HEPTAGON
Capital

FUTURE TRENDS

Volume 9

Key themes for 2023 and beyond

ALEX GUNZ
Fund Manager

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

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

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

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

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Executive Summary

Welcome to the ninth edition of our Future Trends compendium. We have been writing about and investing in future trends since 2011. We believe that the themes we continue to investigate – many of which are discussed in more detail later in this document – 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. **The Heptagon Future Trends Equity Fund**, which enables investors to gain exposure to our best thematic ideas, was launched in January 2016 and so will soon celebrate its seventh anniversary as a UCITS Fund.

Since 2011, we have now published almost 60 dedicated pieces of thematic work (a full list is provided on page 68), covering everything from artificial intelligence to water shortages via robots and novel payment systems. Our first piece, "The Data Deluge", remains as relevant now as it did in March 2011. In brief, the amount of data that is produced and consumed is growing exponentially, but for these data to have any value, they need to be secured, analysed and stored effectively, creating a range of potential investment opportunities. Data should be considered as the effective enabler for almost all industries, and arguably the force with most disruptive potential.

Over the past year we published four new detailed thematic pieces, all of which are reproduced in detail in this report. For each of these pieces we also have produced a 10-minute video interview which provides a brief overview. A QR code at the beginning of each note will take you straight there. Topics covered in 2022 comprised the case for digitising the water sector, the role that decentralised finance may play in the future economy, why electrical grids need to get smarter and how drones could revolutionise the transportation of both goods and people.

Beyond our core thematic work, our quest to better understand the future (and then invest in it) remains ongoing. The easing of travel restrictions meant that many real-world activities were able to resume, a welcome return to relative normality after almost two years of pandemic-inspired restrictions. We undertook our first road trip to the US since March 2020 in May, visiting 23 companies across 6 states. We also conducted face-to-face meetings with management teams in countries including Denmark, Switzerland and the UK. Needless to say, Zoom still played a role in our dialogue with businesses. In total, we have undertaken around 100 corporate interactions in the past 12 months. Beyond this activity, your author also attended several interesting conferences, of which Wind Europe in Bilbao and Intersolar in Munich were particular highlights.

Much of our activity is captured in the Future Trends Blog. All our Blog posts can be found on the Heptagon website and are accessible via LinkedIn and Twitter too. A summary of everything we have written about year-to-date in our Blog appears at the end of this document (see page 70).

Throughout all the work we have done, we continue to observe that **the pace and reach of technological development is increasing**. Although we have argued consistently that *technology is a means to an end* (rather than an end in itself), it is transformative. **Expect more disruption**. Time and again, new technologies improve capabilities and decrease costs. Think of them not as replacements for old applications, rather as a mechanism for expanding market size. Innovation is all about creating new demand.

However, **progress has consequences**, both intended and unintended. Technologies can help transform human capabilities and experience, but also create new tensions and disruptions for all involved. Further, global competition for the core elements required for technological supremacy looks set only to increase. This broad topic forms the subject of this year's annual bigger picture introductory essay, which can be found on page 8.

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 12-23). **Digitalisation, decarbonisation and decentralisation** are driving almost every development currently. Our most recent theme pieces spanning our works from the past two years then follow in their complete and unabridged form (pages 26-65), with links to related video recordings where relevant. All our pieces – both those reprinted in this volume and the others for which there was not space – are on Heptagon Capital's website, as is more information about the Heptagon Future Trends Equity Fund (see also page 72).

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.

Alex Gunz
Fund Manager, Heptagon Capital
November 2022

Photos by author

Part One: In Brief

The Bigger Picture: The Seemingly Unstoppable Rise Of Techno-Politics

If the big news for the past two years was the pandemic, then without doubt the main story of 2022 has been Russia's invasion of Ukraine. For context, this warfare marked the first such attack on another European nation since 1945, not to mention the largest humanitarian crisis in the region since then too. The event, however, should be considered more of a 'grey' than a black swan scenario since it constituted confirmation of something many already knew and feared: **the decline of a liberal world order**.

The world is evolving to one which is distinctly multipolar. It is a world which de facto opposes American hegemony and seeks to challenge the US-led Western liberal world order established after the Second World War. It also seeks to reverse perceived historical injustices. We believe that **there is no turning back from this change** in the near-term. Think of it as a Rubicon having been crossed. This is an expression we have used in our publications since 2020 (and more recently this year). It relates not just to the military crossing of the Rubicon River by Julius Caesar in 49BC but also expresses the idea of *passing a point of no return*.

Think of the above, crucially, as a *process* and not as an event. Expect to see an emerging and ongoing hybrid conflict fought between an incumbent and rising new world order across multiple fronts. These could be economic, media, space, data or cyber-related, to name but a few examples. When seen through this lens, it is necessary to view **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."

Have no doubt, **the digital sphere will be a crucial future battleground**. Over 20% of global GDP is comprised by the digital economy and with global data doubling every two to three years, the technology market should continue to outgrow world GDP by around four percentage points annually (figures from Accenture, IDC and IBM respectively). Data, then, might be considered *as the currency of the*

online world: an asset that can be gathered, analysed, sold and even sometimes stolen. It might also be fair to consider data *the new oil*, or a resource that is valuable and scarce in its own right. Countries may even go to war over data, or the tools that support it. We first wrote over a decade ago that **data have no value unless secured, stored and analysed**.

The United States has long held a leadership position within the digital economy, enabled through its investments in research, innovation and development as well as in establishing the norms of the digital sphere such as the TCP-IP protocol that powers the Internet. The world's largest tech companies are predominantly American. For context, the spend on research and development by country's five largest tech businesses (Amazon, Apple, Google, Meta and Microsoft) totalled $149bn, or 0.2% of global GDP in 2021.

However, this is now changing. We believe **the next decades will see increasing global competition for the core elements of technological supremacy**, including foundational tools such as talent, knowledge and markets. Critically, in many areas, *new norms are still in an early stage of development*. This could set the stage for future conflict. Areas of importance would include the ethics of artificial intelligence and biotechnology as well as topics including resource extraction and Arctic/Antarctic access.

Some readers may be familiar with the notion of the 'Sputnik moment'. For those who are not, it pertains to early success of Russia's space programme that created a drive in the US to support scientific efforts that eventually led to the moon landing. It is worth contemplating whether China's progress in areas such as Artificial Intelligence (AI) could be considered as the 21st century's Sputnik moment. Will the US seize the initiative and pull ahead, or potentially cede control to China, with significant global implications?

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). More generally, 6 of the 10 biggest recipients of patents globally in 2021 were Chinese (per IFI Claims). With its 1.4bn population, China has the potential to develop a significantly deeper pool of data from which to build AI models. America's population is less than a quarter of this size. A 'digital silk road' would constitute a clear rival to the long domination that the US has enjoyed in tech hardware and software.

Richard Moore, the head of the UK's Secret Intelligence Service, has said that adapting to the rise of China is now the "single greatest priority" of MI6. The FBI has gone further. Christopher Wray, its head, asserts that "the Chinese government is set on stealing your technology - whatever it is that makes your industry tick - and using it to undercut your business and dominate your market."

The politics of technology, however, extend much further than statements such as these. Do not forget that semiconductor chips (and by implication AI) are playing an increasingly crucial role in military warfare. Russia's invasion of Ukraine highlighted how the rules of engagement have changed. At a simplistic level, **all future wars will be conducted by land, air, sea – and cyber**. The last battlefield is, of course, the most opaque.

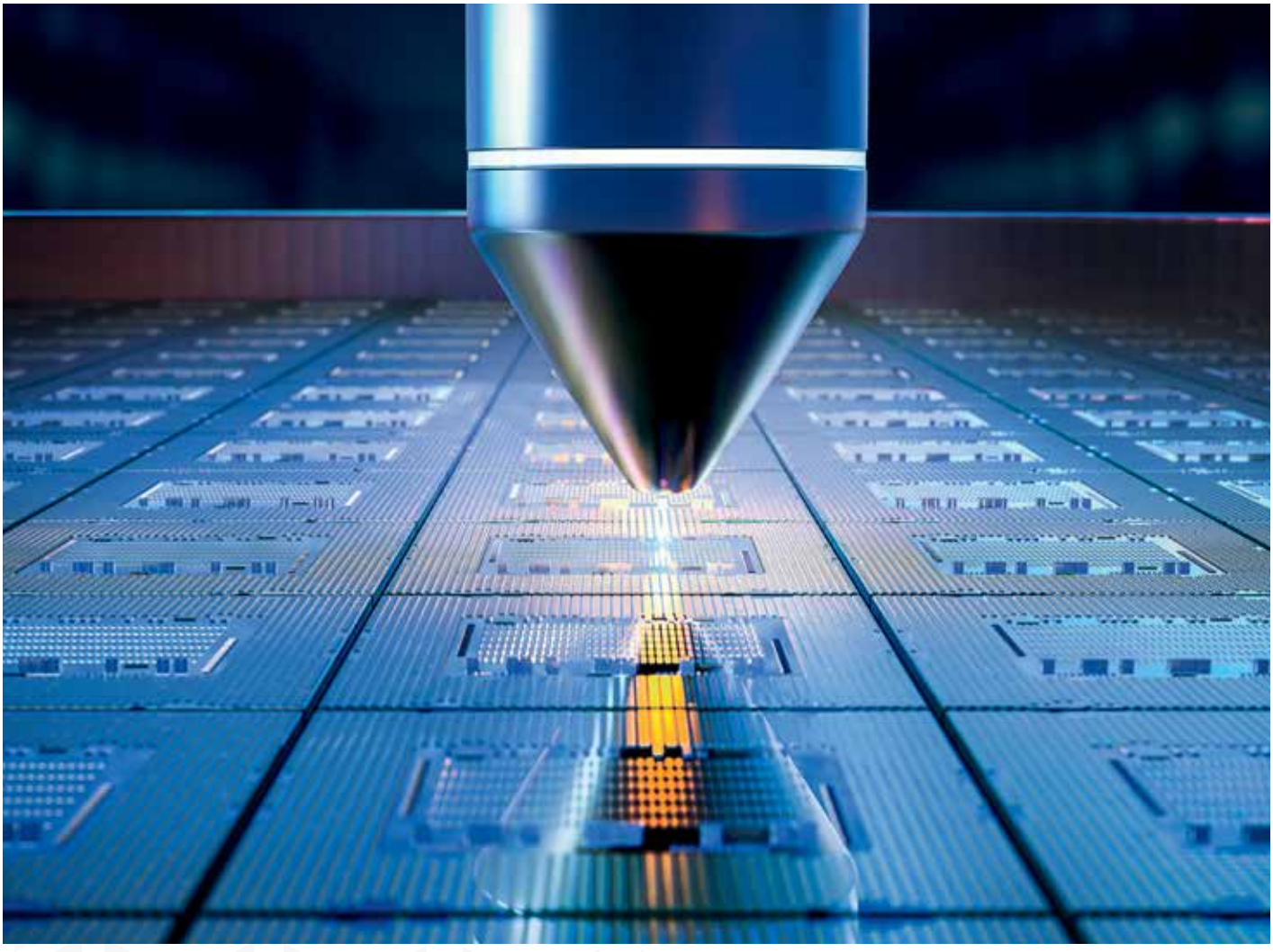
Governments are making their intentions increasingly clear. Consider that the America Competes Act (and within it, the Chips and Science Act) provides $280bn of total funding of which $52bn was allocated to encourage more semiconductor production in the US and $45bn was disbursed as grants and loans to improve supply chain resilience and manufacturing. The EU announced a similar, smaller plan and has said it intends to reach a 20% share of global semiconductor production by 2030, double current levels. It was also hard to ignore Nancy Pelosi's recent visit to Taiwan (home of the world's largest outsourced semiconductor production company, TSMC). China made no secret of its displeasure. In a further, more recent ratcheting up of tension, President Biden announced plans impose strict export controls on various integral semiconductor components sold to China.

So, what may the future hold? There is a clear danger that **in the absence of consensus, the world of technology could splinter**. In this scenario, digital protectionism would be widespread. Some might argue that we are already there, or at least well along the way. China has employed a 'Great Firewall' controlling which information its citizens can access for some time. Russia effectively does the same.

In periods of conflict there is also a natural tendency to turn to the idea of autarky, or the desire to become self-sufficient in certain key sectors of the economy. This world view embraces not only food and energy but encompasses the digital economy (data localisation, digital platforms, rare earth materials and more).

The most likely outcome, then, could be a likely fissuring of tech standards: one for China and its partners and another for everyone else. At the same time, there also appears to be a recognition that ***if* democratic countries cannot agree on common rules in the digital realm, China *could* end up setting the rules for large swathes of the world**.

Despite such a disconcerting backdrop, it is also important not to forget that ***shared* global challenges such as climate change and disease remain to be solved**. Optimists (or at least those polled in the western world by Wunderman Thompson) see technology as a *force for good*: 89% believe technology can make the world a better place and 78% agree it can help create a more equitable society. Let's not forget that significant progress has been made in the last two centuries. During this time, globally, both extreme poverty and child mortality have fallen by around 90%, basic education levels have risen by a factor of five and crop yields fourfold (per Our World in Data). Also, do not forget Kurzweil's Law of Accelerating Returns: **technology advances exponentially, not impacted at all by wars, economic recessions or depressions**. We concur and sincerely hope the future continues to play out along these lines.



Theme Summary: Our Most Recent Pieces

	Theme, title and date	For more, go to page	Potential beneficiaries (non-exclusive list)*
	**Drones:** Now Ready For Take-Off? (October 2022)	26	• Pure-plays: Joby Aviation, Lilium • Small caps: Parrot, Drone Delivery Canada, Drone Shield • Digitial ecosystem beneficiaries: ASML, Equinix • Defence names: Lockheed Martin, Raytheon etc
	**Keep The Lights On:** Make The Grid Smarter (September 2022)	32	• Energy solutions: Alfen, EVgo, Landis&Gyr • Integrated players: ABB, GE, IBM, Schneider, Siemens • Indirect plays: Quanta Services, MasTec, Itron • Smart water: Xylem
	**Decentralised Finance:** Demystifying Defi (May 2022)	36	• Privately ownned platforms: Ethereum • DeFi infrastructure: Block • Mega-cap tech: Meta, Twitter • Digitial ecosystem beneficiaries: ASML, Equinix
	**Liquid Data:** Digitalising The Water Sector (February 2022)	40	• Pure-plays: Mueller Water, Pentair, Tetra Tech, Xylem • Niche plays: Kurita Water, Evoqua Water • Indirect exposure: IDEXX, Thermo Fisher
	**Food's Future:** How To Feed The World More Intelligently (October 2021)	44	• Food innovators: Kerry Group, Chr. Hansen, Symrise • Early FMCG movers: Nestlé, Unilever • Listed pure plays: Beyond Meat • Private businesses: Impossible Foods, Meatless Farm
	**Metaverse:** Welcome To The Metaverse (September 2021)	48	• Listed plays: Roblox, Unity Software • Indirect plays: Microsoft (Minecraft) • Private businesses: Epic Games (Fortnite) • Mega-cap tech: Apple, Meta Platforms, Netflix, NVIDIA
	**Pet Economy:** Digitalising Dogs; The Long-Tail Opportunity (June 2021)	52	• Diagnostics: IDEXX, Heska • Healthcare: Zoetis, Elanco, Dechra • Online: Chewy, Zooplus • Distribution: Covetrus (private)
	**Micromobility:** Disrupt The Car, And Rethink The City (April 2021)	56	• Indirect plays: Uber (Jump/ Lime), Lyft • US private businesses Bird, Spin • European private businesses: Voi, Tier • Chinese plays: Didi Chuxing, Mobike, Hello Bike, Ofa
	**Telemedicine:** The Virtual Doctor Calls (February 2021)	62	• US listed: Teladoc, Amwell • Chinese listed: Ping-An Good Doctor, Ali Health • Private businesses: Doctor on Demand, Live Health • Data/ software providers: IBM, Microsoft

*Heptagon Capital may or may not be invested in any or all of these businesses at any given time across their different products. The businesses mentioned on this page also reflect our current thinking on each theme and may not be consistent with the businesses cited in each original document at time of publication. Please be aware that this document is provided for information purposes only and does not constitute investment advice or any recommendation to buy, sell or otherwise transact in any investments. Past performance is no guide to future performance and the value of investments and income from them can fall as well as rise.

How We See The World Changing

We're all thinking about the future differently given the current environment. However, our contention has always been that the trends on which we focus will play out over a multi-year if not multi-decade horizon. Of course, some will assume greater priority in the near-term than others. Where we have focused and what we have written on most in 2022 is a partial reflection of this dynamic. As in previous volumes, we present below a summary of how and where we see the world changing most rapidly. Please note, this review is non-exhaustive; think of it rather as a series of interlinked high-level perspectives. Our stance remains that as diverse future trends overlap and intersect, they become mutually reinforcing.

Top of mind for every reader, investor and policymaker this year has been the question of **how do we save the planet?** As Antonio Guterres, the Secretary General of the United Nations, notes, **"we have a choice: collective action or collective suicide."** Although this is a somewhat emotive statement, it highlights the stark nature of the challenge. The World Economic Forum asserts in its latest outlook report that the three largest risks facing the planet comprise climate action failure, extreme weather and biodiversity loss.

The invasion of Ukraine by Russia (also discussed in our theme essay in the previous section) has shown how one nation might be prepared to use energy as a political or economic weapon. Put another way, climate and security priorities have merged. Jack Fusco, the Chief Executive of Cheniere Energy, highlights appropriately that "criticality of energy security has never been more evident to governments."

