talk' in person, but to do so uses a lot of technology. Every minute of the day, humans send 97m WhatsApp messages, 12m iMessages, 2m Snapchats, and make 575,000 posts to X (Twitter). In this same minute. some 5.7m Google searches will

**Relevant Theme Pieces:** 

(October 2020)

The data deluge (March 2011);

Ten Years On: The Data Deluge

Drowning in data( October 2012);

occur, over \$283,000 will be spent on Amazon and more than 167m TikTok videos may be watched (all data per Visual Capitalist).

A figure of 1.8bn visits to Chat-GPT in March may sound enormous, but it pales in comparison with the 85.4bn for Google, 32.4bn for YouTube and 16.0bn for Facebook that occurred in the same month (based on a report shared by Digital Native on Substack). The answer is compelling: when asked which technology had been "the most revolutionary", 57% of respondents to a recent YouGov survey cited the internet, versus 27% for smartphones and only 9% for AI. That said, were every iPhone ever sold stacked, the metaphorical tower would extend 250.000 miles, the equivalent distance to the Moon and a third of the way back, based on calculations at NYU.

"Digital is the most transformational technology our world has ever experienced" Chuck Meyers, Chairman of Equinix

The reality is that mobile devices account for two-thirds of the world's internet traffic. Around the globe, some 3.5bn people use them each month. However, while internet penetration stands at 92% in North America – with the average person spending five hours a day staring at their devices – penetration in sub-Saharan Africa stands at just 34% (per the World Bank). In other words, **there is a long way to go**.

Two subsequent related questions naturally occur to us: how do we secure all this data - for **data have zero value without being secured** - and how do we build the appropriate infrastructure to support the data deluge? These topics inform our next two sections.



Coffee with the CTO, 2024 edition (29 May); "Human-like decisions, but better" (17 July); Hanging out with the cyber experts (8 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) "Cyber is the most dangerous weapon in the world - politically, economically and militarily" Bob Gates, former US Defence Secretary

We need to secure the cloud. Remote infrastructure will store half the world's data by 2025 while more than 70% of workloads will run off cloud infrastructure by the end of the decade (per Gartner). Within the last three years, there has been a fourfold increase in cyberthreats. This year cyberattacks may cost the world \$9.2 trillion (according to Statista). For perspective, that's about onethird of the United States' GDP or 24 times Apple's annual revenue in 2023.

Other statistics make for sobering reading. The US lost a record \$12.5bn to cybercrime last year, a 22% annual increase. Included within this figure is a loss of \$1.3bn on the part of individuals from scammers pretending to be either technicians or from government agencies. More than 70% of firms with annual revenues exceeding \$5bn have been attacked in the last year. Ransomware cases rose 300% in the second half of last year relative to the equivalent period the year prior, with cybercriminals pocketing more than \$1bn in the process (data from the FBI, KKR and Visa respectively).

Against this background, **cyber**security is consistently cited as the top priority for enterprise tech spending. 83% of executives polled by Lightspeed gave this answer, and 66% to Gartner. Further, more than 70% of business leaders believe that generative AI may increase the risk of cyber breaches (this figure courtesy of PWC).

Even if human error remains the number one reason why cyberattacks occur, spend on cybersecurity is set to rise almost 15% in 2024 relative to 2023 levels, per Gartner. At the same time, this may be just a fraction of the spend truly required. McKinsey estimates that **the potential addressable market for cyber spend could be up to nine times the level of current investments**.





The transition mission (21 February); Hot times (7 August)

#### **Relevant Theme Pieces:**

What happens when the lights go out? (May 2011); What if the sun always shone? The coming energy storage revolution (September 2015); Keep the lights on. Make the grid smarter. (September (2022) "The macro demand for electricity is picking up [with AI]... we're seeing more demand than we've ever seen" Earl Austin, Chief Executive of Quanta Services

Grid modernisation should be front and centre for policymakers globally since it is critical to support economic growth and digitalisation. Grids and their potential compromise are also a matter of national security. Remember. most electricity transmission systems in the developed world were built in the 1950s and 1960s. Given that they were typically designed with a 50-year life expectancy, it is not surprising that they have now "reached or surpassed their intended lifespan", per a report issued by the American Society of Civil Engineers in September

2020. The problem will only have deteriorated since then. Building new grid capacity can take between 5 and 15 years, depending on the location and complexity, according to the International Energy Agency (IEA).

The growth in all things AI will only exacerbate the problem. A typical ChatGPT query requires ten times the electricity of a Google query. Or, put another way, Al requires four times the power and infrastructure of traditional server farms, increasing the strain on electricity generation (per Berenberg). As a result, power consumption in data centres could more than double between 2022 - before ChatGPT was launched - and 2030. For further context, data centres consume between 10 and 50 times more energy per square metre than does typical commercial office space, based on work conducted by McKinsey.

Data centre energy consumption is driven by IT equipment, which accounts for 40-50% of energy demand and encompasses servers, storage systems and network infrastructure. Cooling systems account for another 30-40% of energy consumption and auxiliary components (uninterruptable power, security etc.) for the remainder. With rising global temperatures, the need for cooling solutions is set to soar. The IEA estimates that the global demand for space cooling will more than treble over the next 30 years. Data centre needs could account for about over 30% of global electricity demand by 2050.

Meeting this demand will not be easy. The IEA estimates that **80m kilometres of power grids worldwide must be added or upgraded by 2040**, nearly double the entire existing global power infrastructure. This will take time and cost money. At present, the total capacity of power projects waiting to be connected to the US grid is 30% higher than a year prior, with wait times for connections currently ranging 40-70 months, according to Goldman Sachs. The American Society of Civil Engineers believes that the cost of upgrading the US grid (generation, transmission and distribution) could reach \$200bn by decade-end, while BloombergNEF estimates that the global cost could reach \$2tr over the same period.

The next question which logically follows is **where is all the electricity going to come from?** In our view, there can be no transition without transition. Read on.



The transition mission (21 February); Winds of change in Spain (26 March); Sunny times (sort of) (14 May); Make Euros while the sun shines (26 June); Hot times (7 August); Watt about the hot rocks? (23 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 key point is diversity in your [energy] mix... [and] the world cannot decarbonise without access to wind" Henrik Andersen, Chief Executive of Vestas

Only one country had a net zero goal in 2015. Over 100 did at the end of 2023. If these targets are to be met, then not only will countries need to upgrade their power transmission and distribution lines, but also continue to invest in energy transition technologies. The good news is that global spending in this area rose 17% year-on-year in 2023 to hit a record \$1.8tr. This is double 2010 levels, according to BloombergNEF (BNEF).

Even more encouragingly, global investment and spending on

energy transition technologies surpassed investment in fossil fuel supply by \$671bn in 2023, an increase from the \$508bn gap in 2022. Further, for the first time ever, zero-carbon sources made up over 40% of the electricity the world generated in 2023 (again, per BNEF). This figure includes energy sources such as nuclear and hydro, but the share accounted for by solar is growing at a faster rate than any other energy input.

The IEA describes solar as "the fastest growing energy technology in history." On its analysis, 413GW of solar was installed globally in 2023, up 58% versus 2022. Worldwide solar capacity has doubled in the last 18 months. Whereas it took it took the world a year to install a gigawatt (GW) of solar capacity in 2004, this had fallen to a month in 2010 and a week by 2016. In some days in 2023, a full gigawatt was installed in one day. BNEF forecasts 520-655GW of installations in 2024. The technology is improving while costs are falling. Lazard estimates that since 2009, the cost of solar power has fallen by 83%, while the cost of producing wind power has fallen by more than half.

Against this background, the wind sector has also seen impressive growth. In 2004, 8 gigawatts of wind power were installed; Last year, the figure was around 110GW, including 12GW of offshore wind (data per BNEF). Just as the average solar project has seen a sixfold increase in size over the last decade, so wind projects are growing in scale too. The latest series of turbine blades being manufactured by Vestas will be taller than the Statue of Liberty.

Project forward and the IEA expects renewables to account for 47% of the global power mix by 2030. Crucially, renewables will account for 80% of new power generating capacity additions through to 2030, led by solar. The growing importance of solar can be seen through assumptions that energy from this source will overtake nuclear by 2026, wind by 2027, dams in 2028, gas-fired power plants at the decade-end and coal-fired ones by 2032. By the middle of this century, solar could become humankind's largest source of primary energy.

This is exciting, but solar (and wind) should be considered as necessary but not *sufficient* for solving the world's energy needs sustainably. Battery storage technologies since both the sun and the wind are intermittent sources - need improve markedly. BNEF to estimates that if countries globally are to hit their net zero targets by decade end, then investment levels will need to triple over this period, relative to current spend. Countries may also need to think about broadening their alternative energy portfolios and including other potential sources such as geothermal energy.



#### **Future Trends**



Season Six Blog Posts: "Water, water everywhere..." (10 September); Airports (and water), seen in a whole new light (30 October)

#### Relevant Theme Pieces:

The curse of Coleridge: global water shortages (June 2011); Liquid data: digitalising the water sector (February 2022) "Water is increasingly complex - [there is] either too little or too much. Solving water has never been more urgent" Matthew Pine, Chief Executive of Xylem

When you consider that it takes 1,500 gallons of water to make just one semiconductor chip, then it should be evident that **water is a critical component of the digital ecosystem**. Global semiconductor sales are forecast to double over the next decade, fuelled by the data deluge we have previously discussed (statistics from Xylem and IDC). More crucially, **without water, humanity cannot survive**. And there simply isn't enough.

The World Economic Forum estimates that there will be **a 40%** 

gap between water supply and demand by 2030. Other data from the United Nations suggest that over 2bn people lack access to safe drinking water. Meanwhile, more than half the global population experiences severe water scarcity for at least part of the year, according to the World Health Organisation. Populations affected by water scarcity could double between now and 2050.

It is easier to improve water supply than curb demand, in our view. Outdated water-management infrastructure is already causing global economic losses of approximately \$470bn annually. By mid-century, water risk could wipe out \$5.6tr from global GDP. Against this background, over \$6.7tr of water infrastructure investment is required by 2030. This figure rises to \$22.6tr by 2050, on World Bank projections. It seems clear that governments need to take action now.



What we're going to be eating in 2024 (10 January); My type of fish (4 April); The rise of the vertical farm (2 May); Restaurants of the future (20 June); The lunchtime robot revolution (27 August); On coughs, chocolate and compost (5 September); Sightseeing with salmon (3 October)

#### **Relevant Theme Pieces:**

You are what you eat: health, wellness and food innovation (October 2014); Alternative meat: beyond impossible (August 2019); Food's future: how to feed the world more intelligently (October 2021) "We are at the tipping point of how food systems work. Sustainable food is not just about protecting the planet, but about creating healthier, more inclusive food systems for future generations" Emmanuel Faber, former Chief Executive of Danone

Agriculture might be a logical place to begin if you wanted to consider curbing water consumption. The industry accounts for ~70% of global water demand. It needs cheap water in order to produce affordable crops. The World Water Council, an international non-governmental organisation, estimates that it takes around 1,000 litres of water to produce just 1kg of wheat. Almost 13,000 litres are used on 1kg of beef, and more than 20,000 litres are required to generate a kilogram of coffee. Furthermore, nearly a quarter of freshwater resources are lost due to food waste.

**1bn more people will need to be fed by 2050, resulting in 50-70% higher food demand**, according to the United Nations Food and Agriculture Office. At the same time, some 2bn people today lack access to safe nutrition. How to match demand with supply constitutes one of the major challenges facing the world, particularly when environmental considerations are taken into account. Animal farming alone uses over 25% of all land, equivalent to the size of the Americas. The food industry is also the single largest driver of biodiversity loss, says The Circularity Gap Report.

#### **Future Trends**

It is clear that we need more sustainable solutions. 84% of consumers list sustainability as "very important" when making a purchase, per a recent McKinsey study. More fish might be one potential solution. Its carbon footprint and water usage is markedly lower than for other comparable sources of animal protein. Although 70% of the Earth's surface is covered by the oceans, fish currently accounts for just 7% of all protein sources produced for human consumption. Fish farming is, however, the fastest growing

form of food production in the world. Global fish consumption is therefore set to expand by 15% over the ten-year period to 2030 (data from the United Nations and the OECD respectively).

Go a few steps further and consider the potential of **plant-based solutions, alternative meats** and even **lab-grown products** (your author has tasted and enjoyed all the above, including salmon from a laboratory <u>earlier this year</u>). Plant-based beverages already account for 15% of all milk sales by value in the US and 11% in the

EU. For context, the global dairy industry is worth \$900bn. Expect further share gains. The alternative meat market is currently growing at three times the pace of the conventional meat market. There is scope for expansion here too. Meanwhile, the cell-cultured meat market could reach \$6.9bn in value by 2030 (statistics from the Good Food Institute, Kerry Group and Grand View Research respectively). Venture capital investment into food tech has increased 40-fold over the last decade, per Nesta. More innovation should mean more novel products.





Hot topics in healthcare (18 January); "The job is far from done" (12 March); On coughs, chocolate and compost (5 September); Wonder drug, or, just too good to be true? (19 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)

"The need to treat diabetes and obesity is massive and unmet" Lars Freurgaard Jorgensen, Chief Executive of Novo Nordisk

While it is shocking that 690m people suffer daily from acute hunger, it is also highly concerning that **every tenth adult in the world suffers from obesity**. More than 1bn people, including 7% of girls and 9% of boys are now classified as obese. In 2019, it led to around 5m deaths, 20 times as many as malnutrition did. The number of people with obesity has doubled since 1990. By the

end of this decade, more than 3bn people globally could be classified as either overweight or obese (all data per the World Health Organisation).