Extreme weather conditions across both Europe and other parts of the world over 2022 have further heightened the criticality of robust energy infrastructure. **Every nation, in our view, is now seeking to accelerate its path to greater energy (and food) independence wherever possible**. As we will see below, progress is being made, although there is much still to be done.





Alternative Energy

- **Relevant Season 4 Blogs:** Tailwinds, Headwinds too (7 April); Sunshine in Munich (12 May); What, no global warming? (19 July); Robo-taxis and the two key EV debates (31 August); Looking outwards (22 September)
- **Relevant Theme Pieces:** A 'natural' solution to the world's energy needs (April 2011); What if the sun always shone? The coming energy storage revolution (September 2015); Winds of change (March 2018); Everybody loves the sunshine (January 2020); The missing element (June 2020)
- **Key Statistic:** 90% of the global economy is now covered by national net-zero emissions targets

"We have only touched the beginning of the energy transition."

Henrik Andersen, Chief Executive of Vestas

The good news is that **90% of the global economy is now covered by national net-zero emissions targets**, up from 68% at the end of 2020 (per the United Nations). The past year has been a record-breaking one for renewables globally. Solar additions of 180GW meant that more solar was added in 2021 than the combined level of coal and gas additions this century. Meanwhile, offshore wind energy installations doubled compared to 2020 while storage solution capacity tripled (all data per Future Crunch).

As far as 2022 is concerned, **Vladimir Putin has arguably done more to accelerate the clean energy transition than anyone in history**. 19 European Governments have fast-tracked their decarbonisation plans since the invasion of Ukraine. Under the latest set of national commitments, **EU countries are now aiming for 63% of renewables in electricity generation by 2030**, up from 55% under previous commitments. The EU's current plan is for wind power installations to grow by a factor of 2.5 between now and 2030.

On the other side of the Atlantic, the recently passed Inflation Reduction Act is also hugely significant. The deal provides just under $400bn of funding for energy and climate change, the biggest ever federal investment in clean energy. The Act embeds within it the intention that **US emissions will be cut by 40% by 2030** (from a 2005 base). At the end of this decade, renewable solutions could account for 38% of America's energy mix.

The intentionality on the part of nations is evident from the numbers. **Global clean energy investment reached a record level of $750bn in 2021 and is on track to cross the $1tr threshold this year** (per Bloomberg New Energy Finance, or BNEF). When

taken together, wind and solar are already the fourth largest source of electricity globally, behind coal, gas and hydro. Impressively, wind turbines in the US now produce more power than the entire country used in 1950.

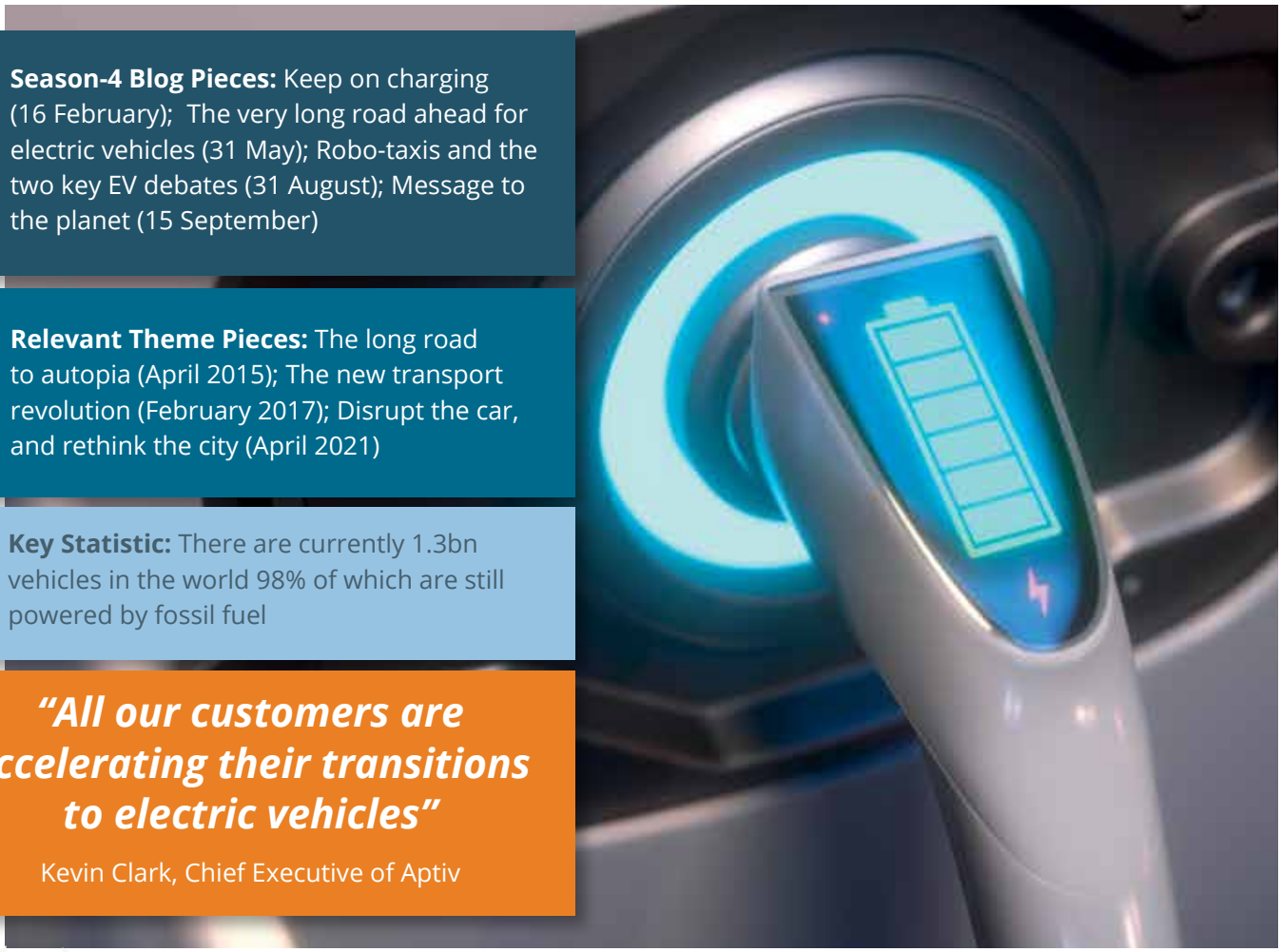
However, despite such progress, Henrik Andersen, Chief Executive of Vestas (the world's largest manufacturer of wind turbines) is almost certainly right when he says that **"we have only touched the beginning of the energy transition."** There is a *major difference* between passing legislation and getting infrastructure practically deployed, particularly in the context of raw material and workforce challenges. Consider, for example, that the EU's permitting backlog is four times the size of the number of renewable projects currently under construction (per Wind Europe). It typically takes up to five years from an order for a wind turbine being placed to it being fully operational and connected to the grid. Some forecasters also note that **annual clean energy investment worldwide would need to triple to $4tr by 2030** to meet the widely held commitment of net-zero carbon emissions by 2050 (per the International Energy Agency, or IEA).

Transportation

- **Season-4 Blog Pieces:** Keep on charging (16 February); The very long road ahead for electric vehicles (31 May); Robo-taxis and the two key EV debates (31 August); Message to the planet (15 September)
- **Relevant Theme Pieces:** The long road to autopia (April 2015); The new transport revolution (February 2017); Disrupt the car, and rethink the city (April 2021)
- **Key Statistic:** There are currently 1.3bn vehicles in the world 98% of which are still powered by fossil fuel

"All our customers are accelerating their transitions to electric vehicles"

Kevin Clark, Chief Executive of Aptiv



Given the level of energy investment highlighted above, the **logic for collective action is high**. Consider that G20 nations account for c80% of global greenhouse gas emissions with transport being the leading source responsible (per BNEF). One trans-Atlantic return air ticket, for example, carries the same atmospheric burden as two years of a meat-based diet, eight years without recycling or four lifetimes' worth of plastic bags (per Our World in Data). While flying is a potentially avoidable luxury for many, **electric vehicles do help to displace roughly 1.5m barrels of oil per day** (2021 data, per BNEF).

More efficient transport solutions therefore matter. The last twelve months has, fortuitously, been a period in which the **world's carmakers seem finally to have accepted the inevitability of an all-electric future**. General Motors said it would eliminate the sale of all fossil fuel powered cars and SUVs by 2035, Jaguar said it would stop selling them within the next five years and Hyundai has committed to no more by 2040. Ford has gone on the record as saying it would sell only electric vehicles (EVs) in Europe from 2030. Fiat said it would be an all-electric company by 2030 and Volvo said its entire car line-up would be fully electric by the same year. Neither Audi nor Daimler is developing combustion engines any longer.

Global EV sales have grown at a 56% CAGR in the last decade. In order to meet the stated targets of all countries to phase out sales of combustion engines, the IEA estimates that worldwide EV sales would need to increase to 25m by 2030, equivalent to a 15% market share. For context, this number of vehicles would be double 2020 levels and compares to just 130,000 EVs sold a decade ago. Some 50 EV models currently exist, but based on statements from automakers, this number could reach 60 by the end

of this year and over 250 by 2030. **"All our customers are accelerating their transitions to electric vehicles"** notes Kevin Clark, the Chief Executive of Aptiv, a leading systems integrator. BNEF estimates that by 2040, EVs could be *outselling* petrol-powered vehicles.

As with any other future trend, the development of the EV industry will not be without its challenges. Consider that there are currently 1.3bn vehicles in the world and 98% of these are powered by fossil fuel (per McKinsey). This implies that **the green transition is non-trivial and will take time**. Growing material costs and shortages of critical inputs such as lithium, cobalt and nickel will likely constrain availability. There is also the issue of customer buy-in: only 36% of Americans says that they would consider buying an EV given concerns about charging logistics, driving range and cost (per Axios). This may, however, change given that the Inflation Reduction Act provides a $7,500 clean vehicle tax credit. Europeans are also more positive.

To return briefly to **other collective action to save the world**, consider that **over 100bn tonnes of raw materials are consumed globally each year, but just 8.6% of this total is currently recycled** (per 13D Research). This implies both a logic for, and opportunity in, growing circular economy solutions. Whereas Europe recycles just 32% of its plastic annually, the comparable figure for the US is less than 10% (per the European Environment Agency). More worryingly, 11m tones of plastic enter the ocean every year. *Without radical change*, the amount of plastic waste generated worldwide could double by 2040 (per Pew Research).

Food Innovation

- **Season-4 Blog Pieces:** Food's fancinating future (13 January); Feed the world better (30 March); Metaverse meals and more (19 April); Food Forever (8 September)
- **Relevant Theme Pieces:** You are what you eat: health, wellness and food innovation (October 2014); We're all hungry for some agtech (February 2019); Beyond impossible (August 2019); Food's future; how to feed the world more intelligently (October 2021)
- **Key Statistic:** Oceans cover c80% of the planet's surface but provide us with only 2% of our total food

> ***"If you don't feed people, you feed conflict."***
>
> Secratary General of the United Nations, Antonio Guterres

Saving the planet also means feeding the planet. Data from the United Nations (UN) paint a concerning picture. Between 720m and 810m people faced hunger in 2020, up 18% year-on-year. Given recent conflicts around the world, this figure is almost certainly higher now. A further 2.3bn globally lack adequate access to food. As its Secretary General, Antonio Guterres, notes, **"if you don't feed people, you feed conflict."**

The UN estimates that crop production would need to increase 60% by 2050 to feed an estimated 9.3bn people, while water reserves may only be able to meet 60% of global water demand by 2030. Note that the human diet is highly dependent on just four grains: rice, wheat, corn and soy. These comprise almost half of the calories of an average global diet. Further, almost two-thirds of the production of these crops is derived from seven countries: China, the US, India, Brazil, Argentina, Russia and Ukraine (per McKinsey). All of these are experiencing at least one of the following: war-related disruptions, extreme weather conditions or export controls. The risk of a full-blown food crisis is therefore high.

Against this background, **there is a high logic for thinking about alternative food solutions**, particularly given that around a third of all food produced is wasted (per the World Health Organisation). Diversification makes sense. Consider that oceans cover c80% of the planet's surface but provide us with only 2% of our total food. The amount of feed required to generate a kilo of salmon protein, for example, is significantly lower than for any other commonly farmed land animal. Given the health benefits of salmon, "we have a lot to thank it for" says Ivan Vindheim, the Chief Executive of MOWI, a major producer. The fish could become "the food icon of the 21st Century."

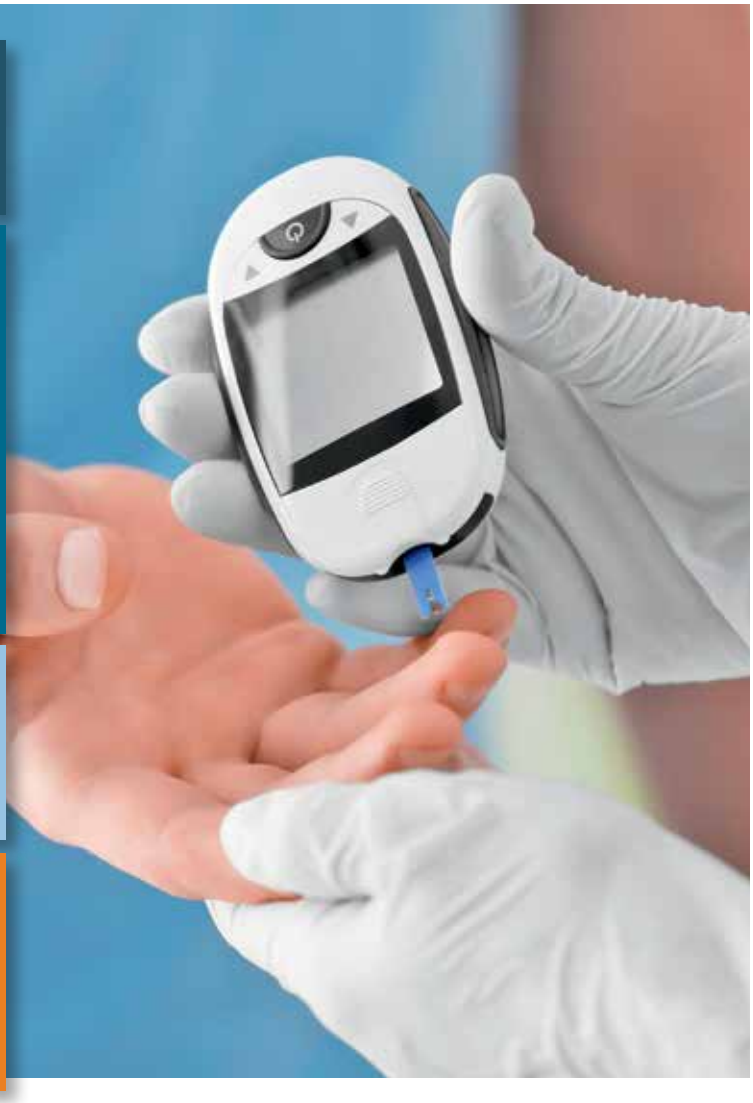
Go one step further: Impossible Foods, a producer of alternative protein products, says that its environmental footprint is far less than similar animal-based products. Its plant-based chicken nuggets, for example, have 25% less salt that regular chicken equivalents and use 55% less water, 24% less land and 24% fewer greenhouse gas emissions to produce. Globally, the plant-based foods market reached $29.4bn in 2020 but could rise to $162bn by 2030 (per Bloomberg). It's also encouraging to hear the two-thirds of consumers worldwide say that they are willing to pay more for sustainable brands, while 43% state they would be happy to replace meat-based proteins with plant-based alternatives (per Nielsen).

Health

- **Season-4 Blog Pieces:** Bending the diabetes curve (15 March); The $100 genome (14 July); Looking outwards (22 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); Implantable technologies: The man-machine merger (September 2016); Time for a DNA upgrade? (June 2017); Gut feeling (June 2018); Who wants to live forever? (October 2019); Telemedicine: the virtual doctor calls (February 2021)
- **Key Statistic:** In the UK 28% of adults were classified as obese in 2019, double the level reported in 1993. Obesity is now a bigger cause of death than smoking

"There are significant unmet needs for treating people with diabetes."

Lars Jorgensen, CEO of Novo Nordisk



How much and what we eat also has a significant impact on our health. It might be great that six in ten global consumers say they are currently looking to purchase food and drink products that help raise their immune systems (per Innova), but the bigger problem is that more than **650m people live with obesity, but few than 10% seek help** (per Novo Nordisk, a major insulin producer).

Worldwide obesity rates have tripled since 1975 (per the OECD). Take the UK where 28% of adults were classified as obese in 2019, double the level reported in 1993. The NHS (the source of the data) says that obesity is now a bigger cause of death than smoking. Data from the US is similarly depressing. Around half of Americans are expected to be obese by 2030, with 18% of all US healthcare spend allocated to treating this and other comorbidities such as heart disease, stroke and osteoarthritis (per Harvard University).

At the same time, some 537m people globally have diabetes, yet only 40% of these are treated and 50% are not even diagnosed. By 2045, 784m adults are expected to live with diabetes, an increase from one-in-ten to one-in-eight. Against this background, no surprise that the CEO of Novo Nordisk, Lars Jorgensen – the data source – says **"there are significant unmet needs for treating people with diabetes."**

Diabetes and obesity, of course, are not the only healthcare challenges the world faces. Harvard University observes that Alzheimer's is currently *the*

most *expensive* illness to treat in the US. Declines in genome sequencing costs (from $3bn in 2003 to less than $500 currently) provide a cause for optimism. **Although scientists know the molecular cause of nearly 4,000 different diseases, they currently have treatments for just 250** (per 13D Research). We were also impressed to note that 2022 marked the first time a case of xenotransplantation successfully occurred with a patient receiving a genetically modified pig's heart.