Obesity is a major problem for healthcare systems. 80% of their cost burden goes on managing chronic diseases. And if patients experience either diabetes or obesity (the two are highly correlated), then their **odds of**  suffering from a co-morbidity are high. In the US, obesity is associated with ~40% of cancer cases, according to Cornell University. Those with type-2 diabetes (a function of lifestyle choices as opposed to heredity) have a 30% likelihood of suffering from cardiovascular disease and a 40% chance of experiencing chronic kidney disease, based on data shared by Novo Nordisk. An even bigger challenge for healthcare systems is that fewer than 40% of people with diabetes are currently being treated, while the figure drops to just 2% for obesity. With ~3% of global GDP and ~8% of global healthcare budgets are spent on treating obesity today (according again to Novo Nordisk), the need for solutions should be evident. In the UK, the NHS reports that obese patients cost the system roughly twice as much as their non-obese counterparts. The Milken Institute in the US calculates that the overall cost of obesity to the US economy (if lost productivity is included too) could amount to \$1.7tr.

The growing availability of GLP-1 (glucagon-like peptide) drugs such as Wegovy and Zepbound for helping people manage obesity has dominated headlines over the past year. While by no means a panacea, they can play a clear role in helping solve the growing obesity burden. More than 70% of people polled by McKinsey say they want to be healthier, and 50% rank it their

top priority. It should come as no surprise then, that some 45% of US adults say that they would be interested in taking a safe and effective prescription weight-loss drug. Prescriptions for GLP-1 drugs in the US grew 300% between 2020 and 2023, albeit from a low base. Project forward and they are expect to see compound annual growth of over 50% through to the end of this decade. Correspondingly, medication sales in this area could reach \$80bn by 2030, according to estimates from JP Morgan.

Benefit consultants estimate that 30-40% of employers already have plans in place to cover drugs such as Wegovy for obesity treatment. This figure could rise to 60-80% in the next few years, using the same research analysis from JP Morgan. While the cost of these drugs will inevitably fall as production scales and more generics become available, the current price point (of between \$300 and \$1300 a month) means that **GLP-1s alone cannot be the main solution for the world's obese people**, for they cost too much. To treat every obese American might amount to \$1tr annually, or 4% of US GDP.

Technology might provide the answer. Healthcare spend on Alrelated hardware is set to triple over the next five years, while over \$30bn of new equity funding has gone into start-ups seeking to leverage AI to help solve healthcare challenges over the last three years (per Research & Markets and CB Insights, respectively). In case you missed it, in 2023, ChatGPT passed all three parts of the US Medical Licensing Exam. This accomplishment was a defining moment for Al's role in healthcare as it proved that a general-purpose Al model could demonstrate human-level complex medical reasoning. Look forward and AI could become increasingly helpful in respect of not only drug development but also medical diagnostics, predictive analytics and robotic surgery.



### HONOURABLE MENTIONS

There is, sadly, never enough space in this publication to cover all the topics that deservedly merit attention. Below follows a brief comment on three other themes that we continue to follow with interest.

#### **Humanoid robotics**

Walk into the most modern BMW car factory in California and you may see a two-legged, fivefingered robot working alongside human counterparts. Robotic performance has improved 30fold in the last decade and 2025 might prove to be the year when humanoid robots will become increasingly viable (and visible) within factory settings. Such robots can help not only improve productivity but address shortages in manufacturing labour. An additional use-case might be to help satisfy elderly care demand. Some analysts (such as Goldman Sachs) believe that the humanoid robot market could be worth \$6bn by 2035. Watch this space. Our first theme piece next year will explore this topic in more detail.

#### Autonomous vehicles

If the future seems bright for humanoid robots, then prospects for autonomous vehicles look bleaker, in our view. While we have written extensively about the importance of both electric vehicles and transport as a service, the reality is that the industry has grown far more slowly than experts had initially predicted. The auto industry remains driven (no pun intended) more by cyclical factors than secular ones. We are still in an autonomy winter. Advocates. of course, remain. Waymo (a business backed by Alphabet, Google's parent company) says that its autonomous vehicles successfully completed 100,000 paid rides a week for the first time this summer. Further, Waymo says that in over 3.8m miles driven without a human behind the steering wheel, there have been zero bodily injury claims, Humans typically incur 1.1 for every million miles driven. The expectation (or hope) of some, such as BCG, is that 25% of all new cars sold by 2035 could be autonomous.

#### **Plastic waste**

On a different topic, plastic waste remains a subject close to our heart and a priority for the world to address. The statistics are shocking: 1.2m tons of plastic waste, or over 80% of all that is produced, finds its way into the oceans annually. Every second of the day, 20,000 plastic bottles are sold. Fewer than 15% of these are currently recycled (all data per the OECD). The good news is that sustainability is becoming an increasingly significant priority for both manufacturers and consumers. The latter are pressuring brands to clean up their act. Retailers currently account for ~25% of global carbon emissions. Scientists estimate that the textile industry alone contributes to ~35% of microplastics found in the ocean. Hopefully by the time we produce next year's 'how we see the world changing' piece, there will have been tangible improvements in all the above metrics.

### PART THREE: Recent Thematic Work

# CYBERSECURITY: THE MORE THINGS CHANGE...

**Executive summary:** Cyberattacks could cost the world \$9tr in 2024. This is despite annual cybersecurity spending growing at over 10% and remaining the number-one priority in enterprise budgets. Artificial intelligence (AI) has changed the rules of the game. It has increased both the range and sophistication of potential cyberattacks as well as the tools with which defenders can potentially manage them. Al needs to be incorporated into defences before large-scale adoption occurs in the hacker community. While the imperative is clear, the

challenge relates to prioritising IT spend and ensuring appropriate ongoing training and education. Human error remains the number one reason why cyberattacks occur. From an investment perspective, there are multiple ways of playing the cybersecurity theme in both the public and private arena. Given the number of players, we expect industry consolidation to remain an active force and favour seeking exposure either through niche businesses or those with sufficient scale to develop dedicated platforms.

The more things change, the more they stay the same



A lot has changed since 2017, when we last wrote a <u>dedicated theme</u> piece on cybersecurity. There has been a global pandemic, war on Europe's borders and in Gaza, a marked change in monetary policy and the relentless rise of artificial intelligence, to name just some of the most significant. We all know that AI has been a game-changer and will only revolutionise the way we work. However, as the French author Jean-Baptiste Alphonse Karr prophetically wrote in 1849, "the more things change, the more they stay the same."

Cybersecurity remains at least as big a risk today as it did when we previously explored the topic. Logically, AI will increase the sophistication of both attackers and defenders. See it as a security challenge, but also as a tool that can help CISOs (Chief Information Security Officers) win. As we have regularly noted. data have no value unless secured, stored and analysed. Cybersecurity remains an asymmetric risk. Even if 99% of threats are countered, the sole attack that is successful can have a massive impact on its target and their reputation.

First the facts. There has been **a** fourfold increase in cyber threats in the last three years. 72% of firms with annual revenues of more than \$5bn say they have been attacked over the last 12 months. Tech, telecoms, financial and retail businesses as well as government entities are the most common targets (data from Statista, KKR and CrowdStrike respectively). Or, as Nikesh Arora, the Chief

Executive of Palo Alto Networks puts it, "cyberattacks continue unabated." Data outages (such as the incident that occurred in July as a result of a failed CrowdStrike software update) may also allow threat actors to promote malicious websites with malware to compromise victims seeking legitimate information about the event.

The average cost of a cyber breach stands at over \$4m, but when annualised. the annual cost of cyberattacks could surpass \$9tr in 2024 (according to Statista). For context, that's equivalent to about one-third of the United States' GDP. or almost 25 times Apple's annual revenues. If anything, this figure may be under-stated, since some organisations may choose to stay quiet about cyberattacks so as both to protect their reputations and to avoid potential fines for exposing personal information. Nonetheless. it should be no surprise then that cyberattacks rank as number-five in the World Economic Forum's Global Risk Report. The document suggests that cyber could "present a material risk on a global scale" in 2024. When respondents were asked to assess risks on a five-year view, cyber rose to number-four.

No surprise then that **cybersecurity is the top priority for enterprise tech spending**. It was cited by 83% of respondents in a recent Lightspeed Venture Partners CISO survey, while a similar Gartner study saw cyber ranked highest by 66% of those polled. Correspondingly, cyber spend by businesses is set to rise by 14% year-on-year (according to Gartner's work), with the industry predicted to grow at an annualised rate of more than 10% through to at least 2027. Over this period, **an incremental \$100bn could be spent on cyber**.

It is hard to disagree with the advocates of AI when they argue that it represents "an opportunity far larger than the Internet" and will bring "productivity gains to nearly every industry" (per Jensen Huang, the founder and Chief Executive of NVIDIA). However, Nikesh Arora is almost certainly right too when he argues that AI will result in "an even faster pace" of cyberattacks. Whether we like it or not, AI is more than just a pioneering innovation; it is being woven deep into the fabric of enterprise life. At the same time, however, AI provides an opportunity for enterprises to build (and buy) solutions that can enable them to gain an edge against an increasingly more sophisticated threat landscape.

Against this background, а significant majority (86%) of **CISOs** believe that implementing Al tools represents an important strategic priority over the next two years. 58% said that they already made had strategy changes due to the AI revolution (based on information reported in Lightspeed's latest report). A similar study by Darktrace of 1800 security leaders and professionals found that 74% believed AIaugmented cyber threats were already having a significant impact on their organisation, while 60% were of the opinion that they were unprepared to defend against these attacks. Of potentially greater concern, almost nine-in-ten of the above (89%) agreed that Al-powered threats would remain a major challenge into the foreseeable future.

From the attackers' perspective, the rise of AI has been a clear enabler, increasing not only the novelty of attacks, but accelerating their evolution and widening their vectors exponentially. The combination of AI and LLMs (large language models) has led to the launch of attacks at machinespeed and scale. Attacks could take the form of novel and highly convincing phishing campaigns, the autonomous creation of malicious code. deepfakes designed to elicit trust and the emergence of autonomous agents (or bots) that are enabled with advanced reasoning and decisionmaking capabilities, to name but a few examples.

Generative AI could also be deployed maliciously in order to accelerate open-source intelligence-gathering. This could result in the inadvertent leakage of sensitive and confidential data. Over the past year, there have been numerous instances of accidental data leakages or breaches of Al training data from some of the largest AI tool providers. These have left potentially exposed terabytes of customers' private data. A related risk is the threat of model inversion. whereby attackers use the outputs of an LLM paired with knowledge about its model structure to make inferences about, and eventually extract, its training data.



As threats such as these grow, the cyber security industry is hastening to integrate AI into technologies used across workflows in prevention, detection, response, and recovery. In theory, the defenders *should* have the upper hand owing to greater resource availability. In our discussions with various stakeholders across the industry, the consensus opinion is that AI needs to be incorporated into defences before large-scale adoption occurs in the hacker community. It is necessary to view Al as an opportunity for the cyber industry - to better identify and respond to threats.

The implementation of generative Al cyber solutions could clearly help businesses in numerous ways by significantly improving the speed and efficiency of prevention, detection, response, and recovery. Practically, this 74% believed AIaugmented cyber threats were already having a significant impact on their organisation

could mean accelerating data retrieval processes and creating rapid incident summaries. AI tools could also be used for simulating phishing emails and other attack tactics as well as automating lowlevel tasks in security operations.

Over 70% of those polled by Darktrace were confident that Alpowered security solutions would be able to detect and block Alpowered threats (even if there may be a vested interest on the part of Darktrace in showing this response). Nonetheless, it is

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Data ultimately matters more than anything else

important to recognise that **not** all Al-based cyber solutions are created equal and similarly, that not all of them may be able to help drive the risk reduction that CISOs are hoping for.

Data ultimately matters more than anything else. Practically, any novel AI tool must be **explainable**, transparent and controllable. This calls for robust testing, evaluation, verification and validation. At a practical level, effective tools will likely need to be personalised for each unique organisation. Humans need to see exactly how AI systems operate, in an easily understandable way. 'Black box' models can potentially erode trust between humans and AI as well as creating compliance concerns. Equally, security teams should be able to decide on the role humans play in decision-making. They should also be able to customize models and set thresholds to guide how decisions are made.

The problem, of course, is **how to prioritise IT spend**, especially in the context of structurally growing demand for AI overall (and corresponding GPU shortages) and the ongoing structural shift from on-premise data storage to cloud-based solutions. The latter trend is still in an early innings, with fewer than 25% of corporate workloads currently migrated to cloud environments, based on most estimates. CISOs face multiple choices and competing options as well as the question of how well different tools may work. With regard to AI specifically, there also remains **a strong need for education** across the industry. Unsurprisingly, the more attention generative AI has received, the high expectations around it tend to be. Proof of concept matters.

Anecdotally, a typical industry approach currently requires 12-15 principal IT products and up to 75 dedicated cyber tools in order to monitor and manage their data assets. Clearly there is a strong case for vendor consolidation, but it is no surprise when some cyber executives have recently cited 'buyer fatigue' as a concern.

An additional structural concern is the lack of trained IT professionals. The World Economic Forum notes that 4m professionals are needed to plug the talent gap in the global cyber industry. Its report also notes that two-thirds of organisations face additional cyber risks owing to skills shortages, yet only 15% of firms expect this hole to be filled within the next two years. These observations are corroborated by data from CyberSeek (an information provider) which show that the US cyber industry is missing an estimated 225,000 security professionals in order to close its talent gap. Only 85% of the economy's available cyber jobs are currently filled. As a result. 53% of CISOs admitted to burnout compared to last year, while 66% feel they face excessive expectations, per a recent study from Proofpoint, a cyber business.

#### **Future Trends**

It may then be **necessary to learn** to live with cyber threats. Just as a human can never be free from illnesses, so any organisation may never be immune to cyber risks. This dynamic is exacerbated by the fact that human error remains the number one reason why cyberattacks occur, typically a combination of laziness and gullibility. 74% of CISOs identify this as their most significant vulnerability (per Proofpoint), reinforcing the logic for ongoing training and cultural buy-in. As Heptagon's own Chief Technology Officer puts it, "creating a culture of paranoia" (via simulated phishing incidents, for example) should be paramount.

From an investment perspective, there are multiple ways of playing the cybersecurity theme in both the public and private arena. However, by definition, cyber remains a highly competitive market and owing to both the evolving technology and threat landscape, it may not always be easy to predict future winners. Further, given the asymmetric nature of cyber incidents, credibility can quickly be lost should breaches occur.

These dynamics have helped to ensure that **M&A activity continues to feature heavily within the cyber industry**. Three of the publicly listed businesses that we cited as strongly positioned in our 2017 theme piece – Carbon Black, Cylance and Sophos – have been taken over in the intervening period. More recently, Darktrace (which only listed in 2021) agreed earlier this year to a takeover from US private equity group, Thoma Bravo. Other recent major deals in the space have included the acquisitions of Imperva, Splunk and Veritas. Per Verdict Consultants, in Q1 2024, alone, there was more than \$23bn of global cyber-M&A.

Expect more of the same, particularly given the significant number of cyber start-ups (many of whom have a dedicated focus on Al solutions) active across the US, UK, Israel and the rest of mainland Europe. China also has a separate tech ecosystem.

Our perspective has typically been to seek to gain exposure to the cyber theme through niche businesses such as Sophos and Darktrace historically. Other smaller listed companies that operate in the space include CyberArk, Rapid7, Rubrik, Tenable, Varonis, Zscaler. An alternative perspective would be to embrace the logic of platformisation and recognise that there is a growing logic for organisation with scaled operations that are able to offer a complete suite of (AI-enabled) cyber tools to organisations, reducing complexity and diminishing the risk of buyer fatigue.

Palo Alto Networks stands out as one potential beneficiary. Founded in 2005, it is a leading nextgeneration global cybersecurity provider with a full platform of cloud-native applications. It has over 85,000 customers across more than 150 different countries and has seen a roughly fourfold increase in its market capitalisation over the last five years. For the industry as a whole, we expect the cyber opportunity only to grow.

17 September 2024




**Executive summary:** There is much more to warehouses than meets the eye. They are critical to the functioning of the global economy. From an investment perspective, the industry can be considered highly attractive, growing faster than global GDP, with demand heading only one way and supply being constrained. Demographics and technology are accelerating consumption patterns while every business has had to think about increasing supply chain resilience since the pandemic. Limited numbers of new buildings

are also driving warehouse innovation. Future warehouses are likely to be both greener and more automated. Investing in logistics real estate businesses, or companies that operate in close adjacencies, can be a compelling strategy owing to the consistency of their returns across cycles. While there is a scarcity of pure-play assets, Prologis (an owner-operator of real estate) and GXO Logistics (a major contract logistics provider) stand out as particularly strongly placed beneficiaries, in our view.

"The line between order and disorder lies in logistics" (Sun Tzu)



Few people normally get excited aboutwarehouses. They are typically hulking grey edifices located in industrial parks on the outskirts of cities or at strategic locations such as motorway junctions. Even fewer have any reason to visit a warehouse. However, should the opportunity ever arise, your author cannot recommend a trip highly enough. Viewed from the inside, warehouses are absolute marvels.

The sheer scale of many warehouses is impressive. One, visited by your author in April, is of a size equivalent to 12 Wembley-sized football pitches. At peak it can hold up to 14 million units of stock and pick daily around 625,000 items. Another, visited in 2022, contains 750 metres of dedicated monorail track. Some of the trolleys on it travel 100km a day.

More importantly, consider that warehouses are essential to the global supply chain. They facilitate the flow of goods around the world. Memories of early COVID-19 lockdowns and shortages of everything from toilet roll to pasta should serve as a reminder of their criticality. The global warehousing and storage services market is valued at \$300-600bn (depending on the methodology used) and is growing currently at a rate more than double CDP.

Think of warehouses, then, as **musthave solutions for any company in the business of selling physical goods**. Warehouses allow them to manage their supply chains and optimise their order fulfilment process. This, in turn, should result in increased productivity, more satisfied customers and higher profits.

So why are warehouses often overlooked? Put simply, for most businesses. rent is a fraction of total supply chain costs. Consultant CBRE estimates that transportation is the single largest cost in this respect (45-70% of the total burden) followed by variable facility costs including labour (15-25%) and then inventory costs (12-16%). In other words, while logistics typically comprises only 2-6% of overall supply chain costs, it can have a disproportionately large impact on consumer experience. As many readers will recognise, get the wrong clothing items of delivered or find something difficult to return and the likelihood of you using that company again is low.

No surprise then that logistics real estate is a growth industry. **Demand is being driven by two main factors: consumption and supply chain resilience; or revenue generation and risk mitigation**. Begin with consumption. It is the largest share of economic activity (c70% globally) and typically outperforms across economic cycles. Work from Prologis Research shows how retail sales have a higher correlation with logistics demand than do other factors such as manufacturing and trade.

Think of consumer demand as having three main sources: basic daily needs (driven by population growth), cyclical spending (or lifestyle upgrades) and structural trends (online shopping). These are split roughly equally, per estimates from Euromonitor. Against this background, demographics and technology are helping to change the face of retail. Not only does the Internet as a platform for commerce continue to expand around the world, but Millennials now comprise over 20% of the global population, according to the United Nations. This cohort, more than any other, has higher expectations, favouring convenience, choice, reliability and immediacy.

Even with regional variations. the global e-commerce market is growing at more than twice the rate of physical retail and will account for a 28% share of total global retail sales by 2027, per Activate Consulting. Crucially, online retailers use around three times more logistics space relative to physical retailers, according to Prologis, a major warehouse owner. This is a function of the much wider range of goods available online compared to in a physical store; or. as Jeff Bezos once described it, the marvel of "the infinite shelf." In addition, the shift from pallets (sent to physical stores) to packages (delivered to homes) requires more space, as does the growing need for reverse logistics. A positive returns experience for unwanted items is critical to retaining customers. For retailers, the ability to reposition returned goods for resale also matters.

The second major driver for warehouse demand is the need for supply chain resilience, which has been exacerbated recently by geopolitical considerations. For decades, supply chains had been moving to globalise, take advantage of cost differentials and streamline to a just-in-time model to reduce inventory carry costs. However, disruptions to this model have extended beyond natural disasters, congestion, and labour disputes to include major trade renegotiations and a global pandemic. As a result, **the industry paradigm has moved from just-intime to just-in-case**.

Prologis estimates that for every Dollar of US GDP, at least 20% more logistics space is needed than before the pandemic. This contention is supported by recent work conducted by McKinsey, which confirms that **78% of supply** chain leaders say that they are now using inventory buffers and dual sourcing strategies, while 49% believe that disruptions have caused major planning challenges over the past year. Another study (by EY) highlights that over 50% of European companies it surveyed state that they are looking to create more regionally based supply models.

At the same time that demand is heading only in one direction for warehouses, **new warehouse building supply is falling sharply, and will only become harder to deliver in the future**. This creates an attractive potential investment opportunity, in our view. Since supply chains can be considered as a key source of competitive advantage, *location* matters more than ever for logistics and real estate customers. Proximity to customers is essential, particularly in the context of reducing transportation costs for suppliers (and recall, transport is by far a larger cost item). Further, a recent MIT study on carbon emissions reveals that adding an urban fulfilment centre can cut transportation emissions (and therefore costs) by half compared to out-of-town distribution.

The problem, however, is that the world's urban population has doubled over the past 30 years and is forecast to double again over the next 30 years, according to the United Nations. Urbanisation drives competition to use land effectively, but it also increases demand for warehouses. Barriers to supply are therefore rising owing to zoning restrictions about where new properties can be built. Consider also the context that a 5-acre warehouse requires 10-12 acres of land owing to the logistics of transport coming both in and out. No surprise then that warehouse occupancy rates at Prologis (the source for the above statistic) are currently running at over 95%. This is a global average figure. In some regions, vacancy rates may be as low as 1%.

There is a strong argument, then, for **retrofitting warehouses to make more efficient use of space**. The average age of a warehouse building in the US is over 40 years. More than 82% were built before 2000 and some 30% of assets are more than 50 years old, according to CBRE. Put another way, **the warehouse of the future will likely be taller, greener and more**  **sustainable**, whether retrofitted or built-to-suit from scratch. Expect solar panels on the roof, water recycling systems and EV charging points across the site.

However, as we noted at the outset of this piece, it's what's inside that matters as much as the location of the warehouse. Anv innovation that can help with receiving, stocking, picking, packing and shipping should be under consideration. An automated warehouse facility can have a smaller footprint with the same throughput, potentially saving between 10% and 50% on square footage, according to research by Prologis. Meanwhile, work by GXO, a major contract logistics provider, suggests that cost per unit can be improved by between 50% and 80% via automation. Full warehouse automation, per GXO. can also reduce the number of employees needed by up to two-thirds.

There's more to come too. Project forward and future warehouses could contain advanced automation solutions with intelligent robots capable of sorting, picking and packing. Many of these activities are currently complex owning to varying picks and packet sizes, providing a source of potential future upside. These intelligent machines could plausibly form part of a broader cloud-based system where routing activities are continually updated and optimised using a combination of machine learning and artificial intelligence. Last-mile delivery could also be enhanced

via a combination of drones and self-driving robots. Both have a sustainability angle too. Think of a warehouse not just as four walls, but more as a *service*.

So, what might undermine the warehousing opportunity? We believe that the drivers outlined above are secular in nature. However, it is hard to deny the potential impact of cyclicality. For context, Prologis says that it sees goods with an economic value of ~\$2.7 trillion flow through its distribution centres annually, representing ~2.8% of the world's GDP. Demand for goods is, of course, strongly correlated with trade patterns, consumer confidence and credit availability.

In addition, there is the challenge of finding new sites for warehouse conversion. Economic, political, physical and legal factors may builds. constrain new Many authorities prefer to use spare land for re-tenanting to housing. Zoning restrictions and tax considerations (warehouses typically raise fewer tax revenues than do rents from housing properties) are also potentially limiting factors. Assuming that warehouses do get built, there remain barriers to adopting automation. These also apply to owners of existing

warehouse properties. Not only is there a fear of the unknown and a risk of disruption to business continuity, but some highly automated facilities may consume significant amounts of power, which will impact returns on investment.

Despite these concerns. warehousing demand should continue to grow faster than GDP, and the outsourcing of contract logistics at an even faster pace. As an asset class, logistics real estate has delivered consistent returns ahead of other comparable segments such as apartment, retail and office. From an investment perspective, there is a scarcity of pure-play listed **assets**. Beyond direct investments in physical property, which can provide a reliable source of passive income (from high rental vields, low maintenance costs, long-term leases and minimal tenant turnover), Prologis and GXO Logistics stand out as the two leading listed candidates to consider.

Founded in 1982, Prologis is the world's larger owner, operator and developer of logistics retail estate, Cost per unit can be improved by between 50% and 80% via automation

with unparalleled scale. It controls over 1.2bn square feet of property across 20 countries in 4 continents across 5,500 buildings. Prologis will rent its warehouses to businesses such as GXO Logistics. GXO will then operate the warehouse on behalf of its customer. Think of GXO as a leading systems integrator, or largest pure-play contract logistics provider, within the warehouse and logistics space, providing its customers with high-value-add services. For both these businesses (and their smaller rivals too), the future certainly looks bright.

18 June 2024

AJH

# ALZHEIMER'S: THE FINAL HEALTHCARE FRONTIER

Executive summary: Ageing populations mean Alzheimer's disease other forms of and unfortunatelv dementia will become more prevalent. The disease already kills more people in the US than breast cancer and prostate cancer combined. By 2050, the number of people with early onset Alzheimer's is forecast to double versus current levels. The social and economic cost will be significant, potentially exceeding \$1tr globally over the next decade.

While there is no current cure for Alzheimer's, the good news is that extensive research is being focused on finding treatments for both slowing the disease and treating its symptoms. Major players such as Biogen, Eli Lilly, Novo Nordisk, Pfizer and Roche are conducting promising trials. Even with a significant drug treatment market opportunity ahead (worth at least \$14bn by 2030), progress will unlikely be linear and predicting winners at this stage difficult.

A rapidly growing public health concern causing significant detrimental consequences



"Imagine a bookshelf falling over, with your most recent memories being the books at the top. These go first, with the oldest memories, or lowest books, last. And that's just the beginning of it." This was how the onset of Alzheimer's Disease was once memorably described to your author by a leading expert in the field. Alzheimer's represents a rapidly growing public health concern causing significant detrimental consequences to the affected people and their families. It also has a substantial and increasing global socioeconomic impact.

Your author has been lucky that no one in his immediate family has been affected by Alzheimer's, although many readers of this piece will be unfortunately familiar with the devastating consequences it can have. However, demographics mean that we will all, be more likelv to encounter people affected by Alzheimer's going forward. That is, unless drugs are developed to counter the effects of Alzheimer's and even prevent or pre-empt its onset. Although still early days and with many hurdles to overcome, developments are encouraging.

People worldwide are living longer. Most people globally can expect to live into their sixties and beyond. In developed nations, these figures will clearly be higher. **Every country in the world is experiencing growth in both the size and proportion of older persons in the population**, per the World Health Organisation. By 2030, 1 in 6 people in the world will be aged 60 years and over. By 2050, the share of the population falling into this category will have doubled relative to 2020 levels.

With ageing comes deterioration. Molecular and cellular damage inevitably accumulates over time. This leads to a gradual decrease in physical and mental capacity as well as a growing risk of disease, and ultimately death. Managing the ageing process (particularly at a state level) is complicated by the fact that changes are *neither linear nor constant*.

One of the most common consequences of ageing is dementia. The term is often used interchangeably with Alzheimer's but the two have different meanings. Dementia is not a specific disease. It is an umbrella term that describes a wide range of symptoms that could include memory decline, decreased focus and attention, worsening judgement and reasoning skills as well as broader behavioural issues.