The Power Of Technology

- **Season-4 Blog Pieces:** Virtual coffee with Head of IT (19 January); Where did those five hours go? (26 January); Live from Big Data and AI World (3 March); The boiled frog (16 March); Data download in Docklands (28 April); Quantifying quantum (21 June); The ethics of AI (7 July); A day in Silicon Fen (27 August); Mission to the dataverse (27 September); How cool is your data centre? (4 October)
- **Relevant Theme Pieces:** The data deluge (March 2011); Drowning in data (October 2012); Watch out! The growing privacy invasion and cybercrime threat (April 2014); Connecting the unconnected (July 2014); The rise of the smart machine (April 2016); The next generation (September 2017); A leap forward (October 2017); Ten years on; the data deluge 2.0 (October 2020)
- **Key Statistic:** People spend 4.8 hours a day on their mobile phones 31%, say they feel anxiety or withdrawal without them

"AI is the only way to process large amounts of data."
Arvind Krishna, CEO of IBM

Beyond trying to save the planet, we would all like the world to be *a better place*. We have consistently argued for over a decade that **technology is an enabler; a means to an end for solving the world's biggest problems**. Consider that a combination of processing power, cheap data storage and improved machine learning solutions is driving every industry. By way of example, optimal wind turbine speeds are partially determined by computer programmes and large datasets; salmon harvesting can be improved through tagging fish and analysing their weight and health versus historical precedent; drug discovery everywhere is accelerating. The list could go on.

Against this background, readers should not be surprised to learn that **22.5% of global GDP is made up by the digital economy**. With global data doubling roughly every two to three years, the technology market is currently outgrowing global GDP by four to five percentage points annually (figures from Accenture, KKR and IBM respectively).

At a consumer level, people spend 4.8 hours a day on their mobile phones (per App Annie), up 30% from 2019 levels. Interestingly, the Illinois Institute of Technology found in a poll that 56% of people say they are somewhat dependent on their smartphones while 31% say they feel anxiety or withdrawal without them. Do not forget, however, that **smartphone penetration globally is just 50%** while some 390m people are still not even covered by 2G cellular networks (per the International Telecoms Union). Look ahead though and given the rate of development – albeit still at a faster pace in developed rather than

developing countries – and the number of connected devices could, according to IDC, grow from 40bn (equivalent to roughly 5 per person) to 350bn (over 40 per person) by 2030.

The implications from this forecast are twofold. At a simple level, **more devices mean more semiconductor chips**. To elaborate on the point made in our introductory essay, one of the best indications of *data as the world's most mercurial commodity* comes in the form of TSMC's announcement to spend $36bn building new semiconductor fabrication plants this year. For context, it spent $30bn last year and 'just' $17bn in 2020. Peter Wennink, ASML's Chief Executive talks about "unprecedented customer demand [for semis]" enduring "well into next year." Next, as we have said repeatedly, **data have no value unless secured, stored and analysed**.

Begin with cybersecurity. The global cost of cybercrime reached $945bn in 2020, double 2014 levels (per McAfee). It is almost certainly higher now and *too big to ignore*. IBM notes that the average cost of a data breach to an organisation is $4.2m while Mastercard talks of how 71% of its merchants cite identity fraud as a 'top concern.' Losses in this area alone totalled $56bn last year. No surprise then that 85% of respondents to Equinix's 2022 Global Tech Trends survey say improving cybersecurity is a key priority. It will, according to Arvind Krishna, IBM's CEO be "the issue of the decade."

Turn now to storage and the data are impressive. Hyperscale cloud spend is growing at ~$50bn per quarter, with the two largest cloud service providers – AWS and Azure – both generating revenue growth at an annualised run-rate approaching $100bn (per Bloomberg). The Equinix survey cited above showed that 70% of respondents believe migrating to the cloud is a top priority, while 80% are currently focused on (further) digitalising their IT infrastructure.

When it comes to analysis in general and artificial intelligence (AI) in particular, some 33% of businesses now say that they are using forms of AI in their daily activities. **AI is "the only way" to process large amounts of data** according to Arvind Krishna, while Google's CEO, Sundar Pichai, says that **AI will be "helpful to people and businesses everywhere."** By 2030, AI *could* add over a percentage point to global GDP growth, per McKinsey. Look further ahead, and quantum computing could accelerate everything we have discussed above at *an even faster pace*.

Addendum: Hype Watch

- **Season-4 Blog Pieces:** Where's the hype? (13 April); Metaverse meals and more (19 April); Mission to the dataverse (27 September)
- **Relevant Theme Pieces:** Time to get real? (June 2016); Welcome to the metaverse (September 2021)
- **Key Statistic:** The metaverse could be worth $5tr by 2030

"You can think about the metaverse as an embodied internet, where instead of just viewing content – you are in it."

Mark Zuckerberg, CEO of Meta Platforms (formerly Facebook)

Every trend we have discussed above is *real and tangible*. Had space permitted, we would have sought to discuss other relevant topics. Consider, just briefly and by way of example, water scarcity. A quarter of the world's population now live in areas characterised as having water stress (per the United Nations). In order to improve water infrastructure, the World Water Development Report estimates that over $6tr of cumulative investment would be required by the end of this decade, a figure which rises to more than $22tr by 2030. The logic for investment is high, since every Dollar allocated can generate at least a $4 return, primarily due to reduced healthcare costs and increased productivity.

Beyond a crucial area such as water, some readers may have been surprised by the relative lack of commentary in this piece about either online retail or digital payments. Both these important thematic areas became super-charged during the pandemic era. We are confident that looking forward, people will shop and transact financially more online, particularly given the length of runway ahead. Adoption in both areas is less than a quarter of the potentially addressable market.

The more interesting question, perhaps, is *how and where?* Our view is in a broadly similar way to currently and that **we will not do these things in a**

metaverse environment any time soon. The best way to think about the metaverse is as a nebulous buzzword for now. Sure, there is a large opportunity given that $54bn currently is spent each year on virtual goods, almost double what is spent on music (per JP Morgan estimates). Almost every large consumer-facing business, from Adidas to Disney and from Chipotle to Walmart has now established a metaverse presence.

However, forecasts that the metaverse could be worth $5tr by 2030 (issued this year by McKinsey) simply look too *optimistic*, in our view. As things currently stand, the smartphone remains the centre of the digital universe, where consumers lead their digital lives. Metaverse proponents seek to change this with (more) compelling hardware, software and service solutions. A seamless evolution is by no means a foregone conclusion. *At this stage*, it seems hard to agree with Mark Zuckerberg (CEO of Meta, formerly Facebook) when he says "you can think about the metaverse as an embodied internet, where instead of just viewing content – you are in it."

As we have noted in every annual edition of our thematic book, **it is crucial to make a distinction between hype and reality**.

Part Two: Recent Thematic Thinking

Drones: Now Ready For Take-Off?

Watch here

Executive summary: We may be on the cusp of a transformation in how people and goods are transported. If the full potential of drones is realised, then how we shop, travel and do almost anything else may be revolutionised. The number of possible drone use cases is almost limitless. The industry has evolved from a conceptual or hype-based phase to practical trials and real-world deployments, accelerated by falling costs and improving technology. Regulators are getting on board. Over $5bn has been committed to funding 130 different start-ups in the last two years. By 2030, the (non-miliary) drone opportunity could be as large as $100bn. Although there are few listed pure-play drone businesses today, watch this space. If you think of drones as being self-flying computers that can transmit data directly into the cloud, then the whole digital ecosystem should benefit from the industry's growth.

By 2030 the industry could be worth at least $100bn

Say drone to most people and the image they might form is of a stealth military device capable of flying undetected into a warzone to wreak havoc. Alternatively, it could be of a keen hobbyist using one to film some novel views from their holiday. Think again. While both these visions are relevant, **we are in the early stages of a historic shift in the transportation of goods and people**.

Although we have followed the topic of drones for much of the last decade, it is only now becoming more interesting from an investment perspective. As with almost every other future trend we consider, **a combination of falling costs and improving technology has made the business case for drones more attractive**. The evolution of the Internet or GPS (global positioning systems) serve as good templates. They have developed from their original military roots to now encompass a broad array of business applications. The COVID-19 pandemic has also helped heighten the logic for remote and convenient deliveries – something which can easily be achieved by drones.

The terms drone, UAV (unmanned aerial vehicle), RPAS (remotely piloted aircraft systems), AAM (advanced aerial machine) and VTOL (vertical takeoff and landing devices) are used increasingly interchangeably. Where there is commonality is that all the above constitute **powered, aerial vehicles that do not carry a human operator, use aerodynamic forces to provide vehicle lift, and can fly autonomously**, typically by being piloted remotely. Drones were originally developed through the 20th century for military missions that were typically viewed as too dull, dirty or dangerous for humans. In this century, they have become essential assets to most militaries, as the Russia-Ukraine conflict has recently demonstrated.

The potential broader opportunities for drone deployment have, however, grown substantially owing to two factors, hardware, and software. Take the former, and similar to electric vehicles, the 90% decline in the cost of lithium-ion batteries over the past decade has markedly improved both the economics of drones and also their range and durability. Although drones are often categorised as being either fixed or rotary winged, based on their physical architecture, the bigger recent revolution, however, has been in their underlying software. Think of **a drone as a self-flying computer that can transmit data straight into the cloud**. The value add that derives from their adoption may lie in the (visual) data that drones can collect, often at a fraction of the cost of acquiring this data via other means. Further, how we use drones may change fundamentally once they start to be networked and can work in teams.

A more sustainable and environmentally friendly solution

The benefits of using drones relative to other forms of either transportation or data collecting alternatives can be characterised as **improved efficiency, lowered costs, and enhanced safety**. Additionally, six in ten industry leaders interviewed in a recent study by Deloitte believe that drones also constitute a **more sustainable and environmentally friendly solution** relative to comparable alternatives. Hard numbers, of course, are more difficult to come by given the general nascence of the market and the diverse scenarios (many of which are still hypothetical) where drones could be deployed.

Nonetheless, it's still very easy to conceive of how **drones may transform the ways in which people and cargo are moved, potentially revolutionising shopping behaviour, reducing travel times and saving lives**. At the least, increased drone deployment should be thought of as a tool by which remote or rural communities could be better connected with the rest of the world. Put another way, drones could transport just about anything or anyone (particularly once the opportunity is expanded to include people-carrying devices).

Against this background, **the potential number of use cases for drones is almost indefinite**. Based on various consultant reports, the commercial (i.e., non-military) drone market was already worth ~$15bn globally in 2020. Given that consensus assumptions call for a ~20% compound annual growth rate through to the end of the decade, **by 2030 the industry could be worth at least $100bn**. Importantly, these assumptions typically do *not* include the advanced air mobility market of transporting humans. One study (by Deloitte) predicts that this market segment alone could be worth $115bn by 2035.

At present, **the five largest end-markets in which drones are deployed comprise agriculture, construction and mining, insurance, media and law enforcement**. Begin with the former. If you accept the prediction of the United Nations that the world's population will reach 9.7bn by 2050, then this will cause agricultural consumption to rise 69% between 2010 and 2050. Drones could play a major role in helping to align demand with supply by enabling farmers to enhance their yields through several mechanisms.

The adoption of precision agriculture with more accurate land and crop data could allow for increased efficiency in the planting, measuring, scanning and monitoring development of crops. These developments could also help reduce the costs and hazards related to spraying of fertilisers and pesticides. DroneFly, a private player within the sector, estimates that its **drones can spray fertiliser some 40-60 times more efficiently than doing so by hand**. Separately, drones could also be used for tracking and herding livestock. Around a third of farmers say that they are either using or considering using drones (per Global Insights). High-profile success stories can be found across the US, Australia, Canada and China.

Within the construction and mining space, it is easy to conceive of how drones could perform construction surveys as well as prospecting opportunities for miners. Remote monitoring (of oil rigs, wind turbines, electricity cables, gas pipes, or other infrastructure) represents another opportunity. Both the UK's National Grid and Florida Power and Light in the US are currently trialing drones in this respect. Deloitte's study highlights the potential benefits. Whereas a traditional ground-based inspection team could only cover 2-5 turbines/day, this figure could grow to 10-12 turbines/ day when using drones with manual flight control. Assume advanced software with autonomous flight and the level may rise to as much as 15-20.

When you consider that the average global annual cost of insurance claims from natural disasters has increased approximately eightfold since 1970 (per Allianz), the logic of deploying drones in this area should be clear. Drone technology could provide faster and more accurate property assessments by quickly reaching often remote locations immediately after a disaster hits. From there, they can capture precise images and videos of damage that can be transmitted back to mobile devices for assessment in real time. Ultimately, drones can help claims adjusters process property significantly faster than doing so manually.

Drones have other benefits too when natural disasters hit. They can be used for the delivery of humanitarian aid. Drones have provided post-hurricane relief to communities in Puerto Rico and Haiti and also helped deliver critical pandemic supplies (both personal protective equipment and COVID-19 testing kits) to remote communities in countries as diverse as the US, Israel and Ghana. Zipline, a privately-owned drone business based in California says that it has completed over 150,000 drone missions across the world, supplying hospitals with blood, medicine and vaccines. Britain's National Health Service announced in July that it would be trialing the use of drones to help critical drugs from one part of the country to another, especially to more remote areas such as the Isles of Man and Wight.

Beyond these areas (as well as the unrelated new media and surveillance opportunities that drones could generate), **the largest addressable market for unmanned aerial vehicles could be in e-commerce**. At present, an estimated 2,000 drone deliveries of goods are currently occurring daily (per McKinsey). Given the developments within the space, over 1.5m such transports might be made in 2022, up more than threefold from last year's level. Major players are getting involved in the space. Subsequent to successful trials by Walmart in its home state (Arkansas), America's largest retailer said in May that it would expand its delivery network to 34 sites in 6 states by the end of this year, with deliveries made to customers within 30 minutes of orders being placed. Amazon announced in June that it would launch a similar 'Prime Air' drone delivery service on a trial

basis at some very selected locations in California and Texas before year-end.

Customer interest is already there for such services. Nearly 60% of respondents to a six-country survey conducted by McKinsey said they would use a drone-delivery service today if it were available in their area, compared to only 16% who said they would not (the remainder were ambivalent). With such a backdrop, many other companies are also joining the fray. Among the most high profile, Wing (a subsidiary of Alphabet) is launching a "drone delivery where you need it" store-to-door offering with a 15-minute delivery time in certain districts of Helsinki, Canberra and Virginia. Additionally, UPS and DHL are seeking soon to offer postal deliveries by drone and Domino's is said to be keen to trial aerial pizza deliveries.

Looking even further ahead, **the holy grail for the drone industry *could* lie in the transportation of people**. Think of vertical take off and landing devices as drones 2.0, or a novel way to move people with less congestion in a form that is fundamentally different to a helicopter (since no pilot would be involved). The hope is that VTOLs could absorb segments of the transport market that are currently too slow, inefficient, or alternatively too costly. Regional trains and flights might fall into the former category; expensive helicopters or jet charters into the latter.

Anecdotally, over 40 companies are trialling services at present. Joby Aviation says it plans to launch an app-based aerial ridesharing service direct to end users in 2024. It has already conducted over 1000 test flights (some in conjunction with the US Air Force) and has partnered with players including Uber and Delta. Another business, Lilium, has said it is planning to build a vertiport in Florida with a view to offering services from 2025. It has already signed a memorandum of understanding with NetJets by way of building out its franchise. Similar initiatives are underway in cities as diverse as Paris, Singapore and Dubai. Private company Faradair has plans services in the UK, linking both cities and more remote locations, by around the middle of the decade.

As exciting as all these initiatives seem, with people especially (but also cargo), **the technology needs**

Drones can spray fertiliser some 40-60 times more efficiently than doing so by hand

to be not only readily available and cost-effective but also secure. Regulation is therefore key. At the least, it will be critical to develop clear policy relating to altitude and range restrictions in order to manage the effective development of the industry as well congestion in the skies. Other important considerations relate to contingency planning in the event of severely adverse weather, potential communications failure, signal jamming or cyber breaches.

While many trials have been successful (and the underlying technologies are improving constantly), regulators may still need further convincing. Some form of regulation is already in place in countries including Australia, France, Japan, South Africa, the UK and the US. The landscape is continuing to evolve. As recently as June, America's Federal Aviation Administration said that it was in the process of finalising rules that would allow companies to fly drones "beyond the visual line of sight." Three similar trials are also underway in the UK as is a government plan to potentially create a 'drone superhighway' linking aerospace across 165 miles of the country. Successful implementation would enable more widespread drone deployment. Watch this space.

Another concern relates to the noise generated by drones (the clue is in the name!). Devices that weigh up 5kg typically produce noise levels between 70dB and 85dB when flying 1m above the ground, similar to a car passing at 30 miles an hour. Meanwhile, a drone with a heavier 20kg payload would produce a noise level comparable to a helicopter hovering at 500m (per the Swiss Federal Laboratories for Materials Science and Technology). A separate survey by NASA also found that people were more annoyed by drone-related disturbances than by the loud noises made by cars and vans. These concerns may take time to assuage as might other charges levelled by sceptics such as where drones might be able to land safely in dense urban environments without causing excess disruption or whether drones could be deployed for more nefarious purposes such as the delivery of illegal drugs.