There are many types (and causes) of dementia, with **Alzheimer's being the most common** one. First identified by Alois Alzheimer, a German psychiatrist, in 1901, it is behind more than **60% of cases of dementia**. Specifically, it is a neurodegenerative disease that usually starts slowly and progressively worsens. Other forms of dementia may include vascular, frontotemporal, Lewy body and more.

What causes Alzheimer's (and other forms of dementia too) is still poorly understood. Factors that may be responsible include genetics, head injuries, clinical depression, high blood pressure and other adverse lifestyle choices. The most common early symptom is difficulty in remembering recent events - hence the bookcase analogy. As the disease advances, symptoms can include problems with language, disorientation and mood swings. The world becomes a more confusing and frightening place as the person struggles to understand what is going on around them. Your author witnessed some of these impacts when he worked as a volunteer for the Alzheimer's Society (a leading UK charity) as a student and visited several care homes during his time with them. With Alzheimer's, bodily functions are gradually lost, ultimately leading to death.

The speed of progression can vary, but patients who are affected by Alzheimer's can typically expect to live between 2-20 years from onset. The typical life expectancy following diagnosis is 3-9 years. people Worldwide, 70-100m are estimated to have early Alzheimer's disease, a figure which could double by 2050, per the World Health Organisation. Alzheimer's is already the fifth leading cause of death among Americans 65 and older, per the Alzheimer's Association (a leading American charity). It kills more people in the US than breast cancer and prostate cancer combined.

The cost to the economy is also meaningful. In 2023, Alzheimer's and other dementia will have cost the US an estimated (by the Alzheimer's Association) \$345bn, a

15% increase relative to 2022 levels. This relates to lost productivity and the cost of treatment. Add in the estimated 18bn hours of care provided by unpaid caregivers in the US and the cost rises to almost \$700bn. **By 2030, total costs in the US could exceed \$1tr.** 

At present, there is no cure for Alzheimer's disease or any other type of dementia. Optimists assert that research will beat dementia. The good news is that around 150 drugs are in trials for Alzheimer's **disease** (per the Alzheimer's Society). Over 100 of these aim to slow the progression of the disease, while the remainder seek to treat symptoms. Advances in Al should also lead to an acceleration in the rate of drug discovery. As we have discussed elsewhere, by 2030, over 30% of innovative pharmaceuticals could be created by generative AI. Unlike a human researcher. Al can work 24 hours a day.

There are currently only two drugs that have been approved by the FDA to treat Alzheimer's. Both have been developed and manufactured jointly by Biogen and Eisai. Aducanumab (sold under the brand name Aduhelm) was approved in June 2021, albeit in a controversial decision that led to three advisers to the FDA resigning, based on concerns that there was an absence of evidence over the drug's efficacy. It is still available in the US but has been superseded by Lecanemab (sold under brand name Legembi). Following clinical trials that showed that the drug slowed the speed at which memory and thinking skills



deteriorated by 27% relative to its placebo, Leqembi was approved by the FDA in July 2023. When taken over an 18-month period, its manufacturers assert that the drug may slow the progression of Alzheimer's by about seven months.

As with all drugs, there have been reported side effects associated with taking Legembi. These include bleeding, headache and nausea. Japan is the only other country where Legembi has been approved to-date, although the European Medicines Agency is expected to reach a decision before the summer. Biogen and Eisai are currently working on a new subcutaneous version of Legembi (currently it is available only intravenously). This is expected to become available by late 2024 or in 2025, which could help drive greater uptake.

There is no cure for Alzheimer's disease or any other type of dementia

Much of the recent work being undertaken on Alzheimer's drugs relates to treatments involving GLP-1 molecules. As demonstrated by both Novo Nordisk and Eli Lilly, GLP-1 (glucagon-like peptide) has proven highly effective in managing the impacts of diabetes and obesity as well as in potentially suppressing addictive behaviours beyond hunger, such as smoking and alcohol. Real world evidence trials in Denmark cited by Novo show a reduced risk of dementia

or Alzheimer's with GLP-1 by up to 60%. Randomised controlled trials by the company also point to less decline in cerebral glucose metabolism. lower risk of dementia diagnosis and short-term а memory improvement. Similarly, pre-clinical studies involvina semaglutide (an anti-diabetic medication) point to improved memory function and reduced neuroinflammation.

Against this background, Alzheimer's is "high on the agenda" for Novo. This comment was made by the Chief Executive of the business at its March Capital Markets Day. He highlighted how the company had initiated two phase 3 trials (evoke and evoke+) in 2021. Each involves 1840 patients with the idea being to confirm the superiority of an oral semaglutide solution versus a placebo on the change in cognition and function in people with early Alzheimer's disease. Expected completion is in 2025. Eli Lilly started a similar trial with 1800 patients (involving a drug called donanemab) in 2022. While it achieved primary completion last year, full completion is not expected until August 2025. Separately, Lilly is in the midst of phase two efficacy trials (with a drug called remternetug) to help manage early onset dementia.

Research and drug development is also continuing apace in other areas relating to Alzheimer's. At one end of the spectrum, work is being conducted around **bloodbased diagnostics**. These could measure some of the key proteins associated with Alzheimer's that would be critical to **enabling earlier treatment**. Companies such as Quanterix and Roche are active in this field. The other major area of focus is on **drugs for treating symptoms of Alzheimer's**. The aim here is for medications not to stop the damage Alzheimer's causes to brain cells, but rather to help lessen or stabilise symptoms, at least for a limited period of time.

Several cholinesterase inhibitors (such as Donepezil, branded as Aricept) are currently approved by the FDA for the treatment of Alzheimer's symptoms in the US. These drugs support communication between nerve cells. Another angle is in the development of glutamate inhibitors (memantine, branded as namenda is a good example), which are prescribed to improve memory, attention, reasoning and language. Some companies are also working on treatments for agitation, or clinical restlessness. This is considered a significant unmet need, with 70-80% of Alzheimer's patients affected. Axsome Therapeutics' AXS-05 drug has already reported positive phase two and three results.

Given the growth in people likely to experience Alzheimer's Disease, **the market size for drug treatment is significant**. It was already worth \$2.2bn at the end of 2020, per GlobalData, a leading data and analytics company. **By 2030, the market could be worth ~\$14bn** across the world's eight largest economies, equivalent to a compound annual growth rate of 20%. Other research providers incorporate different scopes (such as including therapeutics, for example) into their projections, but consensus opinion seems to settle on an overall market opportunity that could be between \$10bn and \$20bn over the next decade.

Such growth prospects ought to be attractive to businesses developing novel drug treatments as well as other ancillary services such as palliative care. However, many experts in the field believe that in order for Alzheimer's treatments to be effective, a range of key barriers need to be overcome. Given existing hurdles, current patient journeys in treating the disease tend to be complex. Obstacles might include the fact that early symptoms are dismissed as normal ageing. There are also limited screening tools and diagnostics tools available at present.

There is also the broader issue of market preparation. Three issues (at least) need to be considered. First, governments will likely need to support healthcare system preparedness. With large numbers of patients with Alzheimer's Disease set to enter the system, this may lead to significant bottlenecks and corresponding delays to patient care. Next, it will be important to increase the rate of diagnosis, through better education. screening tools and techniques. Finally, there remains a burden of evidence generation, particularly in terms of understanding the impact of treating the disease at different stages of its progression.

It is also important to remember that **new medicines will come** 

at a cost, particularly given the size of the anticipated treatment populations. A year's treatment of Aduhelm or Legembi would likely cost \$25,000-30,000 at present. Both the US government (via the Medicare scheme) and certain employers are preparing based on several published working papers. For Alzheimer's drugs, the US Centers for Medicare & Medicaid Services (CMS) has said that it will be tracking patients in a registry to assess the real-world benefits of the treatments. Similar approaches are being reviewed elsewhere in the world.

In most scenarios, uptake of new drugs is likely to be gradual. Clinicians, nurses, caregivers, and patients will all likely need time to become acquainted with new medications. These may require infusions as well as intermittent MRIs in the first few months of treatment to assess for serious side effects. At the same time, while current drug development will likely delay disease progression by two to three years, remember that there is no cure for Alzheimer's at present. Optimists, of course, assert that if drugs can slow the rate at which Alzheimer's develops, then patients could remain in their homes for longer before transitioning to long-term care centres. Any delay of disease progression would also help to return a portion of the 18bn hours lost in the US to caregivers.

With very few drugs currently approved for treating Alzheimer's and the disease itself still poorly understood, it is hard to predict the likely stock market beneficiaries

at this stage. Drug development is often prone to setbacks and fewer than 10% of all drugs successfully progress from laboratory to full commercialisation. Moreover, beyond start-ups or smaller biotech businesses, no major pharma business has dedicated its research and product development efforts exclusively to finding treatments for Alzheimer's. Biogen, Eisai and Pfizer are the listed businesses responsible for the distribution and development of the major Alzheimer's treatments currently available. Eli Lilly, Novo Nordisk and Roche are among those working on new solutions at present. Given the opportunity, expect more to follow.

Alzheimer's is certainly a wretched disease and wrenching for all those involved. The bleak projections of those that will be affected should also make treatment of the disease a priority for health systems around the world. Beyond all the capital (both intellectual and monetary) that is focused on developing solutions, if there is cause for optimism, then it may lie in the fact that lifestyle decisions can have a positive impact. Prospects for avoiding dementia appear lower than a generation ago. Better cardiovascular health and more sleep may help. If possible, don't smoke, drink less alcohol and take more exercise. Drug treatments matter, but so do broader strategies for how to outlive.

22 April 2024

It is hard to predict the likely stock market beneficiaries at this stage

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## **Future Trends**



**Executive summary:** We need a more sustainable approach to home building. A combination of regulation and materials innovation is fortuitously driving the industry in this direction. The house of the future may well be prefabricated, built out of engineered timber and contain solar panels on its roof. Boilers will be out and heat pumps in. Everything might be controlled by a smart and integrated set of software. There are, of course,

differences major between conception and installation. Cost, sufficient material availability and appropriately trained contractors are major considerations. Nonetheless, by the end of this decade the global green building materials market could be worth at least \$600bn. For investors, the opportunity is significant. In a stillevolving industry, expect there to be multiple potential beneficiaries across several market segments.

Buildings are among the world's worst climate offenders, yet we need more of them



Buildings are among the world's worst climate offenders, yet we need more of them. Over 60,000 homes will need to be built every day for the next 80 years to accommodate shifts in income, demographics and urbanisation. That's equivalent to almost 2bn new homes before the end of this century, according to data from the World Economic Forum. In India alone, the equivalent of a city the size of Chicago needs to be developed annually to meet housing demand.

At the same time, despite over \$6.3tr spent on renewable energy and another \$3.3tr spent on electricity networks since 2005, global energy use is still ~80% reliant on fossil fuels (per JP Morgan). This is because the **pillars of modern** society - steel and cement (as well as ammonia and plastics) are made primarily using fossil fuels. Buildings account for over 35% of global carbon emissions, with the residential segment responsible for over two-thirds of this figure (per the United Nations Environmental Programme), owing to a combination of day-today running and the embodied carbon in the construction process.

Take concrete. About three tonnes of it are poured annually for every person in the world. If concrete were a country, then it would be the third largest global emitter of carbon dioxide, after China and the US (per The Economist). Next, consider buildings. More than 90% of homes in the US and over 75% in Europe are under-insulated, according to the European Commission. A poorly insulated home can lose 30% of its heat through the attic, 25-30% through the walls, 10% via windows and doors and another 10% from the floor.

We clearly need а more sustainable approach to home While building. the terms 'sustainable', 'future' and 'green(er)' are often used interchangeably in the context of this debate and many definitions for such an approach to construction exist, we take a sustainable home to mean a building that is constructed, operated and maintained in ways that reduce the owner's carbon footprint and the impact of climate change.

The good news is that a combination of regulation and innovation are accelerating the drive towards sustainability. Begin with regulation. Almost 50 countries now have mandatory construction codes that cover their entire building sector, while another 30 have voluntary construction codes, according to the International Energy Agency. The backdrop for this is the United Nations' landmark Paris Agreement of 2015, which aims to limit increases in temperature above pre-industrial levels to no more than 1.5 degrees. The UN estimates that some 80% of countries now refer to buildings as part of their Nationally Determined Contribution action plans aimed at managing emissions.

The UK is a leading example. Its Future Homes Standard (FHS) aims to ensure that new homes built from 2025 will produce 75-80% fewer carbon emissions than homes built under current regulations. The FHS aims to decarbonise new homes bv focusing on improving heating, hot water systems, and reducing heat waste. Out will go gas boilers. In will come solar panels. The EU has launched a Buildings Directive with similar ambitions. California has a Green Buildings Standards Code (although much of the rest of the US is without similar initiatives). Other countries as diverse as Japan, India and Chile have also embraced new buildings codes.

At the same time that standards are improving for the better, there is no shortage of innovation across the whole construction ecosystem. Encouragingly, two different dynamics are at work: the build of new eco-friendly buildings and the retrofitting of existing buildings. As a starting point consider that in buildings, energy is used for a wide array of applications, including heating, ventilation and air conditioning systems (HVAC), domestic hot water (DHW), lighting, household appliances, and electronics.

Begin with the easy wins: heating and energy. The key is to drive a shift away from fossil fuels. Air source heat pumps provide one solution, avoiding the need for a boiler. They work by transferring heat from outside air to water. This can then be moved around a house through radiators, pipes or underfloor heating. Water could also be stored in a hot water cylinder to heat taps, showers and baths. Other initiatives such as thermal skirting boards, infrared panels and waste-water heat recovery systems can drive further efficiencies.

Just as heat pumps can be added into existing homes, replacing older boilers, so could current buildings have photovoltaic solar panels added. Subject to rooftops being unshaded and ideally southfacing, then the addition of 12-15 panels per roof could generate around half the electricity usage of a current UK home (per data provided by the Government when implementing the FHS legislation). Batteries would allow for storage. Excess energy could also conceivably be sold back into grid networks. Both money and energy might be saved through the installation of smart home control systems too.

When it comes to new build, existing products can be improved, and new products introduced. Concrete, just like glass, is infinitely recyclable. Double-glazing has existed for many years, but newer triple-glazing can typically increase window insulation by an additional 20%. However, it was only in 2022 that the world's first cement (called ECOPact) was launched with 20% recycled construction and demolition waste. Lafarge Holcim, the world's largest cement producer and the manufacturer of ECOPact, says that it is now available in 27 markets globally. It recycled over 30m tonnes of materials last year.

As far as new products are concerned, there is **a growing trend** 

towards prefabricated homes. Manufacturers produce these homes in factories and transport them to the building site, where they are permanently assembled. They do not take nearly as long to construct as traditional houses, making them energy-efficient and cost-effective. Engineered timber often features heavily. Think of this as a composite of different layers, each designed to meet the requirements of specific components such as floors. panels, cross-braces and beams. Besides engineering the shape of a component, designers can align the grains in the layers to provide levels of strength that rival steel, on a product that is up to 80% lighter. As an extreme, some firms are experimenting with carbon negative home design, using fully recycled materials from old foundations to shower enclosures built from recycled yoghurt pots.

Close to where your author lives, in London's W9 postal district, two developments provide an insight into future construction. When 300 Harrow Road is complete, Westminster Council says that it will be the leading development in the country in terms of airflows rates for its heating and cooling system. Residents will benefit from use of air source pumps, solar panels, rainwater collection and living roofs, resulting in lower energy bills and a reduction in carbon emissions. Less than two miles away, on the Edgware Road, the Berkeley Group is converting a brownfield site into housing as part of its Vision 2030 project. Homes in the development are billed as low

## **Future Trends**

carbon, constructed from highperformance building fabrics. The site also aims to deliver a minimum 10 % net biodiversity gain. Taylor Wimpey, another builder, seeks to go further. It launched at the start of the year a flagship zero-carbon ready homes trial, an industry first. Your author <u>visited</u> its Westland Heath development as part of his research for this note. Heat pumps, thermal skirting, smart home systems and more featured.

Projects such as these are encouraging. Sales of heat pumps rose 10% globally in 2022 (the last year for which data was available. per the IEA) and by nearly 40% in Europe. In France and the US, the installation of new residential heat pumps has now overtaken fossil fuel-based heating systems. Looking forward, the global green building materials market looks set to enjoy at least 10% compound annual growth through the end of this decade, by which time it would be worth at least \$600bn and up to \$900bn, depending on the methodology used by different consultants.

Even with evident progress and ongoing innovation, it is worth bearing in mind that only 26% of countries have mandatory codes for the entire building sector, while just one-third of global floor area additions through to 2030 will be in countries with such codes (per the World Green Building Council). Retrofitting existing buildings can be particularly challenging, given the long lifespan of current structures.

There are also major differences



from conception to installation. Among the biggest practical considerations is that of cost, both for the builder and the eventual home buyer. Sufficient materials (especially wood) need to be available. Some technologies are still nascent. Feedback around heat pumps has been mixed, with concerns cited about efficiency, value for money and aesthetics. Plumbers, electricians and other professionals in the ecosystem may need to be reskilled too.

It's important, then, to manage expectations. The shift to more sustainable homes will take time, especially since people tend to move relatively infrequently and may not have the spare cash (or desire) to upgrade existing properties. How to accelerate the shift? The best approach would seem to be through a combination of education and incentives. However, both come at a cost. In Italy, for example, it is possible to The shift to more sustainable homes will take time

claim the full cost of green home renovations, plus an extra 10%, through tax credits worth up to  $\in$ 100,000 per house. Over  $\in$ 20bn has apparently been paid out under this scheme since its launch in July 2020. Do not also forget the behavioural consideration: once residents are installed in greener homes, can they be relied upon to consume energy responsibly?

From an investment perspective, the sustainable homes opportunity has a long runway ahead. The field is still evolving and there is a wide range of

beneficiaries potential The theme can be conceivably played through multiple and often overlapping verticals and each market is currently highly fragmented. There will also likely be regional/ country variations based around both regulation and the availability of materials. Almost every business within the broad universe highlights its sustainability credentials in detail in both its marketing and investor materials. At the same time, however important smarter homes might be as a secular trend. it is hard to ignore the inherent economic cyclicality within the construction industry.

Investable areas within the broad field could include: green building materials and products, renewable energy companies, home automation and energy efficiency systems, residential construction and development businesses. water and waste management companies, energy efficiency technologies and. environmental services. Beyond pure-plays in each above area, many conglomerates and megacap technology businesses are also keen to stake claims within the field. Readers should perhaps not be surprised. It seems fitting to conclude with the words of Albert Einstein, albeit used in a different context: "from every great crisis, lies great opportunity."

15 February 2024

# **Future Trends**



**Executive summary:** Expect more offshore wind farms. They are more efficient, have a reduced environmental impact and can be scaled more effectively relative to their onshore counterparts. As a result, the offshore wind industry should grow at between two and four times the rate of onshore. Falling turbine costs, technological improvements and geopolitical considerations mean that offshore installations could account for 35% of all global renewables

investment through to 2030. Many projects are already underway, particularly in Europe, but progress will not be linear. For the offshore wind industry to develop fully, permitting processes need to improve. Given that the market structure is oligopolistic (ex-China), the scope for the major players to earn attractive returns over time looks compelling. Vestas stands in a particularly strong position, as the only pureplay turbine manufacturer of meaningful scale.

Projected renewable capacity additions of ~2500GW over the next five years would match those of the last twenty



To behold an offshore wind turbine, as your author did recently, is an impressive sight. The largest have blades as long as Big Ben is tall and gear boxes bigger than the average house. A single sweep of the biggest turbine currently on the market (GE's Halide-X) is enough to power one household in the UK for more than two days (per information provided by the National Grid). The annual energy generated by such a turbine can save up to 52 million metric tonnes of carbon dioxide annually, the equivalent to the emissions generated by 11,000 vehicles in a year.

It is five years since we last wrote a dedicated theme piece on the case for wind. During that time, its growing strategic importance as a source of energy has only become more evident. Consider that global capital expenditure on wind and solar assets was greater than investment in new oil and gas wells for the first time ever in 2022. Correspondingly, the combined power from wind and solar overtook natural gas for the first time in the EU last year. Looking forward, projected renewable capacity additions of ~2500GW over the next five years would match those of the last twenty (data from Rystad Energy, Ember Analytics and JP Morgan, respectively).

As a reminder, **renewable energy** has very low marginal costs and is virtually unlimited by physical constraints. The only real constraint is how quickly it is possible to invest and build.



Wind, in particular, is cheap and abundant. It produces no carbon dioxide, no greenhouse gases and no hazardous waste. Unlike coal or nuclear, wind does not consume large amounts of water, which itself is becoming a scarce resource. A standard turbine will generate around 240MW of energy during its 20-year operation, sparing the environment the impact of a net volume of ~230,000 tonnes of carbon dioxide that would be produced were a coal-fired power station to generate an equivalent amount of energy (per Bloomberg New Energy Finance, or BNEF).

Looking forward, we believe that the future will not be simply about wind in general, but offshore wind in particular. The advantages (relative to onshore) are threefold: **offshore turbines are more efficient**, **have a reduced environmental impact and can be scaled more quickly**, Offshore wind is forecast to experience a growth rate some four times that of onshore

owing to the available space in which to build them.

Offshore wind farms generate electricity from wind blowing across the sea. Here, wind typically reaches a higher and more constant speed than on land, due to the absence of barriers. Furthermore, offshore breezes can be strong in the afternoon, matching the time when people are using the most electricity. As a result, higher wind speeds and consistency in direction means offshore installations require fewer turbines to produce the same amount of energy as onshore wind farms. Oceans also provide the perfect location to build wind farms in terms of scale and openness. More wind farms being built means more clean, sustainable energy can be produced. Being far from the coast, offshore turbines are – by definition – located away from nearby populations.

Governments across the world are embracing offshore. BNEF describes it as "the fastest growing green technology" and projects c20% annual growth through to 2030, from a starting year of 2020. A forecast seven-fold increase in capacity over this period would be more than double that assumed for onshore build. The assumptions made by Wood Mackenzie, another consultancy, are even more ambitious, calling for a growth rate in offshore wind some four times the rate of that of onshore. Offshore could, on its forecasts, account for 35% of all global renewables investment through to 2030, up from just 6% in 2020.

The industry has certainly come a long way from when the first offshore farm installed at Vindeby in Denmark in 1991. How has such expansion become possible? The best answer lies simply with Moore's Law. As the industry has scaled, costs have fallen. Better (and more reliable) turbines with greater capacity now exist relative to a generation ago. When combined with more robust cables and transformers, this can be a very powerful proposition. Larger turbines typically reduce

per-megawatt project costs. Consider that the average offshore wind turbine capacity installed in 2021 was 7.4MW, significantly higher than 3.3MW in 2011 (per the Department of Energy). Looking forward, all the world's leading turbine manufacturers have announced that models in the range of 13-15 MW will be available for installation from next year. Correspondingly, the levelized cost of offshore wind energy - a key industry metric - will have fallen by roughly three times over the period 2011-2024.

Technological progress is also boosting the outlook for offshore wind. Until recently, turbines have been installed onto bottom-fixed foundations that are grounded in waters with typical depths of up to 50 meters, requiring a relatively shallow continental shelf. Newer, floating foundations, however, can be installed irrespective of the terrain that lies below and may become viable for water depths of 1,000 meters and beyond, an advancement that increases the viable sea area for offshore wind by a factor of five (per McKinsey). Locating wind farms further offshore can also reduce visual pollution, provide better accommodation for fishing and shipping lanes and reach stronger and more consistent winds. One project developer, Equinor, sees floating wind farms as the "next wave" in renewable energy and believes they can achieve profitability by 2030 through scale and industrialisation.

Look further ahead and other

innovations could also make the case for offshore wind even more compelling. Consider the benefits that multi-purpose interconnectors (MPIs) could deliver. Instead of individual wind farms connecting one by one to the shore. MPIs would allow clusters of offshore wind farms to connect all in one go, plugging into the energy systems of neighbouring countries and making it even easier to share clean energy between countries. In one future vision, "energy islands" will begin to appear. Think of these as state-of-the-art clean energy hubs. They could enable the connection of offshore wind to multiple countries via MPIs, while also serving as a platform for the production and delivery of green hydrogen. In this world view, excess offshore wind capacity would serve as an additional fuel source for hydrogen electrolysis.

To get a sense of what might be possible, look at the work underway in the North Sea currently. What was once a hub for oil. now may be one of the best places in the world to develop offshore. With an average wind speed of 10 metres per second, the North Sea is among the windiest locations on the planet. The relative shallowness of its seabed also makes it an ideal place to fix turbines. Already, the UK has the largest installed capacity of offshore wind in the world, with around 10GW in operation beyond its coasts. The Hornsea 2 site. located off the coast of Lincolnshire, spans 462 square kilometres and can power electricity for 1.4m households (per the National Grid).



Hornsea 3 is already being built nearby. Planning permission may also be granted in the future for Hornsea 4.

Last year, the EU auctioned 25GW of offshore capacity in the North Sea, the largest annual amount to-date. Under plans released by Europe's Governments, overall offshore capacity in the region could reach 300GW by 2050. Such a level would - theoretically - be enough to power all households across the Continent. Belgium, Germany and the Netherlands have already announced plans to connect their respective energy islands and a broader plan would see the "North Sea Wind Power Hub" connecting these countries'

offshore energy resources with those of Denmark, Norway and the UK. The Hub may be operational by the early 2030s, per Wind Europe, an industry body.

Offshore wind is not just a European phenomenon. As part of the Inflation Reduction Act, President Biden issued an Executive Order focused on expanding the offshore wind industry. The Departments of Interior, Energy and Commerce (DOI, DOE and DOC respectively) announced a combined goal to deploy 30GW of offshore wind in the US by 2030, while simultaneously creating tens of thousands of green energy jobs. America's offshore wind pipeline rose 13.5% in 2022 relative to the Offshore wind is not just a European phenomenon

prior year, per the DOE. A third major offshore wind farm project in the US recently received approval, in July. Elsewhere, offshore project development is active off the coasts of Korea and Japan, which have many similarities with the North Sea. Many other countries are exploring offshore wind too, including Azerbaijan, Brazil, Canada, Colombia, India, Oman, the Philippines, Sri Lanka, and Trinidad and Tobago.

It all almost sounds too good to be true. Readers should remember, however, that developing an offshore wind project is a complex process, which can typically take at least five years (and often up to seven) from just signing a contract to erecting turbines. During this period, all players in the value chain are naturally exposed to the general vagaries of the market and changes in input costs in particular. The seven-stage process would typically involve planning, site control, permitting, approval, financial close, construction and finally an operational state. Of these, permitting - when the developer files major permit applications -being the one most subject to delays. Over 2,000 wind projects in the EU are awaiting current permitting, per Wind Europe. Also, do not forget that the presence of any offshore wind project is a necessary but not sufficient part of the transition to green energy. Robust grid infrastructure (especially in the form of interconnector cabling) is required to carry energy from generation to demand sources.

Another factor that also bears major consideration is how wind turbines get built and then maintained. There is currently a high industry dependence on China, a source of major geopolitical uncertainty. China is responsible for 53% of all offshore wind towers, 73% of nacelles (where the gears and generator are housed) and 84% of blades. These percentages - and dependency - are higher than for comparable onshore builds (per the IEA). More construction materials (concrete and steel especially) would also be required, as would vital rare earths (by a factor of 1.5 versus onshore and 2.5 versus solar, per JP Morgan). If this were not enough of a cost burden, then consider that their offshore location exposes the units to high humidity, salt water and saltwater spray. All these factors can negatively affect service life, cause corrosion and oxidation and increase maintenance and repair costs. High wind speeds and strong seas can impact maintenance accessibility too.