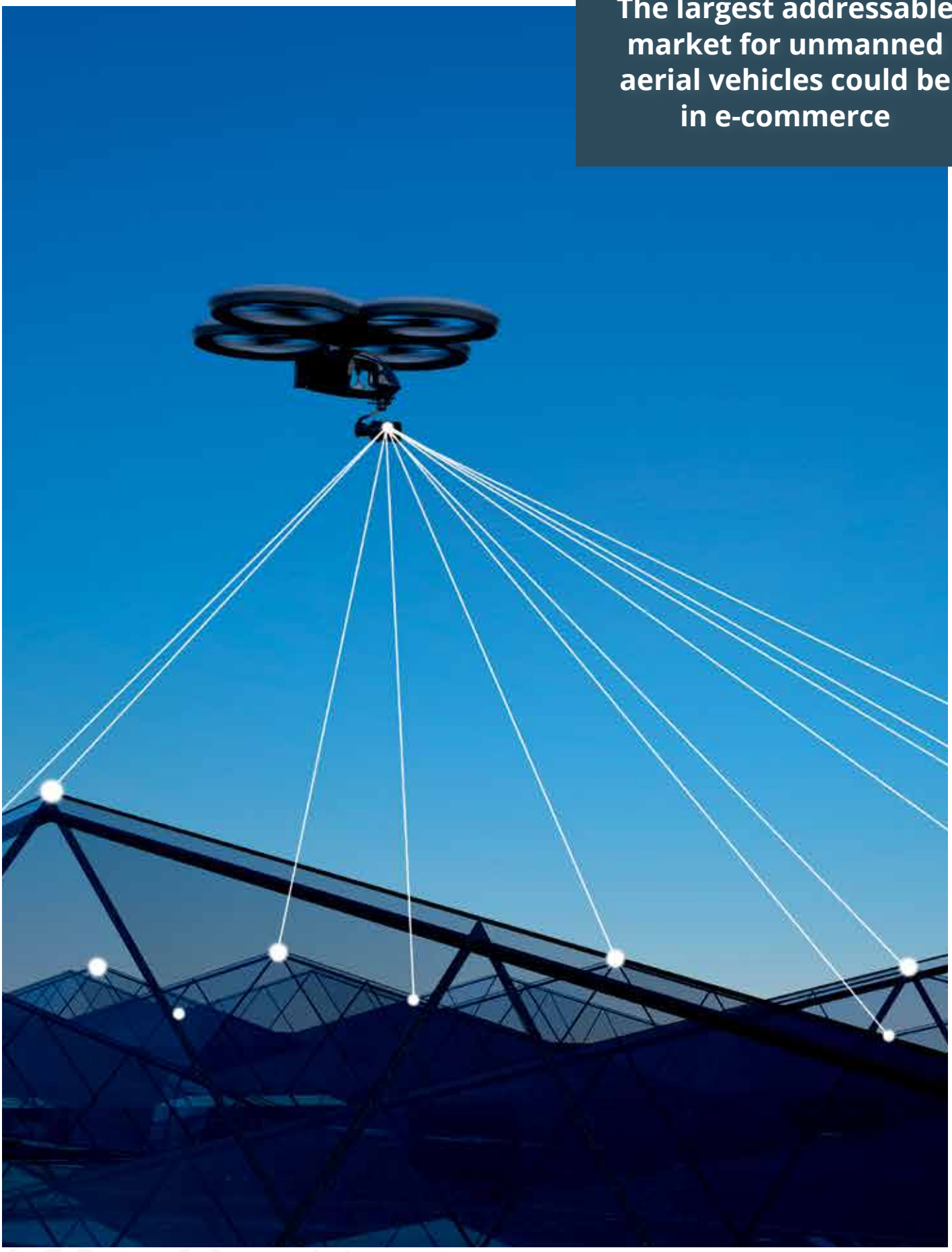
None of this has stopped **more than $5bn of investment in the drone sector during the two years to the end of 2021**, resulting in the formation of around 130 different businesses. Such activity might suggest relatively low entry barriers, but it is worth noting that the majority of new money raised has gone just six players located in the US and Europe: Joby Aviation, Lilium, Paragon, Archer Aviation, Beta Technologies and Volocopter (all information per Phystech Ventures). Even with some scale and first mover advantage benefits, **the time from certification, testing and evaluation through to full launch and commercial deployment could be up to a decade**, implying that while some businesses may succeed, consolidation and failure will also characterise the industry's evolution.

From an investment perspective, **there are few listed pure plays today**. Many of the businesses active in the space are parts of larger conglomerates or private enterprises. If other industries provide a template, it is also worth considering whether most value will accrue to hardware of software players (our best guess would be the latter) and also what sort of model for drone ownership and operation might emerge (drones as a service, potentially managed by platform businesses seems plausible).

The businesses that have developed – for now – the strongest franchises within the drone space can all be found in the aerospace and defence sector (think of Lockheed Martin, Northrop Grumman and Raytheon in particular) although some investors may be deterred owing to sustainability concerns. Adjacencies within the value chain would include TransDigm and Ambarella which design, respectively, gyroscopes and chip systems for drones among other things. Pure plays include Joby Aviation and Lilium. Although the former is capitalised at over $2bn (the latter is much smaller), it is worth bearing in mind that neither business has reported any revenues to-date. Other small cap plays would include Parrot (which provides consumer drones), Drone Delivery Canada (its activities are self-explanatory) and Drone Shield (a defence business). **More drones are also good for the broader digital ecosystem**: they need not only semis, but also cloud storage. Data production and consumption is only heading one way.

27 October 2022

The largest addressable market for unmanned aerial vehicles could be in e-commerce



Keep The Lights On: Make The Grid Smarter

Watch here

Executive summary: Electricity grids need an overhaul. Not only are global energy needs constantly expanding, but current grids were built for a different era. In the future, grids will have to get smarter if we want the lights to stay on. As with almost every other industry, increased digital deployment has the potential to be highly transformational. Smart grids will monitor in real time where power is coming from and where it will be needed. They can bring marked increases in reliability, flexibility, efficiency, and sustainability. Over 15 countries globally currently have smart grid projects underway. Add in the deployment of microgrids and this figure grows substantially. Look further ahead and the global market could expand at least fourfold from its current size, reaching ~$150bn by 2030. Smart grid deployment will not always be easy, however, given its complexity. Buy-in from governments, regulators and utilities also matters. Clear investment opportunities will still arise. At present, there are few dedicated pure-plays and those that are tend to be relatively small in size. Larger systems integrators will clearly benefit. Look further ahead, and as the industry gets smarter, so should potential investors.

Few people even think about the power grid until their lights go out. When they do, that's when the constraints of the current energy transmission system become alarmingly apparent. **Today's grids are antiquated and in need of a major overhaul to reflect the new reality of energy management**. Gone is the model of centralised grids built to take power from large stations and carry it to the millions of homes and businesses where it is used. In its place will be a grid system that is inherently *smarter*, which works bidirectionally (users can also be suppliers) and is much better equipped for the 21st century.

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. Ageing transmission lines are subject to failure not simply through use but also owing to extreme weather conditions (hurricanes, floods, heatwaves and so on), which can often overwhelm the infrastructure. Unmodernised grids may also be subject to cyberattacks and malware, as the Colonial Pipeline incident of May 2021 showed. Russia's invasion of Ukraine has only increased concerns in this respect. Also, don't forget that power outages are not just an emerging market issue. While 350m people were affected globally last year, the number of reported annual incidents in the US has grown from fewer than 25 in 2000 to over 180 (per IHS Markit).

At the same time that the supply of energy is under pressure, demand is only heading in one direction. **Global energy demand is set to grow by 60% over the period 2020-2050**, driven not just by population growth, increased industrialisation and expanding incomes, but also by electric vehicles, an increasing proliferation of smart devices and the growing deployment of IoT (internet of things) networks. Bloomberg New Energy Foundation – the source for the above data – estimates that over $28tr would theoretically need to be spent worldwide to provide all the support required to meet such a level of demand.

Where best to spend this money? Although **the epithet 'smart' is applied to many transformative technologies, the future for electricity grids lies in making them inherently smarter. What this means in practical terms is deploying solutions**

Smart grid systems would almost certainly include microgrids within them

to monitor in real time where power is coming from and where it is needed. Think of a smart grid as containing intelligent devices at all points in the electricity network (from high-voltage transmission lines to appliances in the home) that can send information and receive instructions.

In most electric grids today, power flows in one direction. However, **smart-grid technologies help make the network two-way with the ability for power and communication to flow in both directions**. Complex, two-way communication is essential to capture power generated by customers with their own solar panels or wind generators. Those customers receive power from the grid when their supplies are low, but also send power into the grid when their supplies generate excess electricity.

A smart grid can then be characterised by four key features: its reliability, flexibility (the ability to handle bidirectional energy flows), efficiency (better load adjustment and balancing) and sustainability (integrating renewable energy sources). **Smart grid systems would almost certainly include microgrids *within* them**. Think of a microgrid as being a decentralised source of electricity that can disconnect from the main grid infrastructure and function autonomously as technical or economic conditions dictate (in the event of extreme weather conditions, for example). In this way, microgrids could improve security of supply and can provide

emergency power. These are ideal both for more remote communities and for emerging economies who may typically bypass conventional grid infrastructure.

This is just the beginning. Digital technologies, more broadly, could help transform grid operations. Predictive maintenance, based on machine learning and artificial intelligence can help reduce power outages and improve companies' investment and maintenance decisions. Drones could carry out field inspections, replacing workers, while sensors would permit for more real time monitoring. Robotic processes and automation would markedly improve back-office functions. **Maintenance expenditures could be reduced by 20% and distribution losses by 15% over a ten-year horizon through digital implementation**, per work from the Boston Consulting Group.

At least 15 countries around the world have begun to deploy smart grid solutions. The earliest (and still one of the largest) examples of a smart grid is the Italian system installed by ENEL. Completed in 2005, the Telegestore project was highly unusual in the utility world because the company designed and manufactured its own meters, acted as its own systems integrator and developed its own system software. It remains a success, delivering annual cost savings of ~€500m (versus an original build cost of ~€2.1bn). Currently over 500 discrete smart grid projects are underway across Europe, per data from the European Union. These initiatives include the integration of parts of various national grid systems (for example, between Hungary and Slovakia, or Germany and the Czech Republic) to improve distribution and service quality. Other developments are to ensure improved provision and monitoring in more remote areas. Meanwhile, businesses in some geographies (particularly the Netherlands) are upgrading parts of their grid to integrate electric vehicle solutions.

Although deployment is most advanced in Europe, there are reasons for optimism in other regions, particularly the US. While over 100m American homes are currently equipped with smart meters (per the US Pacific Gas & Electricity Company), the US Infrastructure Bill has the potential to kickstart America's grid overhaul. The Bill allocates potentially up to $65bn for the nation's electrical system for it to deliver 100% clean energy to businesses and homeowners by 2035. This budget includes the buildout of transmission lines and funding for smart grid research and development. Similar projects (with varying degrees of maturity) are also underway in countries including Australia, China and South Korea. Additionally, there are currently over 4,500 microgrid deployments underway around the world (per Guidehouse Insights).

All the technology required to make the electricity grid smart(er) already exists. The challenge is to find ways to make its deployment commercially viable and politically acceptable. The speed of disruption and the regulatory embrace of new solutions will vary market by market. Owing to the complexity and often fundamental change required for operating models, the smart grid opportunity is also a challenge. Many energy utilities are constrained by the often bureaucratic and hierarchical nature of their organisation (anecdotally, a majority have yet to recruit Chief Technology Officers), while regulators typically tend to be risk averse in their planning. In all cases, access to funding is critical. It makes sense to run pilot programmes to test new technologies, but above all, it is crucial to ensure that a new version of the old grid is not built by adding piecemeal solutions rather than a more considered overhaul.

The global smart grid market is currently worth $30-40bn (depending on how different consultancies define the market's size and scope) but should grow at a **15-20% CAGR through until the end of this decade, implying a market worth around $150-160bn** by this time. While North America will be the largest market for smart grid deployment, Asia will likely be the region to experience the fastest growth. In addition, do not forget the seventh sustainable Development Goal of the United Nations: universal access to energy by 2030. For this to be achieved, there would need to be a 35% increase in power connections globally between 2015 and the end of this decade. Even if this target is not met, expect an increasing deployment of microgrids globally.

Against this background, **there is a significant investment opportunity ahead**. The challenge, however, is to identify how best to benefit from it. There are many different angles. Remember also that regulators will have an influence, not just in defining the parameters of permitted returns for utility businesses, but also in potentially taking a

view on whether more independent businesses (as opposed to grid operators) should act as platform providers. Furthermore, deploying smarter grids is a complex issue, in which alternative energy businesses, hardware, software and installation companies will all play a role.

While large and diversified companies including **ABB, GE, Hitachi, IBM, Schneider Electric and Siemens** will all likely continue to play a role in offering key solutions to support smart grid proliferation, finding more dedicated pure-play businesses is more of a challenge. Businesses which could benefit include **Alfen** (a provider of integrated smart energy solutions including grids, storage and electric vehicle charging points), **EVgo** (another provider of charging solutions) and **Landis&Gyr Group** (a leader in smart grid software). However, all three of these businesses are currently small, with ~$2bn market capitalisations. Adjacent, or indirect opportunities might include businesses such as **Quanta Services and MasTec** (specialist grid infrastructure contractors), **Itron** (a leading data analytics provider for the utility industry) or **Xylem** (a leader in water industry technology solutions). Broader ETF options also exist, but given the runway for smart grid solutions ahead, investors interested within the space may also need to get smarter.

06 September 2022

The global smart grid market is currently worth $30-40bn

Decentralised Finance: Demystifying DeFi

Watch here

Executive summary: Forget traditional financial institutions; put users in control instead. This is the promise offered by advocates of decentralised finance. Think of DeFi (the preferred abbreviation) as being a set of protocols that allow for the creation of an open, borderless, autonomous and self-sustaining financial system. DeFi also constitutes part of the broader Web 3.0 revolution, or the democratisation of the internet. Advocates would point to the $2tr digital currency market (primarily Bitcoin and Ethereum) or the fact that more than $30bn was invested in private crypto and blockchain businesses last year. The opportunity to address the currently unbanked – who should benefit from such a financial revolution – might be worth almost $400bn. Despite current interest levels, which verge towards hype in some areas, much still needs to be resolved. Clarity on regulation and security as well as the ability for decentralised networks to scale are paramount. We see certain parallels with the early internet a generation ago. The market is still highly fragmented but winners will undoubtedly emerge. From a public equity perspective, there are very few listed pure plays. Watch this space as things can change quickly.

Read any news source discussing financial innovation and it's almost impossible not to hear mention of bitcoin, blockchain, crypto or NFTs (non-fungible tokens, for the uninitiated). All fall under the broad umbrella of decentralised finance. This term stands in stark opposition to the current centralised infrastructure of global finance. DeFi, as its advocates abbreviate it, promises **a new internet-based, decentralised model for financial interactions with less reliance on conventional intermediaries**. Think of DeFi as being **part of the broader trend of digital transformation** which we are experiencing in all spheres. Despite its appeal, which probably only grows in times of more heightened uncertainty, it is important to proceed with caution. Much of the enthusiasm *currently* seems based around ideology rather than specifically the potential of the technology.

Decentralised finance is the term given to decentralised applications built on public blockchain infrastructure that facilitate financial transactions. These can include payments, lending, trading, investments, insurance and asset management. The willingness to consider *alternatives* to the traditional system arose out of the legacy of the 2008 Great Financial Crisis. This event heightened attention on the inefficiencies, structural inequalities and hidden risks of the intermediated financial system. DeFi is explicitly characterised by its **non-reliance on centralised intermediaries**. Put another way, it is premised on decentralisation.

Have no doubt, **the current system is inefficient**. Consider that the process to clear a transaction can be anything up to three days, which is clearly a major negative for merchants and how they manage their working capital. Further, the average credit processing cost for a retail business is 1.9-2.1% in physical outlets and 2.3-2.5% online. Elsewhere, in the case of exchanges, commissions charged for trades by brokers typically fall in the 0.2-0.3% range (all data from BCG). There are hidden costs everywhere. For contrast, in the world of DeFi, assets are escrowed in smart contracts on a blockchain. No parties, other than the user, can control the movement of funds unless certain conditions are met.