Calculating an accurate like-forlike levelized cost of energy for offshore wind relative to other sources is complex, energy given not only the above factors, but also when taking into account interconnection costs. Nonetheless, cost may not be the only factor that influences how quickly the offshore wind industry develops. Energy independence, environmental factors as well as the creation of new domestic jobs and communities (part of the UK's thought process) are also likely to play a significant role. Offshore wind will, of course, be just one element of the broader energy mix going forward, but the industry's growth prospects and the race to net-zero emissions are attracting more companies with adjacent capabilities. Beyond the established players, utilities, businesses (with offshore oil expertise), and other large capital project developers are entering the market.

Listen to any of the major Western turbine manufacturers (the Chinese market is dominated by local players who do not tend to compete internationally) talk about offshore wind and they are unequivocally optimistic. Cynics might suggest that it is in their interests to be so, but from an investment perspective, the market has an attractive oligopolistic structure: three players - GE Renewable Energy, Energy Siemens (formerly Siemens Gamesa) and Vestas supply ~90% of the offshore wind turbine market ex-China.

Vestas, the only pure-play turbine manufacturer of meaningful scale, says in its Annual Report that it "aims to be a leading player in offshore wind power." Although Vestas currently ranks third by offshore wind market share, the company is guiding that offshore will be a €3bn revenue business by 2025, which would make it, by this time horizon, the leading player in the space. Its current offshore order backlog is greater than that of its peers. Beyond Vestas, both GE Renewable and Siemens Energy may benefit from being part of larger organisations that have the potential to play a greater role in project management through the provision of connectors and infrastructure, other although there is little concrete evidence to support this advantage currently. Alternatively, investors could seek to gain exposure to the theme through project developers such as

Equinor or Orsted, both of whom have a significant presence in green energy in general and offshore wind in particular. **Providers of vital grid infrastructure and smart grids (such as Quanta Services) as well as systems integrators should also benefit**. If the projections are correct, then offshore wind is not only here to stay, but big business too.

18 September 2023

The top three players supply ~90% of the turbine market ex-China

# QUANTUM COMPUTING: ON THE EDGE OF THE QUANTUM AGE

**Executive summary:** The future's not just about the disruptive potential of artificial intelligence; the quantum era is coming. With it, arises the potential to take on any problem at a vastly accelerated speed, resulting in significant efficiency gains. Many bluechip businesses across finance, healthcare and energy are already trialling quantum solutions. While quantum computers are unlikely to replace traditional computers any time soon, they will be able to work effectively in tandem. One in five businesses say they are budgeting for quantum investments this year and momentum should only build

as both the hardware and software improves. At stake is an addressable market which could be worth up to \$120bn by the end of this decade. The winners of the quantum race will likely produce the successor to the silicon microchip and its supporting infrastructure. The quantum ecosystem is necessarily large, and investors can participate across the value chain in both public and private opportunities. IBM arguably leads the industry at present. Listed pure plays have emerged (even if they are typically small-caps and unprofitable) and we only expect the space to grow from here.

However game-changing computing has been, it still can't solve all our problems



Computing is one of the greatest of all human inventions. It's so ubiquitous that it's almost taken for granted. Exponential progress in computer design combined with rapid increases processing power, have in allowed for major advances in all areas: information processing, communication. energy, transportation, biotechnology, life sciences, agriculture, industry and more. Recent developments in artificial intelligence are elevating computing's potential even further.

Nonetheless, however gamechanging computing has been, it still can't solve all our problems. As we have consistently argued, the number-one challenge the world faces is how to allocate scarce resource efficiently in the face of a growing global population. Against this background, we need to figure out better how to live sustainably, cure diseases, and move efficiently people and goods.

Quantum computing may provide the answer. Ask Satya Nadella, the CEO of Microsoft, and he will tell you that quantum computing is "one of the technologies that will radically reshape the world." We first wrote about it in 2017 and for decades, quantum computing has been viewed as a futuristic technology. Optimists assert that it could alter everything. Sceptics, by contrast, argue that the technology remains the preserve of academics and theorists, too arcane and faroff for practical application.

Much has changed in the six years since we last discussed the topic. We see more evidence of



'if' turning to 'when.' Consider that over 4,000 academic papers were published on quantum in 2022. more than double levels at the start of the prior decade (per Elsevier). Crucially, nearly every major quantum computing technology provider has released a roadmap setting out the critical milestones along the path to quantum advantage over the next decade. While most of the action in quantum computing may be limited to laboratories and research problems, the barriers continue to come down, with programming interfaces such as IBM's Qiskit already available over the cloud, capable of exploring potential future applications.

At the same time, in a fashion not dissimilar to how the cloud industry evolved, **an emerging ecosystem of quantum start-ups is developing**, targeting different aspects of the future quantum stack. While only 1% of companies actively budgeted for quantum computing investments in 2018, An emerging ecosystem of quantum start-ups is developing

Gartner estimates c20% will do so this year. A more optimistic study suggests that 48% of UK businesses expect quantum computing to play a significant role in their industry sector by 2025 and up to 80% by 2030 (per EY).

As a reminder, **quantum technology is not new**. The concept dates from the 1940s where the rules of quantum mechanics were outlined, defining what happens at an atomic scale. In the 1980s, academics at MIT began applying these principles to computing. Think of quantum as an advanced form of computing that is immensely complicated but effectively has the potential to make calculations deemed impossible today suddenly doable in seconds. Quantum processors can calculate a range of possible answers simultaneously rather than being limited to handle each step of a calculation in turn.

Classical computers speak in the language of bits, which take values of zero and one. Quantum computers use gubits, which can take a value of zero or one, and also a complex combination of zero and one at the same time. Qubits are thus exponentially more powerful than bits, able to perform calculations that normal bits can't. However. because of this elemental change. everything must be redeveloped: the hardware, the software, the programming languages, and so on.

Against this background, the winner(s) of the quantum race will likely produce the successor to the silicon microchip and supporting infrastructure. its Governments and companies globally are forecast to invest over \$16bn in quantum development during the next five vears. Meanwhile, quantum technology funding and investment activity surpassed \$1.4bn in 2021 (data from IDC and McKinsey respectively). At stake is a sizeable prize: **a \$60-**120bn addressable market by **2030** (per forecasts from Prescient and Strategic Intelligence and Precedence Research) with at least \$450bn in value possible by 2050 (per BCG).

Where might this value accrue?



Put simply, quantum offers the potential to take on any problem at a vastly accelerated speed. Effective systems would have the ability to perform tasks with a high degree of accuracy, considering multitudes of possible answers simultaneously. The three main broad use cases for quantum would be in simulating nature, analysing data patterns and optimising search/ sampling. Major industries that would clearly benefit from quantum applications include life sciences, chemicals, finance, travel, logistics and automotive.

Consider that the average cost to develop a new drug is about \$2.4bn. Pre-clinical research selects only about 0.1% of small molecules for clinical trials, and only about 10% of clinical trials result in a successful product (all data per BCG). Computer-aided drug discovery in the pharmaceutical industry is currently limited by the computing time and resources required to simulate a large enough chemical system with sufficient accuracy to Quantum could be a \$60-120bn addressable market by 2030

be useful. Quantum computers, on the other hand, can efficiently model a practically complete set of possible molecular interactions. This could be game-changing not only for drug candidate selection, but also in identifying potential adverse effects via modelling (as opposed to having to wait for clinical trials) and even, in the long term, for creating personalised drugs.

Take the financial services industry as another promising use-case. More than \$10tr of options and derivatives are exchanged globally (per the Bank of International Settlements). Many are currently

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Quantum computers are unlikely to replace traditional computers any time soon

priced using what are known as 'Monte Carlo' techniques, namely calculating complex functions with random samples according to a probability distribution. This approach is both inefficient and lacks accuracy as well as being time consuming. Quantum computers would be naturally well-suited to modelling such outcomes much more efficiently. Several financial institutions including Goldman Sachs, JP Morgan, Standard Chartered and NASDAQ are already working on the technology to improve options pricing.

Elsewhere, quantum computers could be used to develop

biodegradable plastics, or carbonfree aviation fuel. Additionally, sectors that are reliant on making a high volume of complex calculations such as within transportation and logistics may also benefit. The world's first quantum route optimisation pilot project is already underway in Lisbon, where a computer system (powered by D-Wave) is being used to calculate the fastest route for nine of the city's buses between 26 stops. The quantum computer monitors constantly traffic conditions and other variables and generates individual routes for each of the nine vehicles in near-real-time between the stops. Longer-term, other applications for quantum could include navigation or even running brain simulations to attempt to explore the origins of consciousness.

Corporations in all the above diverse fields are able currently to work with vendors to begin testing applications on existing quantum hardware, comparing their performance with outcomes from classical computers to make sure the results are accurate. Logically, with each hardware upgrade, customers can try out more advanced algorithms. If the outcomes remain correct, that instils greater confidence that the machines are performing as intended. By way of example, in November 2022, IBM debuted its 434-qubit Osprey processor, more than three times as powerful as its Eagle processor (with 127 qubits) unveiled a year prior. The business says it aims to release a 1,121-qubit processor called Condor later this year. Other businesses such as Google have similar product roadmaps.

However, today's machines are generally known in the industry as NISQ or Noisy Intermediate Scale Quantum systems. This means that the number of qubits is still limited, and the gubits are unable to hold their quantum states for more than a few microseconds, something that introduces errors or 'noise' into calculations. The reality is that successfully functioning quantum computers are difficult to build and operate because the physical system of qubits must be nearly perfectly isolated from its environment to store quantum information optimally. Further, quantum chips only work at temperatures typically 100th of a degree above absolute zero - far lower than outer space. Not only does this introduce additional complexity, but also much higher energy consumption for quantum versus classical computers. Some studies suggest the figure could be

up to 50,000 times higher.

Although these are legitimate concerns. thev are beina addressed. Solvina technical challenges requires deep. interdisciplinary expertise and systems engineering/ partnerships between industry and government. China has announced the most public funding of quantum todate of any country (\$15.3bn), more than double the size of the EU (\$7.2bn) and over eight times US aovernment investments. Correspondingly, the country has more patents in the field too than any other (all data per McKinsey). It will also be crucial to ensure that universities and other institutions provide adequate training and skills - there is little point in having a functioning quantum computer if no one knows how to programme it.

For context, it is important not to forget that **quantum computers** are unlikely to replace traditional computers any time soon. Instead, they will likely work in tandem to help solve computationally complex problems that classical computers can't handle quickly enough by themselves.While new use cases are expected to become available as the technology matures, they are unlikely to emerge in a steady or linear manner.

The holy grail for the quantum industry – and that which would effectively herald the arrival of the quantum age – is the achievement of quantum supremacy. This is typically characterised as being when a programmable quantum device can solve a problem that no classical computer can solve in any feasible amount of time (irrespective of the usefulness of the problem). It likely requires both the effective functioning of hardware and software. Darío Gil, the Director of IBM Research believes that **"the ability to demonstrate quantum advantage in the next two years is possible"** even if several technical challenges remain to be overcome.

Reaching quantum supremacy, however, will open a new set of problems. Most pertinently, it could affect the global balance of political power, hence why the broad technology sector has, for many countries, become intertwined with the future of national security. We discussed this topic in detail in our 2023 outlook piece. The U.S. is clearly supporting quantum research (such as through its Chips Act). China's progress on quantum is largely unknown, but China appears to be at a much more advanced stage. Several reports suggest that the government has put forward a clear directive that links the maturity of quantum to the country's economic and national security future. There is the additional (related) question of how to regulate quantum. It remains a highly nascent technology, especially when compared to other emerging tech areas such as artificial intelligence, where the regulatory roadmap is still evolving. In reality, **no one quite** knows what successful quantum computers will look like.

The challenge for investors is

to know how (and when) best to play the theme of quantum. Sceptics argue that we remain in a 'quantum winter' - perhaps not dissimilar to where the artificial intelligence industry stood a decade ago - where the promise of the technology has outgrown its potential. In this world view, quantum is little more than an impressive science experiment rather than a practical technology. Viewed conversely, now should be the time to be looking for more practical approaches rather than just simply theoretical ones. Might quantum computers today be where combustion automobiles were in the early 1900s? Ask IBM and we are in "the quantum decade". Other players suggest that "the dawn of the quantum age is here" and "the time for quantum is now" (per lonQ and Rigetti respectively).

The quantum ecosystem is a necessarily large and diverse one embracing equipment and components, hardware, systems software, application software and services. Both public and private players are active across the space. As noted previously, visibility on China's positioning in the space is low, but per McKinsey, North America commands over 60% of all start-up funding and has nearly 40% of all current market players.

**IBM arguably leads the quantum industry**. Per its website, it has over 20 of the most powerful current quantum systems in use and has created a community of over 210 of the Fortune 500 companies. Along with academic institutions,

national labs and start-ups, its website summarises multiple case studies (including with Daimler and Exxon) where quantum is currently being trailed. IBM also recently announced a strategic partnership with EY whereby the latter organisation can trial IBM's quantum tools to help explore solutions for clients. A pay-as-you-go quantum service (from \$1.60 per runtime second) is available via IBM's Cloud. The company claims over 400,000 registered users. **Google** is also strongly positioned within quantum and opened a dedicated campus in Santa Barbara in 2021. Among the other major US tech players, Microsoft, Intel and AWS also appear to be active in the field. One stage removed from the major bigtech business is Keysight Technologies. As a leading player within the field of network test equipment, the business has developed a portfolio of quantum solutions in conjunction with over 100 adjacent (often academic) institutions. Keysight believes quantum could be a "generational advantage" in terms of technological differentiation. Its solutions can help with error reduction and other related issues. Oxford Instruments is another business that could be wellplaced within the broader quantum ecosystem.