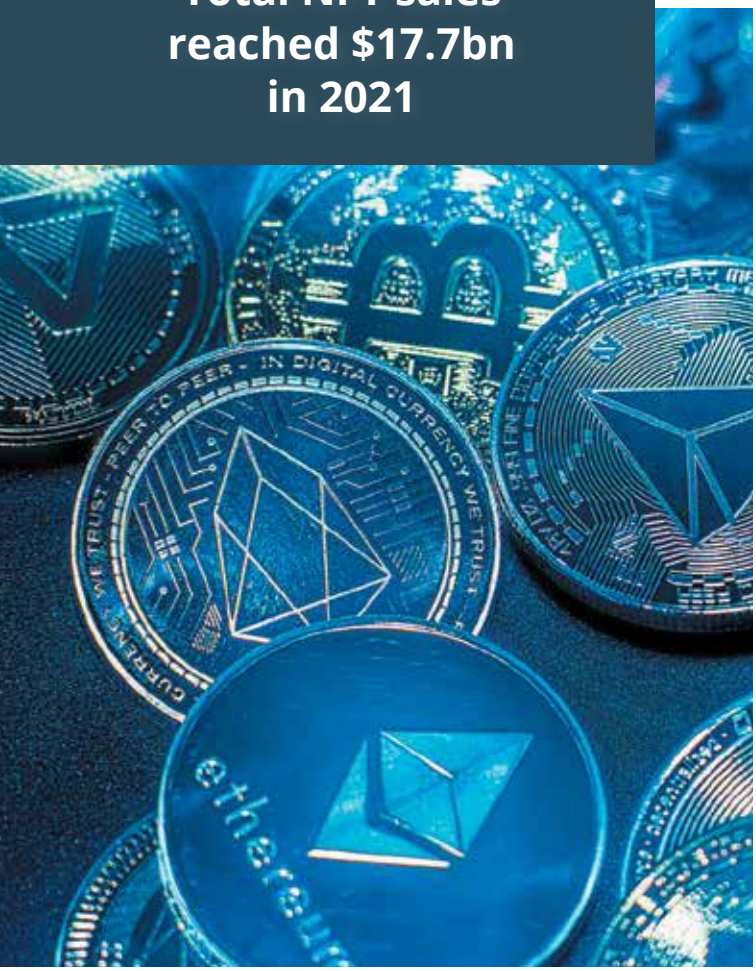
From here, it is easy to see the other advantages of DeFi. It is **permissionless and borderless** – anyone with an internet connection can use DeFi services. It is also an **autonomous and self-sustaining** system. Think of open source as the founding philosophy

DeFi is still at a very early stage

behind DeFi. Anyone can audit open-source code, often to test for security vulnerabilities. As a result, the **DeFi protocols are composable and modular too**. Protocols can be built on top of one another in order to enhance functionality. This is where the term Web 3.0 comes in. If Web 1.0 was a collection of static webpages with html addresses and Web 2.0 is the centralised system of interconnections we currently have (where platforms own data), then **Web 3.0 should be thought of as a conscious effort to build a 'new' form of internet that works for everyone**. Its cornerstones include user-controlled data and peer-to-peer transactions. Think of it as the democratisation of data. DeFi and the applications which have emerged from its protocols are the most visible *current* manifestation of Web 3.0.

Despite its rapid growth and deployment, **DeFi is still at a very early stage**. Much of the activity to-date is highly speculative and targeted at existing digitally native asset holders. 31% of Americans aged 18-29 say they have invested in, traded or used a cryptocurrency. Conversely, however, 45% of US adults say they have never heard of NFTs and a further 28% say they do not understand what they are for (per an October 2021 survey done by Forrester). Nonetheless, **Bitcoin and Ethereum constitute the most tangible examples of the potential embedded within decentralised finance**.

Total NFT sales reached $17.7bn in 2021



Bitcoin can trace its history to 2008 and Ethereum five years later. The latter, arguably, built on the former by introducing the concept of the smart contract (or immutable proof of a transaction logged on a blockchain network). Think of Ethereum as being a decentralised, open source blockchain with smart contract functionality. Ether is the native cryptocurrency of its platform (and second only to Bitcoin in terms of market capitalisation). The Ethereum platform allows anyone to deploy permanent and immutable decentralised apps onto it, with which users can interact.

Financial services represent the natural use case for Ethereum. Applications can be found across the asset management, credit, derivatives and insurance industries. Credit constitutes the largest of these segments (with over $29bn of value-locked assets as of the end of 2020, per BCG – the figure is almost certainly higher now). Here, time-limited interest-bearing instruments are created, which must be repaid at maturity. Businesses including Maker, Aave, Compound and InstaDApp match lenders and borrowers to issue such instruments. Exchanges also play an important role, allowing users to trade one digital asset for another. DeFi exchanges avoid taking custody of user assets, either through a decentralised order book or by matching orders and setting prices algorithmically. Players active in this field include Curve Finance, Uniswap and SushiSwap. Per the same BCG study, around $14bn of assets have been locked in (decentralised) exchanges

Ethereum also allows for the creation and exchange of NFTs. These are non-interchangeable tokens connected to digital works of art or other de facto real world items. The creation of digital assets has made the ownership, trading of, and investing in scarce and authentic (i.e. copyrighted) product markedly easier than in the past. NFTs went mainstream in March 2021 when the artist Beeple sold a digital-only 'art' work via Christie's for the sum of $69bn. Organisations as diverse as Nike and the British Museum (the NFT activities of the latter were profiled in a recent Blog post of ours) have also begun to play in the field. **Total NFT sales reached $17.7bn in 2021**, up over 200 times relative to 2020's figure. Over $40bn went in to total Ethereum contracts last year (per BNP Paribas and Chainalysis respectively).

These sums are, however, dwarfed by **the c$2tr size of the digital currency market** (per Crypto.com). Digital currencies, of course, can be used for multiple reasons, often nefarious or illegal. From a DeFi perspective, think of them as *enablers* of a decentralised financial system. At its peak last year, the market value of digital currencies had surpassed over $3tr with over 15,000 varieties available. This is the space in which the large payment processors (Mastercard and Visa, but PayPal too) have sought to establish a presence, facilitating the purchase and sales of such currencies and even allowing some variants as sources of payment. **At least 14 Central Banks globally around the world have launched digital currency pilots and around 80% say they are considering doing so** (per UBS). Beyond needing to move with the times, the development is perhaps unsurprising given that the market opportunity represented by the currently unbanked (defined as those individuals who have neither a birth certificate nor passport and so no access to conventional finance) is worth at least $380bn according to the World Bank.

If it all seems too good to be true, what's the catch? Have no doubt DeFi is a rapidly growing area, but it remains highly immature. **A variety of economic, technical, operational and public policy issues need to be addressed**. The broad debate relates to access and trust. Traditional financial institutions have built trust over decades (if not centuries) of boom-and-bust cycles. The standards that exist within the financial services industry are some of the most stringent to be found anywhere. They will not be replaced overnight. Regulators (as well as Central Banks) need clarity on issues as diverse as the legal enforceability of contracts as well as consumer protection. KYC and AML (know your customer and anti-money laundering) factors also need to be taken into consideration. The recent Russian invasion of Ukraine has also brought into focus the topic of DeFi's much-vaunted neutrality. Imposed Western sanctions have seen the blocking of some Russian-linked IP addresses that own cryptos. Meanwhile Russia also ranks as the third largest miner globally of bitcoin (per Bloomberg).

Scalability is another important factor to consider. Take Ethereum. At its current size, it can process roughly 15-30 transactions per second, or around 1m a day. Contrast this to Visa, which claims it can process over 55,000 transactions a second. Whether Ethereum and other DeFi platforms could cope with similar volumes remains to be seen. There are also issues such as **interoperability** (Bitcoin and Ethereum are largely standalone platforms today) not to mention **security risks** (over $14bn of cryptocurrency was subject to scams last year, per Chainalysis) and how quickly any such services will be adopted by the mainstream.

Parallels with the development of the Internet a generation ago have some validity. Currently, Bitcoin adoption levels are tracking along a similar path to Internet trends from the 1990s. The potential is evident, but much remains unclear currently. A deeper technical understanding is undoubtedly required. It is also **crucial to separate hype from reality**. The market remains highly fragmented and complex, subject also to intense speculation.

None of this has stopped investors from pouring $30bn+ into private crypto and blockchain companies in 2021, some five times 2020 levels. **A further $10bn found its way into crypto funds and more than $3bn into NFT projects** (all data per Pitchbook). Much of the excitement inevitably lies in the start-up sphere. Nonetheless, the more traditional financial services businesses as well as the mega-cap tech firms are acutely conscious of not wanting to miss out on the DeFi opportunity even if, ironically, it could be considered antithetical to the centralised platforms they have already built. Currently, there are few direct listed ways of gaining exposure to the DeFi trend. Block(formerly Square) represents one possible angle; Conibase (a listed crypto-play), another. Meta (the former Facebook) and Twitter have probably been the most vocal among the major consumer tech businesses. Throughout the DeFi space, build new services and the hope is that the demand will come, eventually. Watch this space.

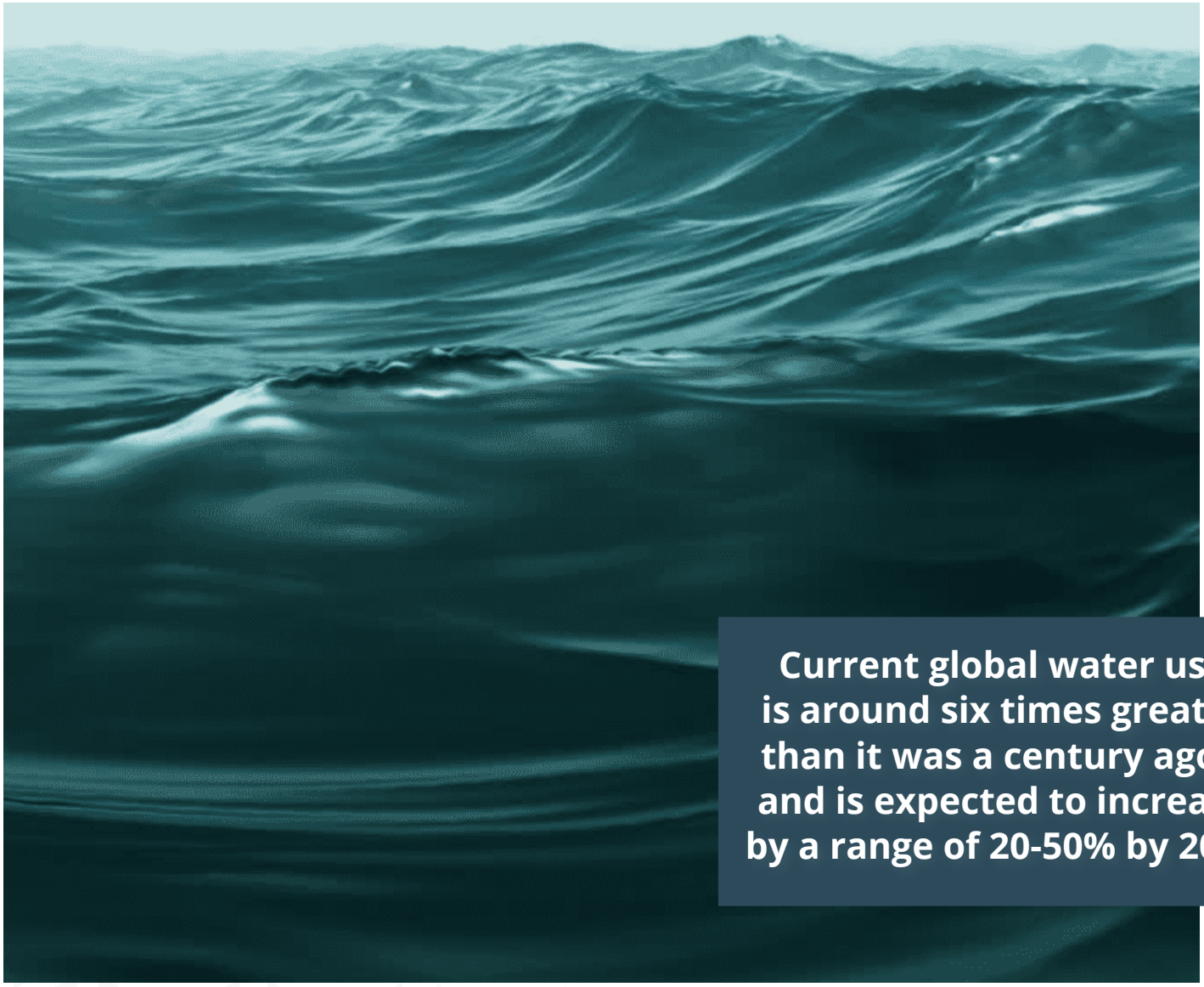
09 May 2022

$10bn was invested into crypto funds in 2021

Liquid Data: Digitalising The Water Sector

Watch here

Executive summary: Over a third of the world's population currently lives under some form of water stress. This figure is only likely to rise given increasing water demand. Usage has already expanded sixfold in the last century and could grow by at least 20% more over the next 30 years. The best way to address this supply-demand conundrum is to improve the efficiency of current water supply through more intelligent investment. The digitalisation of the water sector is as inevitable as it is logical. With every Dollar of water investment yielding a return of at least $4 and the industry already achieving around $70bn of annual savings from implementing digital solutions, the direction of travel is clear. Utility spending on digital water solutions is growing at a pace three times faster than average industry expenditure levels. Real world case studies abound and innovation is continuing apace. Consider businesses such as Mueller Water Products, Pentair, Tetra Tech and Xylem for direct exposure to this important theme.



Earth is often referred to as 'the blue planet.' Sure, water and ice account for around 80% of the world's surface area, but 97.5% of this liquid is salty and a further 1.8% of it is frozen at the poles, glaciers or in the form of perma-frost. All life and economic activity therefore relies on less than 1% of the planet's available water (typically in the form of either surface water or groundwater). There is, arguably, no future trend more important than how to distribute scarce water resources.

Thought of from the perspective of classic economics, water is an externality; it is under-priced relative to its value. As a consequence, it is over-used and under-invested. Similarly, since the social cost of water pollution is rarely paid for by the polluter, this only worsens water scarcity. Solutions are clearly needed. Attempting to reduce water consumption is a lost cause. Decreasing consumption may sound like an appealing idea in principle, but it is hard to enforce, would take time and, most significantly, runs contrary to the deeply entrenched secular trends of population growth, industrialisation and the associated westernisation of diets.

Current global water use is around six times greater than it was a century ago – and is expected to increase by a range of 20-50% by 2050

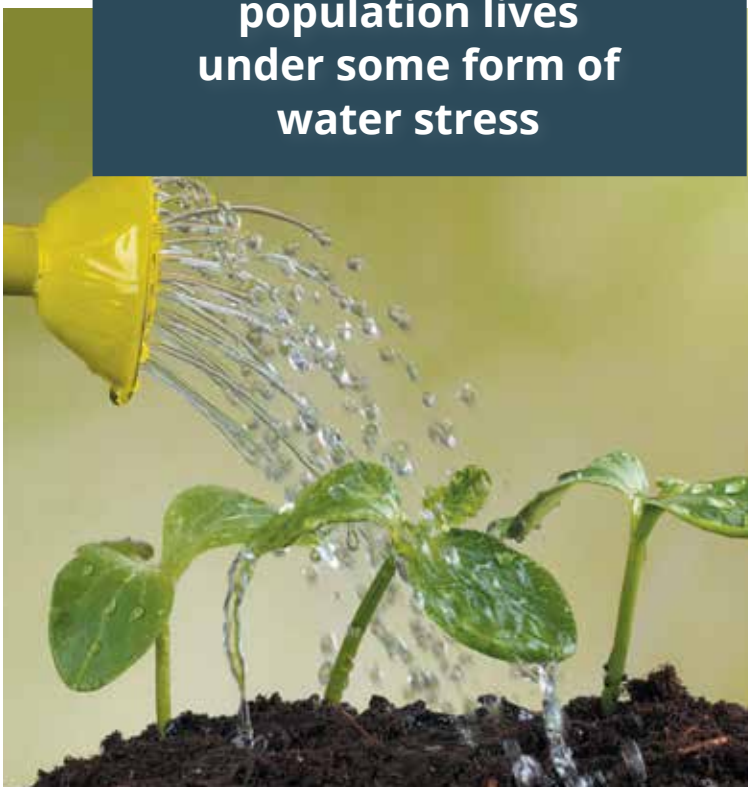
During this period, the world's population is forecast to expand by around 2bn people. Furthermore, with 1.5m people moving on a weekly basis, within this timeframe, 70% of humanity will be living in cities. Urban dwellers consume considerably more water per capita than rural populations (all data from the United Nations).

The above problem is compounded by the fact that, currently, **35% of the world's population lives under some form of water stress**; a function of both increasing water scarcity and global warming (the two are interlinked). By 2025, two-thirds of the people on this planet may find themselves facing water shortages, according to the World Water Federation. If you want to see what water scarcity looks like, then view this alarming visualisation.

By 2035, 2/3 of people on this planet may find themselves facing water shortages

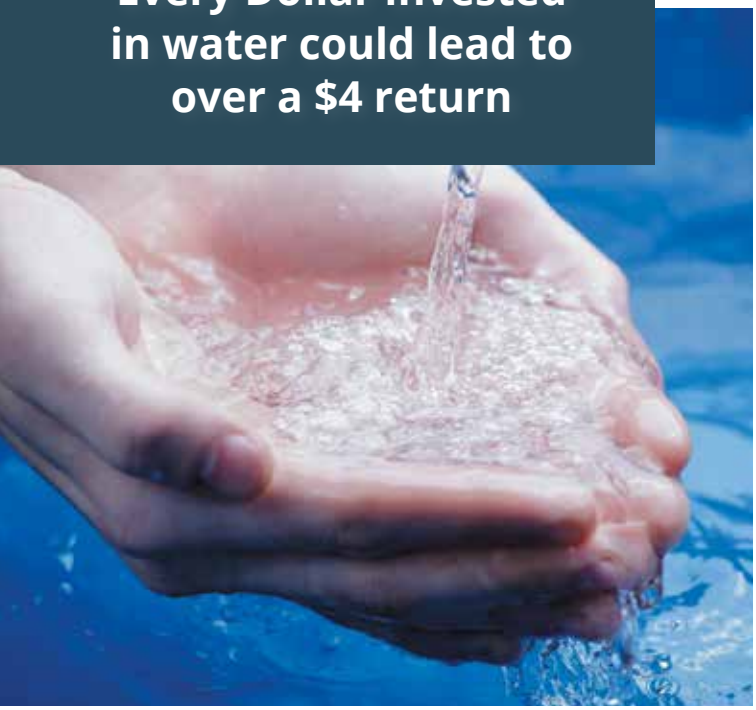
From all the above, it should be evident that **the solution lies in improving the efficiency of current water supply**. Even today, the total cost of water insecurity to the global economy is estimated at an annual $500bn, including environmental impacts (per the United Nations). The problem is not just a developing world issue. Consider that in the US, a water main breaks every two minutes, totalling 250,000 to 300,000 broken mains per year. The country's drinking water systems currently lose at least 6bn gallons of treated water per day, equivalent to 2.1tr gallons annually (per the American Society of Civil Engineers). One final crucial statistic: **every Dollar invested in water could lead to over a $4 return**, improving global GDP by 1.5% by 2030 due to reduced healthcare costs and increased productivity (per the World Health Organisation).