None of the above is a pure-play business. However, within the last two years, several have listed (albeit in

some cases utilising a SPAC structure). These include **Arqit, D-Wave Quantum, IonQ** and **Rigetti**. Many have over two decades of experience within quantum and have developed dedicated niches (Arqit, for example, in encryption and D-Wave in a specialised technology – quantum gates). At peak, this quartet of businesses was worth \$12.5bn although their combined market capitalisation is currently less than \$1.5bn (per Bloomberg). None has annual revenues of over \$20m.

There is also a vibrant start-up system which plays across a range of niches and geographies. Beyond the US, Israel, Switzerland and the UK seem to be developing strong quantum ecosystems. A non-exhaustive list of interesting players would include: Alpine Quantum, Classiq, CloudQuanta, OxfordQuantumCircuits, PsiQuantum, Quantinuum, SandboxAQ, Terra Quantum, Xanadu Quantum Technologies and Zapata Computing. Quantum supremacy may still be some time away, but we expect interest in the sector only to build from here.

05 June 2023





If you haven't heard of Chat-GPT or you don't know that AI is an acronym for artificial intelligence, then you've probably been living on a different planet for the last few months. Sure. there's been media and investor excitement around nascent trends such as bitcoin. blockchain and metaverse in recent years, but the ever-growing buzz around AI is perhaps on a scale akin to sentiment at the time of the launch of the iPhone. Unsurprisingly, we have received multiple inbound questions from our client base on the topic.

### To summarise our core views:

### 1: Al is not new.

Recent developments are exciting, but it is important to keep them in perspective.

2: We should think of AI as a complement to what we do rather than as a substitute, for now.

# 3: It is important to separate hype from reality.

Even though the broad impact of AI in our lives will likely grow exponentially from here, progress will not necessarily be linear. How and when investors seek to gain exposure to the theme is also open to debate. What follows below are the five most relevant issues that seem top of mind currently, and then our perspectives. To be clear, all the answers have been written by your author, without any help from Chat-GPT or any other Alenhanced solution.

> Any AI solution is a function of its inputs





# 1: What's different about Chat-GPT?

Al is not new. The notion of forms of artificial intelligence has been addressed by myth, fiction and philosophy since antiquity. Even prior to the excitement around Chat-GPT. an IBM-designed 'intelligent' called computer Watson beat human champions in the notoriously complex quiz show Jeopardy in 2011. Four years later, AlphaGo, an Al programme designed by Google subsidiary DeepMind, defeated 18-time world Go champion, Lee Se-dol. Notably, the programmers at DeepMind did not teach AlphaGo to play Go; instead, the algorithm taught itself by watching (and learning from) 160,000 professional games. At Heptagon, we first wrote on the topic of AI in 2016, arguing that it is "inherently disruptive" and that "its growing deployment in both the business and the personal sphere will enable us to do things more efficiently."

All AI works on the basic principle of training and then inference. Put another way, give a computer big sets of data, train it to recognise patterns and make distinctions, then allow it to make inferences. This process can occur in either a supervised or unsupervised (by humans) fashion. It should therefore be evident that any AI solution is a function of its inputs. It will also be highly dependent on the hardware that underpins it. Although they appear novel and revolutionary, all chatbots are trained using large language models and reinforcement



learning from human feedback. 'GPT', for those unaware, is an acronym for Generative Pre-Trained Transformer.

It's also important to remember that many of us are using Albased solutions without realising that we are doing so. McKinsey has conducted an annual survey of business adoption of AI since 2017. Five years ago, 1-in-5 of the businesses it surveyed were using Al; last year, it had grown to 1-in-2. Typically, deployments occur in one of four fashions: robotic process automation, computer vision, natural language text understanding and virtual agent conversational interfaces (i.e., chatbots).

Nonetheless, **it is hard to deny that Chat-GPT has been a gamechanger**, even if chatbots are not new. This one is different, with more compute power and parameters Many of us are using AI-based solutions without realising that we are doing so

(numbering over 175bn) than previous iterations. Typical response time to any challenge put to Chat-GPT - whether it be solving a problem, writing a poem, drafting a contract and so on - are answered within five seconds. The appeal is almost magical. With over 100m monthly average users at the last reported count, Chat-GPT has been the fastest-evergrowing social media/technology phenomenon. Since Chat-GPT was integrated into Microsoft's Bing search engine, downloads of Bing

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AI technology will also only get better

have reportedly grown tenfold relative to prior levels.

With the level of fervour around GPT, perhaps a better acronym may be to think of it as a 'general purpose technology' - something that could boost productivity across a wide range of industries and occupations in the manner of steam engines, electricity and computing. Do not forget, Al technology will also only get better (researchers say Al's computational abilities are

currently doubling every six to ten months), and **as it gets better, it will become more engrained in our lives**.

# 2: Where can AI help?

The number of use cases where Al in general and chatbots in particular can be deployed seems to grow by the day. A logical place to begin though would be to consider how we think about accessing information. Chatbots will help engender a paradigm shift to computers being answer engines as opposed to search engines. Logically, with more answers (from better data), it is possible to envisage outcomes where many processes can be automated with higher levels of productivity. The benefits of automation can outweigh costs by a factor of three to ten times (per McKinsey), quantified in terms of better/ greater output of a higher quality, with improved reliability. Optimists might even assert that this could imply faster economic growth.

Another perspective is that **AI** could also become inherently democratising, if it helped to lower dramatically the costs of expensive services in fields such as legal help or healthcare etc. AI might also allow for enhanced creativity and accelerated innovation, which could benefit fields as diverse as marketing, communications and even policy.

Microsoft has already integrated GPT-4 (Open Al's latest iteration) into Bing, its search engine. Other productivity tools could also see Al-related enhancements. Imagine the power of a tool in Teams that could, for example, take notes or provide meeting recaps. To think about the impact of AI in other industries, consider how a car company might seek to merge real images of its logo and cars with the output of a tool like Dall-E (another Al engine) to create commercials at a fraction of the cost. Alternatively, imagine how a film studio might apply generative technology to develop an endless array of sequels, spin-offs or games built around their existing universe of characters. In financial services, expect better designed products with more optimisation.

# 3: Should we think of AI as a complement or a substitute?

Debates about every technology have been framed in this fashion since time immemorial. Remember the Luddites 200 years ago. These were textile workers in Nottinghamshire (led by Ned Ludd), who set about smashing mechanised cotton mills and claiming that new industrial technologies would spark unemployment. They were wrong then, just as fears about Al's transformative effect on employment may be wrong now.

No technology in human history has ever led to a net reduction of jobs. Automation increases the productivity per worker (more can be done with fewer workers). so the market demands more workers because their increased productivity leads to more options for the goods and services that they can profitably provide. When something is automated, costs typically fall and quality increases, reduces pricing and ultimately increasing demand for that product.

While there is a high likelihood that AI could provoke significant job destruction on a gross basis like when cars replaced horses or lightbulbs replaced candles -the number of new jobs that could be created by the technology on a net basis will offset this. Think of evolved supply chains and new economic activity as a result of epochal technological change. We do not deny that the advent of AI may take a toll on certain businesses. Notably, however, in a recent study, Stanford professor Erik Brynjolfsson conducted an analysis of tasks required in 950 different occupations. Al could handle many of the functions, but not all: "we did not find a single

one where machine learning ran the table and could do all of them."

The arrival of AI could also help people move into better and more fulfilling jobs; users' time could be freed up to do more important things. Within healthcare, for example, the diagnosis of many health issues could be automated. increasing accuracy for more common issues and allowing doctors to focus on more acute or unusual cases. Within finance. mortgage loan officers might spend less time inspecting and processing routine applications, allowing them to cover more customers and again deal with issues. particularly complex Indeed, the broader ability to staff, manage and lead automated organisations may become a key competitive differentiator for all businesses over time. Perhaps where policymakers should be focusing is on how best to train workers for a reshaped world.

### 4: What are the limitations of AI?

A different way of answering this question could be to consider **how ready the world is for AI**. The output we have seen from Chat-GPT and its ilk can be either wonderful or terrifying, depending on your perspective. Do not forget, **AI doesn't have a moral judgment** 

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or compass. The clue is in the name; its intelligence is *artificial*. Correspondingly, we should not be surprised when chatbots struggle to detect a boundary between fact and fiction or are prone to making things up to satisfy human users' inquiries, often presenting them with a form of supreme confidence. Unlike search engines, which mostly direct people to other pages and make no claims for their veracity, chatbots present their answers as gospel truth.

For some, this debate may, of course, be moot. Al does not need to fully emulate the workings of the human brain: rather, it is about the creation of software to produce (a form of) intelligence. Even on this view, however, it is hard to escape from the charge that AI tools may reinforce misinformation and biases. Most real-world data inputs are filled with stereotypes and dominated by rich countries. Additionally, chatbots necessarily have to take content from other places to provide value. Some media sources (for example the Wall Street Journal and CNN) have claimed their licensed content has been used to train chatbots. How this issue is dealt with may have implications for the future of AIgenerated content.

A massive potential regulatory minefield that incorporates both legal and ethical issues may be evolving. The key question is not just 'can' and 'how' might technology help solve any given problem, but 'should' it even attempt to? To build AI we need engineers, but to interpret it, to decide how it should be applied and what kind of world we want to live in requires the input of policymakers and lawyers (and even philosophers). Perhaps a significant learning from the Internet age today is to consider the unintended consequences of letting Silicon Valley programmers have an undue influence in deciding what the future may look like.

A bigger picture perspective might also incorporate t he notion of **technology as a form** of geopolitical power. Arvind Krishna, IBM's Chief Executive, has called it "a fundamental source of competitive advantage." Pat Gelsinger, who occupies the same role at Intel, similarly notes that whereas "[the location of] oil has defined geopolitics in the past five decades... fabs [i.e., fabrication factories for chips] will shape the next five - this is the new geopolitics." Against this background, expect to see an effective Al-arms race evolve. China has made clear its ambitions to be the world leader in AI by 2030. Consider that from having only been founded in 1949 and with no AI publication until 1980, the Chinese Academy of Sciences has now reached the top spot in AI research produced (per the OECD). One consequence of the above would be a world of possibly siloed information (and outputs), with different 'truths' revealed by multiple algorithms across the world.

5: How might investors consider gaining exposure to Al?

Most readers will be familiar with Sir John Templeton's maxim that the four most dangerous words in investing are "this time it's different." With regard to Al, we may we be at the peak of inflated expectations now. Listen to Bill Gates: Al is "as important as the PC, as important as the Internet." Sundar Pichai, Alphabet's CEO, asserts that AI is "the most profound technology with which we are working today." Rewind to 1999 and all a business had to do to boost its share price was add the term '.com' to its name. Fast forward a few years and we saw similar with big data, then the Internet of Things, followed by blockchain, web 3.0 and metaverse. History may not repeat itself, but it can still rhyme.

# Al will get better and may well change the world, but don't expect progress to be linear.

Even the most powerful new technology takes time to change an economy. James Watt patented his steam engine in 1769, but steam power did not overtake water as a source of industrial horsepower until the 1830s in Britain and the 1860s in America. A similar argument could be made with the advent of electricity. Consider also that with the launch of the PC in 1981, the World Wide Web in 1991 (for public use) and cloud services in 2006, none of these events was a sudden 'big bang.' Rather, it was a long, drawn-out learning process as businesses worked out how best to use the new tools; a process of stop-start trial and error. AI will likely follow a similar pattern.

Al today is attracting great minds

but also profiteers, in our view. Put another way, companies haven't yet fully figured out how to make money with AI, but they are confident that this will come. There is also a perceived fear of missing out. **Control of a new platform is too powerful a lure and companies that hesitate worry they'll lose out**.

From our perspective, AI will likely result in much greater productivity benefits and disruption relative to many other recently hyped technologies such as metaverse, hydrogen, crypto and so on. Nonetheless, for now, we believe that the clearest

beneficiaries could be those providing the critical enabling infrastructure in the form of computing power and storage systems, for example. Businesses such as ASML, Equinix and NVIDIA may fall into this category. In the chatbot field, Microsoft has clearly established a lead over Google (Alphabet), but it is also abundantly clear that businesses such as Apple and Amazon will likely need to up their game. Siri and Alexa already seem tools of a different era. Others. like IBM. have been deploying demonstrable corporate AI tools for some time and may now have the chance to

further improve their franchises.

Consider by way of conclusion that today, AI is still seen as somewhat of a novelty, perhaps similar to how the car was conceived at the turn of the last century. There is a famous picture which shows just one car on New York's 5<sup>th</sup> Avenue in 1900. It is almost impossible to pick it out, given it is surrounded by horses. Just 13 years later, a similar picture was taken and not a horse was to be seen. Only time will tell whether 2023 proves to be the tipping point for AI, or just another false dawn.

06 March 2023





Executive summary: At least \$2tr of value could be unlocked globally by the middle of this century through the embrace of more circular economy principles. Despite no consistent definition of the term, with less than 10% of all material produced annually being recycled at present, the opportunity is significant. Nearly every developed world government and business has correspondingly begun to recognise the importance of having a more circular economy. Tangible

progress can be seen in sectors as diverse as consumer goods, electronics, autos and construction. Although future advances will not be linear, optimists believe that the transformation from linear to circular could be rapid. Few thought that the car would replace the horse within 15 years, during which time a whole new infrastructure was put in place. The same might be possible for the circular economy. From an investment perspective, there are multiple opportunities.

We have a big problem: we're taking too much and wasting too much



Watch here

Better waste management could unlock \$4.5tr of global value by 2030

We have a big problem: we're taking too much and wasting too much. Put another way, we're using more than the Earth can provide. In the last 50 years, the world's consumption of raw materials has nearly quadrupled, to more than 100bn tons. As a consequence, **the** planet is using about 60% more of the earth's resources than it can regenerate each year. By 2050, with an increased global population resulting in a rise in consumption, this ratio could grow by a factor of at least five (all data per the World Economic Forum). Over-extraction clearly harms people, the planet and economies. The good news, at least, is that there are solutions at hand.

Another way of demonstrating the magnitude of the problem is to consider just how much waste the world produces. Annually, it is equivalent to over 3,500 Empire State Buildings, or ten times the entire weight of Manhattan Island (per the World Bank). Nearly all of this ends up in landfills. If it doesn't find its way to a landfill, then the waste may land in the ocean. The equivalent of one dump truck of plastic alone is tipped into the ocean every minute, every day. On an annualised basis, the total weight of this plastic would be equivalent to 90 aircraft carriers (per Pew Research). Extrapolating



from this, by 2050, there will be more plastic by weight in the ocean than fish.

Less than 10% of all material produced is recycled annually (per the World Economic Forum) hence the logic for a more circular economy. The concept of a circular economy stands in distinct contrast to the more traditional linear economy. Although definitions for the circular economy vary, typically three principles are required for linear economies to transform to more circular ones: the elimination of waste and pollution; the circulation of products and materials; and the regeneration of nature.

A circular economy is **not** the same thing as recycling. The two ideas are related, but a circular economy is more systematic and ambitious. Think of it as a model of economic, social and environmental production and consumption that aims to build an autonomous and sustainable society in tune with the issue of environmental resources; a resilient, distributed, diverse and inclusive economic model.

The concept is far from novel, first developed in the 1960s and present in economic literature since the late 1980s. However, it is only within the last decade that the circular economy idea has gained traction in academia, business and government. At a government level, **a more circular economy can be viewed as a means of combating global warming as well as a facilitator of long-term growth**. It could also enable local job creation and reduce geopolitical risks.

The UN's Platform for Accelerating the Circular Economy (or PACE) calls for a global commitment to double circularity every ten years. PACE has mapped over 200 possible actions that governments could take, centred around materials recirculation, materials efficiency and new business models. To quantify this benefit, the UN believes that the effective implementation of such

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actions and more judicious use of resources could add \$2tr to the global economy by 2050. Some consultants see the opportunity as being potentially even more significant, with Accenture calculating **that better waste management could unlock \$4.5tr of global value by 2030**.

The scope for where circular economy policies and initiatives can be implemented is broad, including products, infrastructure, equipment and services. It covers both 'technical' resources (metals, minerals, energy inputs) and 'biological' resources (food, fibres, timber etc.) and applies to every industry sector. Below follow some of the most tangible examples of circular economy initiatives currently underway.

Begin with the FMCG (or fastmoving consumer goods) sector. Accenture's analysis finds that the industry could capture up to \$300bn by 2030 by optimising packaging for circularity. its The use of virgin plastics has already fallen significantly but can reduce further. Nestlé, the world's largest packaged-food company, has pledged to make 100% of its product packaging recyclable or reusable within the coming decade. Other companies including Kellogg, Kroger, L'Oréal. Pepsi, Unilever and Walmart have made similar plastic pledges. Coca Cola already uses 100% recycled PET bottles in several geographies, while both McDonalds and Starbucks state that all their packaging globally now comes from renewable, recycled or certified sustainable Another impressive sources. initiative is being pioneered by Ikea. It has said that by 2030 it will

seek to design products made only from renewable and recyclable materials.

The textile industry is a different sector ripe for implementing more circular principles. For every five garments produced, the equivalent of three end up in a landfill or are incinerated each year. Some 148m tons of clothing each year are thrown away (all data per McKinsey). Major brands, includina H&M. Adidas and Nike, are responding. H&M has committed to using 100% recycled or sustainably sourced materials by 2030: Adidas currently offers more than 450 products across its range that are made from recycled ocean litter and Nike has instituted a Sustainable Manufacturing and Sourcing Index. This works to incentivize and reward improved environmental, health, safety, and labour practices at the factories along its supply chain. A number of industry players and startups are also experimenting with new business models including subscription/ rental options, repair and enhanced resale.

Another industry where significant waste is generated is **electronics** and electric goods sector. We currently throw away more than 50m tons of merchandise annually. worth at least \$60bn. This includes over 6kg per capita of valuable materials such as gold, silver and rare earths. Less than 20% of e-waste is formally recycled, with the remainder ending up either in landfill or being informally recycled, much of it by hand in emerging markets, exposing workers to hazardous and carcinogenic substances (all data per the United Nations). Solutions include bans of the destruction of unsold electronic products (introduced in France), offering closed loop services for mobile phones with materials recycled on a like-forlike basis into new handsets (such as in the Netherlands, where repurposed handsets get sent to emerging markets) and up-cycling old IT equipment. Additionally, large electronic goods players such as Electrolux and LG are all repurposing materials from old goods into new products.

Many of these arguments also apply to the **auto industry**. Although the shift towards electric vehicles (EVs) is helpful from a secular perspective, do not forget that the costliest part of an EV is its battery. These comprise materials such as lithium, cobalt, manganese and nickel, all of which may have long and complicated supply chains. Against this background, there is a clear logic for auto businesses to develop and/or partner with those developing gigafactories. These are designed with recycling in mind from the start. When batteries reach the end of their lives, their ingredients can be recovered and put into new batteries. Renault and Stellantis (the name for the merged Fiat-Chrysler PSA group) have both said that they believe up to 85% of future vehicles could be recyclable, while BMW has gone a step further; its iVision electric vehicle is designed to be built from 100% recycled materials.

final industry worth One considering is the construction significant sector, а waste generator. Global demand for construction materials has grown alongside population economic development. and Manufacturing new materials consumes energy and resources,
while many existing materials end their life cycle in landfill. Circular economy solutions include the deconstruction of end-oflife buildings, more modular construction systems and buildings made from new resources such as timber. Trees store carbon, provide better insulation, can be recycled and avoid the use of concrete. Finland has been a pioneer in this respect. Over 15% of commercial buildings constructed in this country now comprise wood as a key material.

Concepts and commitments may be one thing and achieving workable circularity may sound simple, but in practice, it can prove dauntingly complex. It demands more than encouraging recycling, repair and reusing. Rather, it requires rigorous environmental and social costbenefit analysis. Trying to reach a 100% recyclability rate might prove counter-productive if the price of recovery remains higher than the value of the materials recycled. The circular economy may also suffer from a similar rebound effect to energy-efficient strategies. Just as more efficient coal plants can lead to lower coal prices and therefore higher demand for coal, more efficient use of materials could make some products cheaper and more appealing. While technical changes succeed in lowering the per-unit impact, overall the environmental benefit is largely offset by economic growth.

This opens up a broader debate over whether the aim of a more

circular economy is to promote well-being or GDP growth (or whether the two are even mutually exclusive). What makes sense environmentally may not always do so for individual companies or regions. Natural casualties would be purveyors of fossil fuels, minerals, agricultural produce and other primary materials. Do not also forget the (potentially valid) charge of 'greenwashing.' Many companies may be guilty of focusing on improving their brand image over fundamentals. Accenture estimates that over 90% of companies with net zero commitments will miss their targets.

If a case for optimism were to be made, then it is simply that the shift from a linear to a circular economy could occur as quickly as the shift from cart-horse transportation to the motor vehicle. This took less than 15 years, although it seemed entirely inconceivable at the time. Over this period, an entirely new infrastructure (paved roads, petrol refining, service stations, automotive supply chains etc.) was put in place. The same may occur this time around, especially when over 70% of consumers polled by

> Many companies may be guilty of focusing on improving their brand image over fundamentals

the National Retail Federation say that they would be willing to pay a premium for circular products.

From an investment perspective, there are multiple ways of getting exposure to the circular economy theme. Beyond the private sphere, the handful of quoted ETF products that offer access to this tend to provide an indication of just how diverse the opportunity within the listed space is. Businesses that fall under the circular umbrella could be any that can be seen to be embracing more circular principles, whether in the electronics, materials or FMCG sectors. Other candidates include pure-play waste businesses (for example, Waste Connections, Waste Management), direct recycling plays (such as Tomra) and those producing products from entirely sustainable materials (like SIG). The latter, listed in Switzerland and capitalised at CHF8bn is a leading global supplier of sustainable packaging solutions based around aseptic cartons. Dig deeper though and the scope of the circular economy opportunity becomes more visible. Almost every business within our universe - from Airbnb to Zebra Technologies is embracing circular principles. Our next sustainability report (due in April) will address this topic in even more detail.

19 February 2023





### HEPTAGON FUTURE TRENDS INDEX

Date	Thematic Papers Published		
2011	Data The data deluge	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	<b>3D-Printing</b> 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	<b>Digital Currencies</b> At the tipping point?	Car of the Future The long road to autopia	Peer-to-Peer Lending The P2P revolution
2016	Get sharing!	Artifical 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	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	<b>5G</b> 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 Crids Keep the lights on: make the grid smarter
2023	Circular Economy In the round	Artificial Intelligence Your questions on Al (answered by a human)	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

We have published 68 dedicated pieces on future trends since **2011,** covering 50 unique themes (several have seen subsequent update notes, owing to their importance growing and evolving dynamics). Below follows the complete list, sorted

chronologically. Every piece since inception is accessible via Heptagon Capital's website.



Coleridge Data Deluge

The curse of



Drowning in data

Water Shortages



Get ready for nanotechnology



**Food Innovation** You are what you eat



Energy Storage What if the sun always shone?



Cybersecurity The next generation

The man-machine merger

Implantable

Technologies



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



The more things change...

The coming age of personalised medicine

**Future Housing** 

future may look...

How the house of the





Fracking



Quantum A leap forward Space To infinity and beyond?



Synthetic Biology

Food for thought?



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

# HEPTAGON FUTURE TRENDS BLOG

The *Future Trends Blog* was launched at the start of 2019. Since then, we have published well over 250 posts including more than 40 so far in 2024. 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 <u>Heptagon Capital's website</u> and also via <u>LinkedIn</u>.

The Blog represents a natural complement to this process and provides a platform for sharing some of the original thinking we are doing with a broader audience. We were pleased to see that the Blog received a 'highly commended' award as runner-up for the Best Blog at the Investment Week Investment Marketing and Innovation Awards 2023.

For the second consecutive year, the topic of AI featured in more 2024 Blog posts than any other although alternative energy, automation and food innovation all received extensive coverage too. Our most read Blog posts was #12 ("California Dreaming") which detailed your author's March trip to Silicon Valley to witness AI hype and more. Post #20 was, however, your author's favourite. Titled "James Bond, for a morning" it details dressing up in a hazmat suit in rural Germany to visit a clean room with some very unique machinery integral to the semiconductor ecosystem. Below follows a complete index of the pieces we have posted to the Blog so far this year.

### Season 6

- #1: The future starts here (4 January)
- #2: What we're going to be eating in 2024 (10 January)
- #3: Hot topics in healthcare (18 January)
- #4: The great housing experiment (25 January)
- #5: exciting.times.ahead (30 January)
- #6: How to save the world "suits and boots" (8 February)
- #7: Red-hot innovation (13 February)
- #8: The transition mission (21 February)
- #9: At the Alrport (28 February)
- #10: Frustrated with logistics? Call an expert. (7 March)
- #11: "The job is far from done" (12 March)
- #12: California Dreaming: Notes from the Valley (19 March)
- #13: Winds of change in Spain (26 March)
- #14: My type of fish (4 April)

- #15: AI and Its Discontents (9 April)
- #16: From golf course to warehouse (16 April)
- #17: "There's never been a better time to be a builder" (25 April)
- #18: The rise of the vertical farm (2 May)
- #19: Sunny times (sort of) (14 May)
- #20: James Bond, for a morning (22 May)
- #21: Coffee with the CTO, 2024 edition (29 May)
- #22: Live from London Tech Week (11 June)
- #23: Restaurants of the future (20 June)
- #24: Make Euros while the sun shines (26 June)
- #25: Money on the move (3 July)
- #26: New governments, more data centres (9 July)
- #27: "Human-like decisions, but better" (17 July)
- #28: We do need some education (24 July)
- #29: Going for gold, sustainably (30 July)
- #30: Hot times (7 August)
- #31: Silly season, serious spending (13 August)
- #32: Postcard from America (21 August)
- #33: The lunchtime robot revolution (27 August)
- #34: On coughs, chocolate and compost (5 September)
- #35: "Water, water everywhere..." (10 September)
- #36: Wonder drug, or, just too good to be true? (19 September)
- #37: Two ends of the data spectrum (24 September)
- #38: Sightseeing with salmon (3 October)
- #39: Hanging out with the cyber experts (8 October)
- #40: "Embrace change" (15 October)
- #41: Watt about the hot rocks? (23 October)
- #42 Airports (and water), seen in a whole new light (30 October)

View Heptagon Future Trends on Linked in

#### **GET THE UPDATES**

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

GET THE UPDATES



## THE HEPTAGON FUTURE TRENDS EQUITY FUND

It is our contention that investing in some of the businesses most exposed to the trends discussed in our notes can be a potentially lucrative strategy. Against this background, **the Heptagon Future Trends Equity Fund was launched in January 2016** and is led by Portfolio Manager Alexander Gunz.

The Fund is managed in-house at Heptagon Capital, a London-based boutique investment firm, founded in 2005 with 47 employees and over \$14bn AUM across various strategies. Alex also manages the Heptagon Future Trends Equity Hedged Fund which launched in March 2018 and is a hedged version of the Fund using index futures.

- Fund launch: January 2016
- Fund AUM: \$115m
- Strategy AUM: \$121m

**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 <20% 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 Responsible
- MSCI ESG Fund Rating: AA (more info here)
- Sustainable Investment Low Carbon/Fossil Fuel Free
- The Big Exchange (UK) Silver Medal Award

All data as of 31 October 2024. **Past performance is no guide to future performance and 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 IEO0BYWKMJ85.

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### 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.

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