35% of the world's population lives under some form of water stress



The case for increasing investment in water infrastructure is not new. The OECD forecasts that global water infrastructure financing needs could total $6.7tr by 2030 and $22.6tr by 2050. The term 'infrastructure' is, of course, a broad one, encompassing everything from construction, engineering and consulting through to irrigation systems, via pipes, plumbing, pumps and fluid control. What's new, however, relative to when we first wrote on water over a decade ago is **the growing case for digitalising water services and solutions**.

Every Dollar invested in water could lead to over a $4 return



Every Dollar invested in water could lead to over a >$4 return, improving global GDP by 1.5% by 2030

Similar to almost every other area of the economy, the digital revolution is opening up new opportunities to make an impact. As we have said elsewhere, technology is an enabler. Think of water-tech as being the tools and systems that can improve the quality and efficiency with which we use water. These applications can sit (not mutually exclusively) within the spaces of consumer technology, industrial technology, monitoring, municipal infrastructure and/or agriculture. Within the water value chain, water technology can impact everything from water supply to environmental services.

The water industry has historically been slow in adopting digital solutions. Purchasing decisions are often characterised by risk aversion. Ultimately, what you do as a utility operator is to treat and clean water and avoid controversy. The pandemic has, however, helped accelerate a change in purchasing behaviour, effectively forcing people to think differently and to make better usage of limited resources, both human capital and actual Dollars. Anecdotally, only when water businesses start implementing technological solutions do the benefits become truly visible, thereby accelerating the process of digital transformation. In numerical terms, Global Water Intelligence (or GWI, a consultancy) estimates that the industry achieves around $70bn of annual savings from implementing digital solutions. It is perhaps no surprise then that over the next five years, water utility spending on digital solutions is forecast to grow at three times the rate of all other areas of industry expenditure, per the same source as above.

Water utility spending on digital solutions is expected to grow 3 times faster than average industry spend over the next five years

So where are these Dollars being spent? The holy grail is a full suite of systems intelligence. Metering and monitoring services can clearly encourage more efficient usage. Such solutions have been available for some time and are now increasingly commoditised. The value-add lies in the analytics. Data analytics can allow for better decision-making. A digital water future would combine artificial intelligence and blockchain: think of immutable, transparent and decentralised records of water usage that permit for the creation of smart contracts and substantially reduce the need for human monitoring. Machine-learning solutions could also allow utilities to better manage extreme weather events such as excess rainfall that leads to floods, as well as wastewater and water leaks.

Even if we are not quite at this vision yet, there are numerous examples available of where businesses/utilities have begun to deploy digital water solutions with positive benefits. London's Heathrow Airport estimates that its wastewater pumping energy has been reduced by over 50% annually since it adopted an intelligent monitoring and analytics solution. In Australia, Melbourne Water has started to use artificial intelligence to calibrate the optimal usage of its pumps without the need for human intervention or oversight. The pilot project indicates that savings of more than 20% are achievable. In the US, the Eastern Municipal Water District has said that digital solutions helped boost its workforce efficiency by more than 75% during the pandemic. We were also impressed to learn about the digital platform being pioneered by a US start-up called Aquasight. Via the monitoring of real-time data from sensors, process equipment and water meters, it claims to be able to detect water impurities with a 96% accuracy level.

Case studies show businesses can generate 20%+ cost savings and 75% efficiency improvement from implementing water tech solutions

Even with the large addressable market opportunity – **over $830bn is spent each year globally on water opex and capex**, per GWI – and even if digital spend in the water space is currently outpacing all other areas, the path to increasing digital adoption is unlikely to be either smooth or linear. Beyond the intransigence of water businesses and utilities (many of the latter, anecdotally, have yet to recruit Chief Technology Officers), changing perceptions also matters. Some in the private sector remain of the opinion that solving water crises is partially the government's responsibility and that investment should correspondingly be state led. Other concerns cited relate to interoperability issues between different digital systems and the potential for cyberattacks in a highly sensitive space, especially for smaller, less well-resourced utilities. On the positive side, regulation can clearly play an important role. In the US particularly, regulators are increasingly influencing utilities to adopt digital solutions as a way of reducing costs (for both companies and customers) and decreasing water loss.

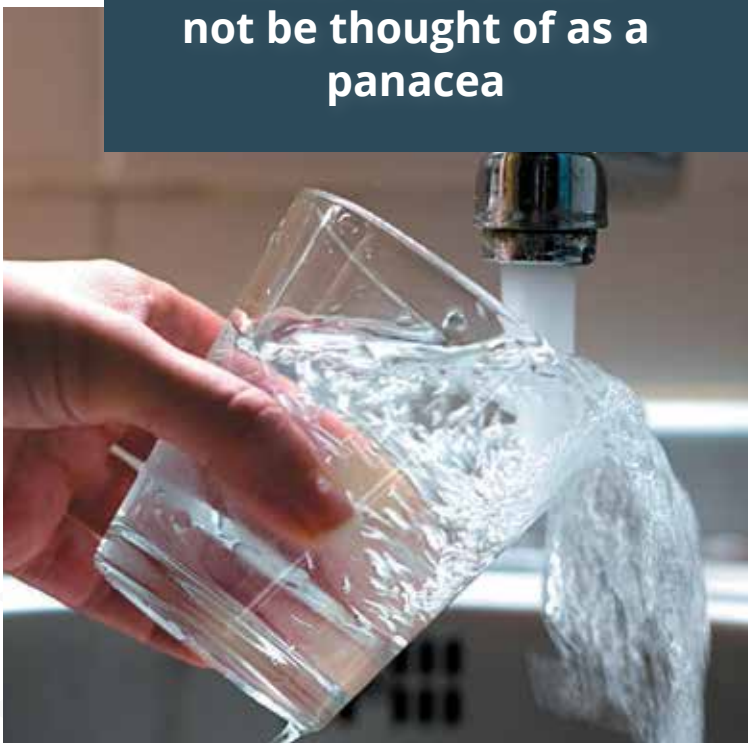
However, **water-tech should not be thought of as a panacea**. Indeed, it is one solution amidst many. There is also a compelling logic in recycling wastewater, improving irrigation and agriculture products, developing energy-efficient desalination plants and investing in new water conservation technologies (to name just some of the current leading initiatives). Taking each in turn, many East Asian countries have already begun experimenting with advanced technologies that cleanse wastewater for other uses. This was also a major discussion topic at last year's World Water Day. Next, with some 70% of the world's freshwater used for agriculture, improving irrigation would clearly help narrow the gap between water supply and demand. Turning to desalination (the process that takes salts and mineral components away from saline water), while popular in large parts of the Middle East, its main drawback has historically been its high levels of energy intensity. The good news in this respect is that costs are falling and solar may represent part of the solution. It is also encouraging to see research initiatives underway in the area of developing conservation technologies to help manage the drying up of aquifers, particularly in areas with unpredictable rainfall levels.

Water tech adoption will not be linear and represents one solution to water shortage problems amidst many

From an investment perspective, water remains a hot topic. There has been increasing recent M&A activity within the segment, particularly from infrastructure funds and specialist groups looking to consolidate the space. While there are many promising ways of gaining exposure to the theme of water in general or water-tech more specifically, one key challenge relates to the identification of listed pure-play businesses. Many companies operate in dedicated niches (such as **Kurita Water Industries** or **Evoqua Water Technologies**) or offer only indirect exposure (**Thermo Fisher**, for example, is a leader in water analysis instruments such as meters, electrodes and solutions for the measurements of pH, ions, dissolved oxygen and other important elements). From a more digital pure-play perspective, a handful of businesses stand out as potential leaders and/or early movers. These would include **Mueller Water Products**, **Pentair**, **Tetra Tech** and **Xylem**, listed alphabetically. The latter is the largest (capitalised at ~$20bn) and has, arguably, been pioneering digital solutions earlier than its peers. As Patrick Decker, the company's Chief Executive, recently said, "the value from advanced analytics continues to grow." We concur.

21 February 2022

Water-tech should not be thought of as a panacea



Food's Future: How To Feed The World More Intelligently

Watch here

Executive summary: The new food revolution is upon us. Alternative protein sources will become increasingly inevitable and necessary for economic, sustainability, environmental and health reasons. Expect plant-based alternatives, insects and cultured meat to complement existing protein (and vegetarian/vegan) options. The meat aisle will become a thing of the past. In the future, shoppers will likely embrace the protein aisle. One-in-ten global protein portions could be plant-based by 2035, implying a $290bn market. Insects and cultured meat will likely be smaller segments, albeit with the potential to grow significantly. Given the opportunity, over $3bn has flowed into start-ups across the broad space in the past year. Most businesses remain private but expect both future listings and industry consolidation. In the listed area, we favour companies which can add clear value.

The world faces no bigger problem than how to feed its population. 9.7bn people will need feeding by 2050 (and 11.2bn by 2100), implying a greater than 50% increase in global food demand relative to current levels. Even today, almost 700m people suffer from hunger. At the same time that the world faces this challenge, the earth's resources are increasingly stressed. Consider that just 3% of the planet's surface is arable land available for farming while only 1% of the world's water is potable (all data per the United Nations Food & Agriculture Office, or FAO). With such scarce resources available, it should be of no surprise that environmental pressures such as water supply, deforestation and soil decline have become more pronounced, exacerbating the problems.

The facts are stark: **a single quarter pound hamburger requires 6kg of feed, 1700 litres of water and six square metres of land** (per the World Economic Forum, or WEF). Meanwhile, the meat and dairy industries account for 14.5% of global greenhouse gas emissions (FAO). In a typical lifetime, the average western diet comprises the consumption of over 1000 animals. Shockingly, the total number of animals slaughtered every two years exceeds the number of people that have ever lived (WEF).

Food production has always defined our societies, with the shift over time from hunter-gatherers to agricultural farming and most recently to industrial-scale production. Now, **the new food revolution is upon us. Alternative protein sources will become increasingly inevitable** and necessary for economic, sustainability, environmental and health reasons.

Currently, 75% of our food comes from just 5 animals and 12 plants (FAO). This will have to change. Think of four broad categories of 'new meat' or 'alt proteins', all of which will likely grow in significance, displacing conventional animal proteins. Most established are classic vegan and vegetarian replacements, such as tofu or seitan in the former category and Quorn – which contains egg – in the latter. Emerging at present are novel meat alternatives, made entirely from plants and meant to resemble meat closely. Insect-based options are well-established throughout much of the world but have yet to gain much of a presence in the western world. Finally, developments in cultured meat (which is typically produced through exponential cell growth in bioreactors) are accelerating, making this another potential growth avenue. These different segments will all likely complement each other (and meat too). The meat aisle in supermarkets will likely become a thing of the past, replaced instead by **the protein aisle.**

Plant-based alternatives represent the initial stage of the revolution. For the first time, these products (in contrast to classic vegan and vegetarian options) have a plausible chance of converting omnivores to make the switch. It seems clear that consumers want protein but that they're also concerned about their health and the environment. At the same time that these trends have become more pronounced, the range and quality of products available has markedly improved. A growing number of products look and taste very similar to conventional products, particularly in the burger and sausage category. Sophisticated production processes are increasingly able to mimic the sensory experience of eating meat.

Data abounds to support these contentions. 93% of plant-based meals are currently eaten by non-vegans in the UK, while 39% of British consumers say that they plan to reduce their meat consumption over the next 12 months. These statistics should perhaps be of no surprise given the knowledge that **if everyone in the UK were to eat one more plant-based meal a week, then this would be equivalent to taking 16m cars off the road,** thereby reducing the UK's carbon footprint by 8.4% (all data from

If everyone in the UK were to eat one more plant-based meal a week, then this would be equivalent to taking 16m cars off the road

Consumer acceptance will be crucial for growing all alternative protein categories

Meatless Farm, a leading player in the field). The products are tasty too, as your author can attest.

This is just the tip of the iceberg and there is a lot more still to be done. **Today, the plant-based meat alternative market has a ~1% share of the global protein market,** albeit that that this figure grew by 45% in 2020 (per Credit Suisse). More product availability, a wider range of options and improved quality should all contribute to driving category growth. Plant-based innovation should see next-generation products with lower fat and salt levels as well as cleaner labels with fewer ingredients. Innovators also continue to push the boundaries, going beyond burgers to replicate products such as tuna. Mimic Seafood, a Madrid-based start-up is using dehydrated tomato seasoned with olive oil, algae extract, spices and soy to this effect. Look ahead and **by 2035, over 1 in 10 protein portions could be plant-based, resulting in a global market worth at least $290bn** (per Boston Consulting Group). Some are even more optimistic, forecasting a 25% share by 2040 (per Kearney).

If plant-based technology is novel and continues to push boundaries, then insect-based protein has a long-established history. Pliny the Elder references the enjoyment of beetle larvae in his 1st Century writings. **Even if bugs barely feature in western diets, some 2bn people globally consume them currently** (per International Platform of Insects for Food and Feed). Given the compelling case for insect protein, it may only be a matter of time before their presence becomes ubiquitous globally. Insects are high in good things and have low carbon footprints. The humble cricket, for example, contains over three times as much protein and five times the amount of calcium as that derived from any animal. Further, for every kilo of insect protein produced, just 1g of greenhouse gas is emitted. The equivalent amount for chickens is over 300 times this figure. For cows, it is more than 2,800 times (all data per Eat Grub, an insect producer).

Around 1900 insects are edible, the most common options being crickets, beetles, mealworms, locusts, grasshoppers and ants, some of which your author has tried. **The edible insect market is still small today but is growing at a greater than 40% compound annual rate and could be worth $1.5bn by 2026** (per Global Market Insights). Notably, the industry saw over $200m of venture capital funding committed to it in 2020 (per Dealroom). This figure looks set only to expand.

While plant-based alternatives are increasingly ubiquitous and insect options can be found without too much difficulty, **cultured meat development is still largely confined to research laboratories at present.** Its potential is significant though. Think of cultured meat as being produced by in vitro cell cultures from animals (as opposed to slaughter). Another term for the idea might be cellular agriculture, with the meat produced by using engineering techniques traditionally applied to regenerative medicines.

2013 saw the unveiling of the first cultured meat burger, by Mosa Meat. Comprising 20,000 thin strands of muscle tissue, the burger had taken two years to create at a cost of ~$300,000. Wind the clock forward and owing to exponential gains in bioreactor technologies combined with falling costs of productions and the cost of burgers has dropped to 'only' around $250/ pound. They continue to decline rapidly. Upside Foods (formerly Memphis Meats)

says that it plans to have its first burgers available for the consumer market within the next six months. Go to Singapore and it's already possible to purchase cultured chicken (made by Eat Just). Over 40 start-ups have entered the field and are working on cell-grown beef, pork, fish, gelatin, milk and egg alternatives. French business Gourmey is even making a lab-grown version of foie gras.

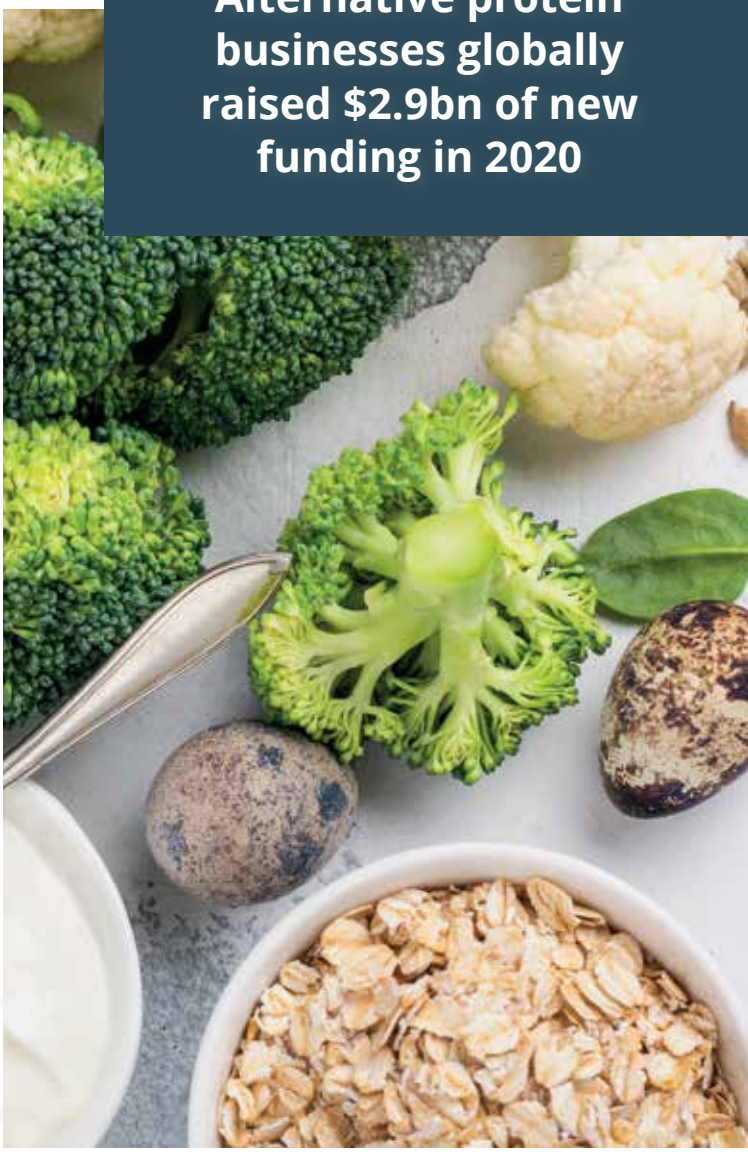
One-in-five UK and US consumers claim that they are eager to try cell-based meat products, although over two-thirds say that they would still prefer to eat real meat from slaughtered animals on a regular basis. The main reason cited for trying cultured alternatives is that they would reduce harm to animals, followed by lowering carbon emissions (per the WEF). **Consumer acceptance will be crucial for growing all alternative protein categories, even if the path for plant-based options is the least controversial.** Insects and cultured meat options continue to suffer from perception and 'yuck' factors, even if these probably need to be set in the context of the horrors of industrial-scale animal farming. Insects are, of course, already eaten widely in Asia, Latin America and Africa. Meanwhile the messaging from most cultured meat players is that their products are grown from natural, non-GMO cells which contain no antibiotics. Supermarkets can also play a clear role in improving product positioning and developing further the concept of the protein aisle.

The other key factor that will likely play a role in how the alternative protein market develops is cost. Consider that the price for 100g of conventional ground beef retails in a US store for around $0.80. This compares to ~$2.50 for an equivalently sized plant-based patty and ~$80 for a cultured meat option (per Kearney). The good news, however, is that as the alternative protein industry (and its various sub-sectors) gains in scale, then costs should fall, increasing access to the category. An increasing amount of venture capital flowing into the industry should also help it in this respect. Alternative protein businesses globally raised $2.9bn of new funding in 2020 (per Pitchbook).

Plant-based meat alternatives comprise by far and away the largest sub-segment of the new protein market. Some 600 players are present in the field (per Credit Suisse), with Beyond Meat (capitalised at ~$7bn) and Impossible Foods (still private) being the most significant. Nonetheless, given the addressable market opportunity, there is clear room for everyone to grow. Watch for many private companies potentially choosing to go public, providing these businesses with expansion capital. Further, the logic for consolidation – whether led by an industry player or private equity – is high. Established animal protein producers also may be forced to gain a presence in the alternatives market, given the direction of travel. Our preference would be to favour either **proven winners, leaders in niches or value-added players.** In this latter category, businesses such as Kerry Group (capitalised at ~€20bn) which provide functional ingredients – or building blocks – to established players in the food industry to facilitate new product development look well-placed. The revolution is only just beginning; the future will be increasingly meatless.

18 October 2021

Alternative protein businesses globally raised $2.9bn of new funding in 2020



Welcome To The Metaverse

Watch here

Executive summary: Imagine an immersive digital world, a space to interact with friends, make purchases, learn, be entertained, and more. This is some of the potential offered by the metaverse. It's seen by many as the next iteration of the internet. In the metaverse, real world experiences can be (re)created without physical or geographic constraints. Gaming platforms such as Fortnite, Minecraft and Roblox offer a sign of things to come. Each offers a virtual world, full of in-game purchase opportunities and the scope to participate in mass events. The global market for interactive gaming experiences and adjacent opportunities is already bigger than the revenues grossed by movies worldwide. Looking forward, the size of the metaverse is set only to grow. Although still early days, software businesses with platform offerings should win-out over their hardware counterparts.

Think of the metaverse as a digital mirror of the physical world

After the internet, what comes next? It's a fair question to ponder. For sure, barriers between our online and offline lives are fast disappearing, a trend undoubtedly exacerbated by the recent pandemic. Online digital environments are already being used increasingly for shared human experiences. Now, most of us are living ever-more dispersed digital lives, moving between different (and sometimes virtual) worlds seamlessly. The future will likely see an even more profound shift in the way people work, play, learn or simply hang out. Welcome to the metaverse.

Think Of The Metaverse As A Digital Mirror Of The Physical World. Go onto Google, type in the term 'metaverse' and you will be confronted with multiple definitions. The word, however, was first deployed in a science fiction novel written in 1992 called Snow Crash, by Neal Stephenson (who now works for virtual reality company, Magic Leap), which your Fund Manager read earlier this year. Stephenson perhaps describes the metaverse most amusingly here as being "like Las Vegas, freed from [the] constraints of physics and finance." Although this may sound like a daunting vision to some readers, the point Stephenson is trying to make is that **the metaverse can be thought of as a digital mirror of the physical world**. Put another way, it is **a collective virtual shared space**. Other terms that try to capture the essence of the metaverse might include the AR [augmented reality] cloud or the spatial internet.

Begin with these conceptions and you can already see the possibilities embedded in the notion of the metaverse. Such an environment could allow for **the re-creation and amplification of real-world experiences in a digital format, without physical or geographical constraints**. Think of it like this: just as every company created a webpage within the last two decades and then, at some later point, launched a Facebook page, so in the future, companies will look to establish a real-time metaverse presence. Perhaps the best definition of innovation is creating a new market where one previously did not exist. When it comes to the metaverse it may make sense to think even bigger – an entire new economy being created.

All companies will look to establish a real-time metaverse presence. How might all this work practically? Simulation games in which people can spend their time are not novel. Readers who remember the *pre-broadband* era may recall the launch of The Sims in 2000 or Second Life in 2003

All companies will look to establish a real-time metaverse presence

as early iterations. Wind the clock forward and with **faster compute speeds, enhanced data storage capacity and vastly improved digital rendering**, new platforms such as Fortnite, Minecraft and Roblox have emerged. While your Fund Manager was reading *Snow Crash,* his children were comfortably spending time in these metaverses.

Gaming is set to emerge as the next dominant technology platform, much in the same way that search engines, mobile phones and social networks helped redefine almost all other industries in the past. The market is a huge one: there were 2.69bn active gamers worldwide in 2020 (or 35% of the world's population), By the middle of this decade, the figure could be ~20% higher, per estimates **from Statista**. **Many already see video games as a 'third space', somewhere that is different both to their home and work environments**. Indeed, the average time spent playing video games is estimated at 1.1 hours per day, per person, according to Ofcom (the organisation also says that 62% of Brits are regular gamers).

As video games have evolved (i.e. got better, so that people spend more time engaging with them), so have their business models. Put simply, they have become more commercial. The logic is simple: **greater engagement generates higher recurring revenues, which are then invested into further innovation to drive even more time spent online**. It's a win-win situation for all. The best evidence to support this contention is that in-game purchases as a percentage of total gaming revenues have increased from ~20% to ~75% over the past decade

Gaming may be the next dominant technology platform

(per Statista). With users migrating to virtual worlds, brands are quickly following. In-app purchases are just one example. Consider another, where companies might purchase space in virtual worlds to advertise their wares. Digital clothing (for online avatars), world-building and/or marketing can and will have a real impact on brand development. Then there is the metaverse mall – rather than shopping through a specific retailer's website, why not meet a friend in a virtual world and check out a series of digital storefronts together? The same principles can be applied to education as well as entertainment. All three might become more shared, immersive experiences.

Gaming may be the next dominant technology platform. There is ample evidence to show the power of the metaverse in action currently. Take Pokémon Go as an early compelling example of how it can impact consumer behaviour. The mobile app drove millions of people outdoors to find, battle and capture virtual creatures at physical locations. Real-world businesses benefited, with restaurants that were virtual stops inside the game generating increased foot traffic, better online reviews and at least a 4% average boost to sales (per a study by McGill University and the Indian School of Business).

Pokémon, however, is a fairly rudimentary example, a blend of augmented reality with basic cartoon-like overlays. Better then to consider the worlds of Fortnite, Roblox and Minecraft. Daily active users on the former two platforms are 25m and 43m, while Minecraft counts 112m gamers that access its service. The commonality across all three worlds is **the existence of virtual currencies** (V-Bucks, Robux and Minecraft Coins, respectively), allowing for users to make in-game/in-app purchases. Fortnite's marketplace, for example, features a rotating set of skins (i.e. clothes), dance moves and cosmetic items. Participants can choose to dress their avatars in clothes from the likes of Burberry or Prada should they wish. The constant rotation of available options encourages repeat purchase behaviour (20% of Roblox users change their avatar daily). At the same time, part of the current in-game culture seems to award status and recognition to those with the most recent, coveted and high-cost purchases. The average paying Fortnite user spends ~$20/month on in-game transactions. Microsoft estimates that ~17% of its Minecraft users make monthly purchases, at an average of ~$12/month.

Metaverse platforms are about far more than just gaming, however. Their future is premised on **the flywheel effect engendered by increased engagement**. Repeat purchases are just one iteration. Others include the ability for gamers to become developers (and get paid for doing so), creating entire online micro sub-communities. Elsewhere, both Fortnite and Roblox have experimented with virtual concerts. The latter achieved a marked recent success by hosting an event with rapper Lil Nas X, which was viewed 37m times. Roblox has since signed music deals with both Sony and BMG.

Increased Engagement Drives A Virtuous Circle Effect. Global virtual multi-player gaming, virtual simulation platforms and interactive media revenue already reached $110bn in 2019. For context, this figure is larger than the revenues grossed by the

global film industry, which recorded $97bn of sales in 2018 (figures from SuperData and the Motion Picture Association respectively). Over 80% of the $110bn total came from in-game purchases on virtual goods with the remainder split between related activities such as retail, digital sales, downloadable content and advertising. Looking ahead, the opportunity is significant. The overall global gaming market is growing at a ~9% compound annual rate and could be worth almost $300bn by 2027 (per Research and Markets). Viewed from a different perspective, Roblox says that its potential addressable market is any person under the age of 24. Consensus estimates assume its daily active user base will at least double by 2024.

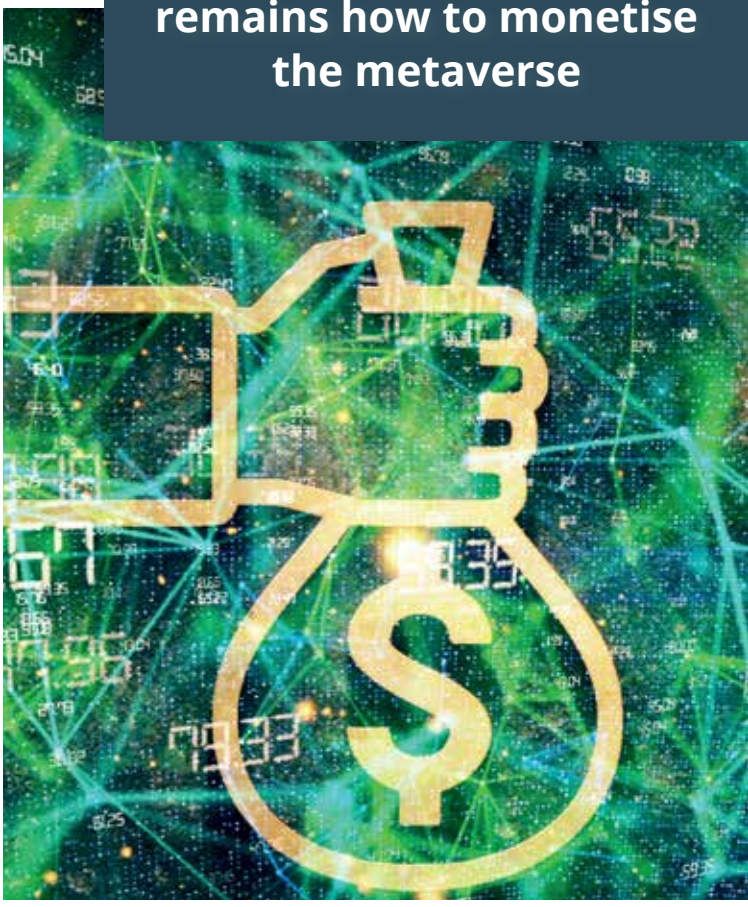
Before we all get too excited, it is worth remembering that **the metaverse is still an emerging concept** without even perhaps a fully agreed upon definition. **Common standards, interfaces and communications protocols between and among (different) virtual environments are still in development**. Consider that the internet, as we know it, was not developed by any single entity, but built collaboratively around open standards and protocols. Whether such principles might govern any successor platform is not clear. Were any company to consolidate its power over a future metaverse world, then the control it could exercise in terms of the sharing of information as well as commercial and security practices could be disproportionate. There are also valid concerns that the more control platforms potentially hand to their users to create and shape their environments and to interact with others, the greater may be the risk of more questionable content emerging. The subsequent impact on adjacent brands could also be problematic. Also do not forget that an increasing amount of time spent in immersive, virtual worlds may have negative social implications, in terms of how we interact practically in physical environments. This charge was, however, levelled at both television and the internet in their early days, although with little justification.

The key challenge remains how to monetise the metaverse. With no limit to the potential range of experiences possible in the metaverse, the challenge is how to monetise them and, for investors, how this translates into value creation. History would suggest that businesses on the software side of the value chain will likely prevail over the manufacturers of hardware. Beyond differentiated IP, the challenge is to create content (or experiences) that will generate recurring revenues and increase the opportunity cost of switching for users. Increasing the in-metaverse monetisation of experience seems the most likely route to success for now.

Of the three currently leading metaverse platforms referenced earlier, **Roblox** is the only one listed, at ~$45bn (Fortnite is privately owned, and Microsoft owns Minecraft). Beyond Roblox, **Unity Software** offers potentially interesting exposure to the theme via its foundational software solutions. These help support ~50% of the world's currently most popular games. Unity is US-listed and capitalised at ~$35bn. Both Roblox and Unity are loss-making. Other, larger businesses that will potentially seek to play a role in the evolution of the metaverse will likely include **Apple, Facebook, Microsoft, Netflix** and **NVIDIA**. Ultimately, it's a competition for gaining more share of consumers' leisure time. See you in the metaverse, maybe sometime very soon!

06 September 2021

The key challenge remains how to monetise the metaverse



Digitalising Dogs: The Long Tail Of The Pet Economy

Watch here

Executive summary: The $210bn pet economy is growing at a high single-digit rate annually, meaning it could be worth over $350bn by the end of this decade. Animals have their own dietary, healthcare and other supply needs distinct from humans, but the demand drivers are consistent: health and wellness, convenience and personalisation. The industry is also increasingly digitalising, with everything from product purchasing to virtual visits via remote monitoring now being conducted online. With a 'long tail' of predictable demand and economically resilient income streams, not to mention the clear scope to offer premium high-margin products and services, the industry is attracting the interest of investors. There are multiple listed ways to gain exposure to the sector, although we currently see most logic in integrated business-to-business players such as Covetrus.

Globally, 38% of households have dogs and 31% have cats

Last November, your author joined the legion of 10m other UK adults and got a pet dog. To say that the experience has been life-altering might almost be an understatement. There have been inevitable highs and lows (early morning toilet trips with a small puppy will never be glamorous), but the unconditional love that pets can offer is quite remarkable, and helped many – ourselves included – through the darker days of lockdown. It's almost hard to remember what family life was like in a pre-pet era. Further, unlike children – who will, at some stage, move out – our pet will be with us for all her life.

Does any of the above sound familiar? It should do to many readers of this piece, since **globally, 38% of households have dogs and 31% have cats** (based on a 17-country survey by GFK). In the United States, the world's largest market for pets, household ownership reaches 67%, with dogs outpacing cats (32% vs 21%, per the American Pet Products Association, or APPA). The Argentineans are the world's biggest lovers of dogs – they inhabit 66% of households – while the Russians favour cats most highly (present in 57% of households, per the GFK survey).

Unsurprisingly, then, **the pet economy is a large market, worth $210bn** (per Global Market Insights). The US market alone is worth ~$100bn (per the APPA). **In the past decade, the market globally has expanded at a faster pace than world GDP** (66% vs 43%, per another study, by Euromonitor) and is set to experience high single-digit growth over the medium-term, based on most consultants' forecasts. Anyone who owns a new cat or dog can expect to have that animal for at least ten years, implying a 'long-tail' of predictable demand.

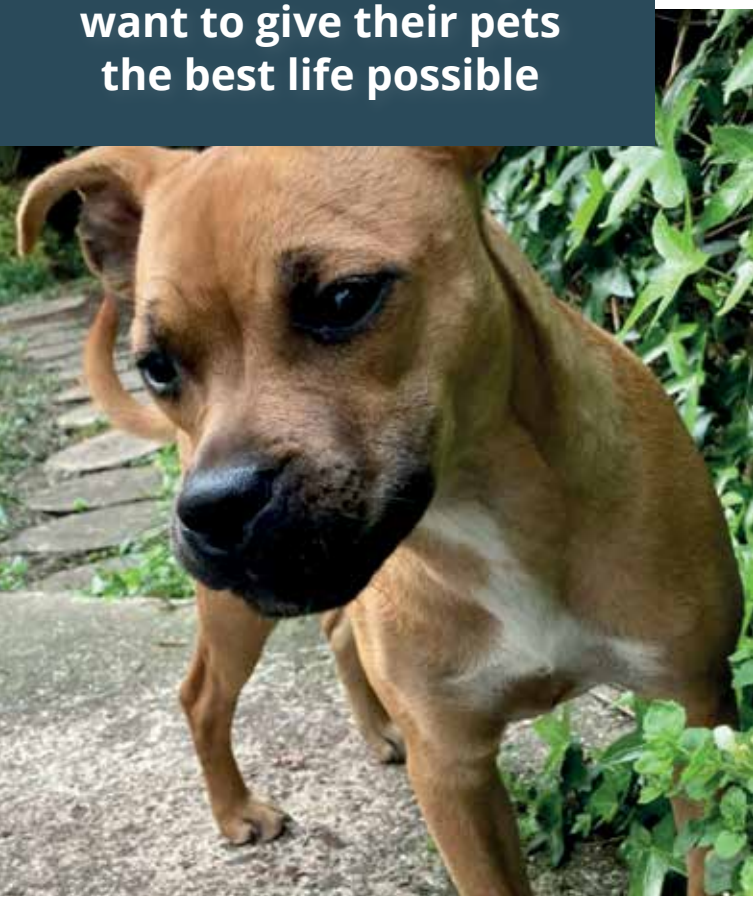
Think of the pet economy as being the ecosystem that embraces the well-being of companion animals. Pets clearly have their own dietary, healthcare and other supply needs, distinct from humans. At the same time, many of the same drivers that support (human) consumer discretionary behaviour also play to the world of pets: wellness, convenience and personalisation. The digitalisation of all the above provides an additional demand driver.

Pet owners clearly want to give their pets the best life possible. 75% of those interviewed said that taking care of their pet's health was as *important* as their own, a conviction reinforced by the fact that 90% of dog owners and 86% of cat owners consider their animals as part of the family (data from IDEXX and Packaged Facts respectively). The reason why is simple: **pets are credited with helping humans with everything from mood to security to exercise and more**. The term 'zooeyia' exists to characterise the positive benefits to human health from interacting with animals. Various studies suggest that interacting regularly with animals can help reduce anxiety, depression, fatigue and physical pain. One recent report from the University of York found that over 90% of pet owners believed that owning a pet helped them cope emotionally through the first lockdown of 2020.

An important consideration here is that **pets offer companionship**. This matters since the number of one-person households is increasing globally, partly as a function of demographics. The UK's Office for National Statistics forecasts a 25% increase in people living alone between 2016 and 2041. Pets are a powerful antidote to loneliness. In China, pets have become a substitute for children, particularly in larger cities. In a country with 240m single adults (or 17% of the population), the pet economy is predicted to expand at a 25% compound annual growth rate over the next five years (per PwC).

Think of the pet economy as being the ecosystem that embraces the well-being of companion animals

Pet owners clearly want to give their pets the best life possible



The corollary of the above is that **the disposable income owners are willing to allocate to their pets is increasing. Longer pet lives also imply more product innovation, primarily to address hitherto unmet needs** (not to mention illnesses). 69% of pet parents say that they are now spending more on pet products than they used to, while 85% stated that they were willing to pay more for pet foods that were healthier for their animals (per Packaged Facts). A separate study highlighted that 69% of Millennials give their pets natural or organic food, with a similar percentage also purchasing products that had a low carbon footprint and/or sustainable packaging (per First Insight Research).

The market for pet indulgences also continues to expand apace, with product innovation in this segment both delighting and bewildering your author (as well as occasionally lightening his wallet). Dog yoga, or doga, is apparently a big thing now. Should owners wish to take their dogs to stay at a Hilton hotel, there is a dedicated dog menu ('Bone Appétit') available, offering the likes of 'Beef Doguinon' and 'Earl Greyhound' tea. Next time you're celebrating a special occasion and want to involve your pet, why not consider 'Pawsecco' freeze pops? The list goes on, but it is worth noting that over 50% of cat and dog owners gave their pet a Christmas treat, while around a third mark their animal's birthday (per Petpedia).

Furthermore, just as consumers are increasingly digitally connected, so they are seeking similar smart devices for their pets. Pet safety and security are the two biggest concerns animal owners say they want to solve. Related is the deployment of pet-tech to ensure that animals feel less lonely when their owners are absent. Solutions include pet cameras, trackers and GPS collars as well as automated feeding devices. Perhaps the most novel idea is DOGTV, which does exactly what it says, creating "personalised patented programming that dogs can watch, learn from and be entertained." Your author has not started a subscription (yet), but over 10% of US households have adopted some form of pet-tech.

As with most humankind use cases, **digitalising the animal world shifts the industry paradigm from a reactive stance to a proactive stance with higher overall engagement levels**. Pet owners naturally want to transact online, whether it is purchasing food or dealing with their vet. More broadly, **the application of technology to the pet sector creates a scenario where everyone wins**, particularly in the context of animal healthcare. Think of it as improving outcomes for all stakeholders: better business and clinical results for veterinarians, increased growth for product manufacturers and more convenience (as well as better care) for animal owners.

Against this background, **many of the future trends we have written about elsewhere are now also gaining in prominence in the world of pets**. Take **telemedicine**, the virtual vet increases convenience and efficiency for pet owners and can reduce the stress (for both animal and owner) of having to take a pet on a long journey for a real-world consultation. If offered as a subscription service (by the likes of Pawp, VirtuWoof, PetDesk, WhiskerDocs etc. in the US currently), then the recurring revenue stream also constitutes an attractive business model. Another example is the growth in animal **DNA sequencing**, which allows not only for the tracing of lineage – important for breeding purposes – but also to pre-empt future potential illnesses. The concept behind

BorrowMyDoggy is also a good one: this app connects busy animal owners with those who want to spend some time with a dog but are unable to own one. It's a great example of the **sharing economy**. Expect further use cases to emerge too.

With multiple demand drivers, it seems there is little not to like about the pet economy opportunity. One charge often levelled at the industry is that animal owners typically use discretionary income to purchase services or products for their pets and hence economic concerns may cause some owners to forgo or defer visits to veterinary practices or, in extreme cases, even cease to continue owning a pet. The good news is that data from previous recessions (particularly during the credit crisis – see information on the Bureau of Labour Statistics website) is that **pet expenditure remains one of the most resilient categories across the economic cycle**. A recent (July 2020) survey by IDEXX found that pet owners said that, were household income to decline, then they would forgo eating out (90% of respondents), personal grooming services (85%) and video streaming services (77%) in order to cover pet expenses. The other important consideration of which it is important not to lose sight is that, as the pet industry preimmunises, animal well-being remains the priority. Not all pampering services may suit all animals, while virtual pet care requires strict regulation. In the US, a pre-existing vet client-patient relationship already needs to be in place prior to any tele-vet services being offered.

From an investment perspective, the industry has undoubted attractions. The category has been stable and predictable, yet also expanding, revenue streams; there is high purchase frequency, low seasonality and resilience in economic downturns. Subscription-style business models abound and for active players within the space, the margin upside potential from premiumisation and/or digitalisation is significant. There is also ample scope for industry consolidation, given fragmentation, particularly in certain segments such as consumables. For businesses that are able to operate across multiple adjacent areas of the pet economy, the opportunity costs for suppliers/customers of switching are also significant.

Multiple ways of gaining exposure to the pet economy theme exist, from animal healthcare and diagnostics through to broad-based solutions via direct e-commerce plays as well as dedicated pet food and animal insurance specialists. Within the former category, US-listed **Zoetis** is the market leader, while **IDEXX** dominates the diagnostics space. **Covetrus** offers an interesting business model, as the global leader in the distribution of veterinary products as well as number-one positions in US prescription management and software solutions, including telemedicine. Even if Amazon has a significant presence in the companion animal e-commerce space, Chewy has established a strong presence in the US as has **Zooplus** in Europe. Several Chinese-listed plays such as **PetPal Pet Nutrition Tech, Dogness International** and **Yantai China Pet Foods** also exist. Expect more players to enter this market over time. The long tail is a large opportunity.

15 June 2021

The application of technology to the pet sector creates a scenario where everyone wins

Micromobility: Disrupt The Car And Rethink The City

Watch here

Executive summary: Personalised short distance transport represents the best future solution for cities. Micromobility offerings from bikes to scooters (both manual and electric) have significant cost, efficiency and environmental advantages relative to cars. Over 200 cities globally have accelerated their micromobility initiatives in the past year and consumers have embraced the concept, evidenced by both purchase and usage data. Although the micromobility market is still highly nascent, it could be worth $300bn by 2030. Even then, with a 5% share of the global transportation pie, the longer-term runway ahead is significant. The industry has begun to consolidate and deal valuation levels are lower now than they were pre-pandemic. This creates a clear investment opportunity for the longer-term, even if the majority of leading players are currently private and likely loss-making.

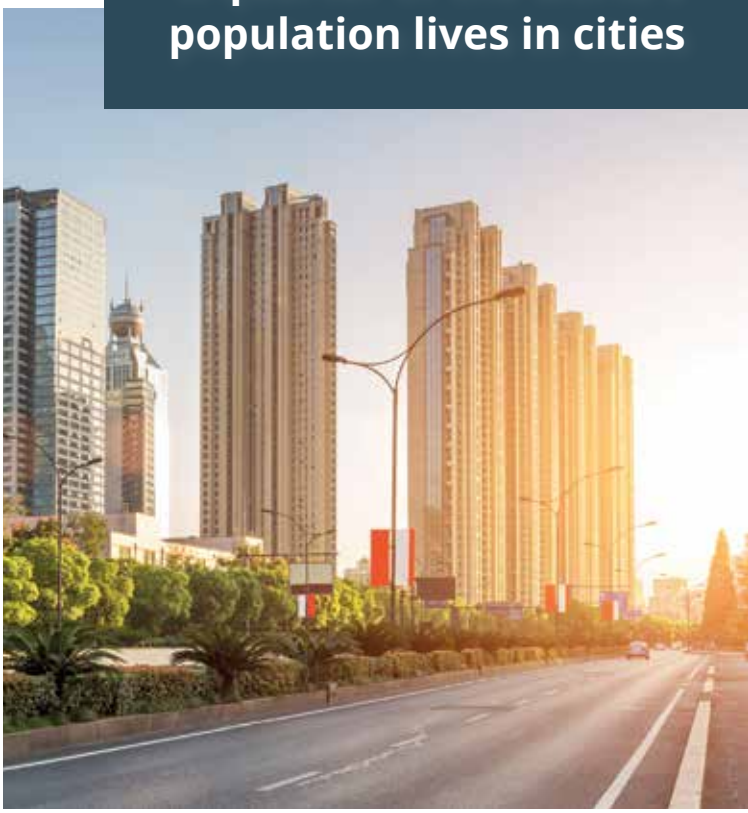
Micromobility can be part of the solution for re-engineering cities and making them a more attractive place to work and live

If ever there were a time for rethinking established ideas, then it would be now. **What will be the attraction of cities in a post-pandemic world** when it has become increasingly possible to live our lives without needing to leave our homes? Commuting currently sounds a much less compelling proposition than it did previously, particularly given growing concerns about environmentalism and pollution. We expect cities to continue playing an enduring role in the world; what needs to change, however, is how they – or the plumbing that underpins them – are configured. **A quarter of the world's population lives in cities**, where the average traffic speed is less than 5km/hour. Congestion had – pre-pandemic – been rising globally. It had increased in New York and Los Angeles by some 30%, while London saw congestion levels 14% higher over the last decade (data from the United Nations and McKinsey respectively). Most journeys are surprisingly short, with 46% of US car trips less than three miles in distance. Being stuck in traffic is clearly not efficient with the average American losing 99 hours a year as a result (per INRIX research). At the same time, transportation is highly polluting, accounting for 28% of global carbon emissions (per Bloomberg New Energy Finance).

Few people can say that they enjoy congestion, gridlock, air pollution or parking shortages. The pandemic then may have only accelerated a trend that was inevitable, compounded by social distancing: why commute/ travel to cities, either by private or public transport? The imperative, then, is to **re-engineer cities and make them a more attractive place not only to commute to, but also in which to live and work**. Imagine the alternative. One future could see crumbling urban infrastructure, declining commercial real estate values, shrinking tax revenues and an exacerbation of inequalities.

Micromobility can be part of the solution for re-engineering cities and making them a more attractive place to work and live. This is where micromobility can play a critical role. Think of the concept as comprising personalised short-distance transport. Bicycles and scooters have existed since the 19th Century but were displaced by cars and public transport for much of the past hundred years. Micromobility devices can now be either manual (human-powered) or electric; owned either privately or belong to a fleet. In turn, these fleets may either be part of a public, planned and city-led initiative or be deployed by private sector firms. Think London's

A quarter of the world's population lives in cities



'Boris bikes' in the former category and Jump scooters in the latter.

The case for micromobility is simple: it's about **disrupting the car** and providing a clear alternative to car ownership (and public transport usage) based on trip length. **Micromobility vehicles could theoretically ferry much of the world's population on a majority of their trips more cheaply and faster than comparable alternatives, while also consuming less energy**. Shared micromobility vehicles are simple to use: just download an app, pay and off you go. The typical cost is around $1 to unlock the vehicle and then ~$0.15 for every minute travelled, although this will vary by country.

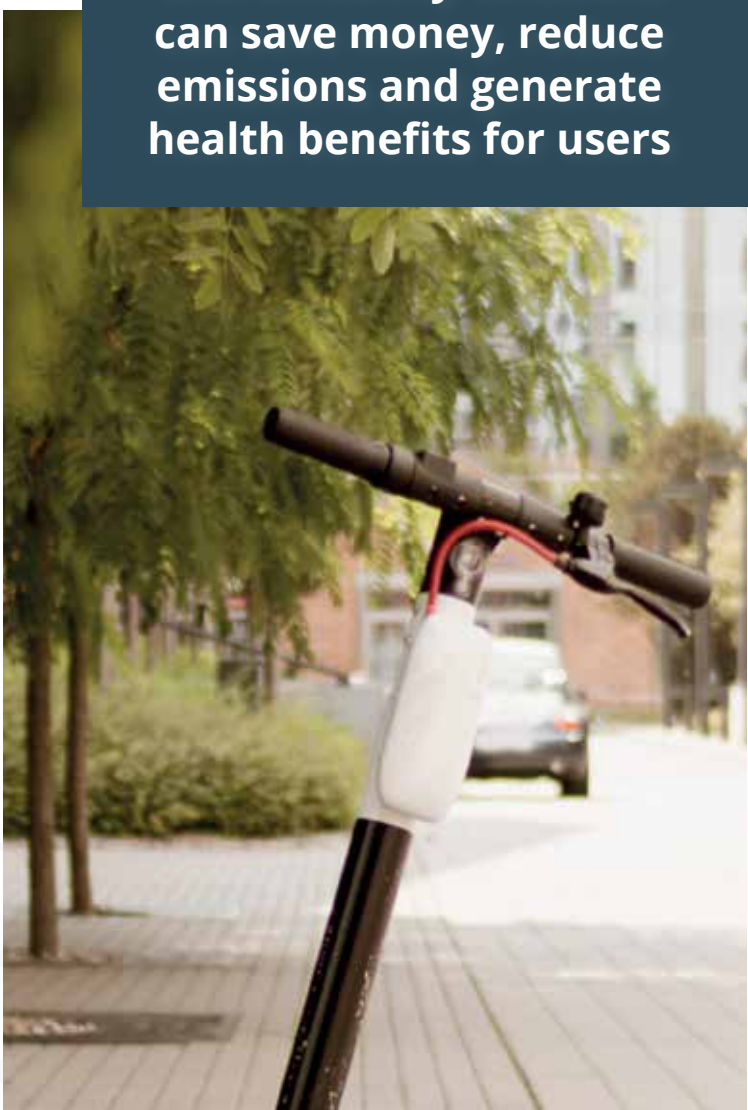
Think of micromobility as personalised short distance transport. Consider the benefits. Begin with cost. Electric scooters currently retail for $400-500, which implies you could buy around 100 of these for the cost of one electric vehicle. **Assume five rides a day and an electric scooter could break even within less than four months** (per McKinsey), implying the economics of shared micromobility are largely favourable to industry participants. It is a lot easier to scale up micromobility assets when

Think of micromobility as personalised short distance transport

compared, say, to car-sharing solutions. There is also a strong efficiency argument. One kilowatt hour of energy can only get a gasoline-powered car to travel 0.8 miles, whereas an electric vehicle could travel 4.1 miles under the same conditions. However, an electric scooter could travel 82.8 miles using the same amount of energy (per Valence Strategic Consulting). Think also of the reduced congestion benefits: around 7,500 bikes can pass through a single 10-foot lane in an hour, compared with between 600 and 1600 cars (per the National Association of City Transport Officials). Put another way, 10 bikes or 20 scooters can fit into the space occupied by one car (per Barclays Research). Also don't rule out the holistic or more qualitative advantages. Consumers may value shared mobility solutions since not only are they faster, but they provide health benefits, help save the environment and allow for cities to be seen in a new light.

Micromobility solutions can save money, reduce emissions and generate health benefits for users. It's no surprise then that **the global micromobility market could be worth up to $500bn by 2030**, with the US accounting for $200-300bn of this total, Europe $100-150bn and China $30-50bn (per McKinsey). The variations in addressable market size reflect

Micromobility solutions can save money, reduce emissions and generate health benefits for users



different pricing assumptions. Viewed from another perspective, **micromobility could account for a 5% share of the global transportation market by 2030** (per Goldman Sachs). These forecasts may prove conservative. Consider that US households currently spend over $1tr annually on the purchase, operation and maintenance of personal vehicles. Even if micromobility services were only to win a small share of this spend, then it could be significant. As a potential sign of things to come, it is noteworthy that electric two- and three-wheelers are currently outselling electric vehicles by a factor of ten to one (per Bloomberg New Energy Finance).

Cities are already beginning to respond. There has been a general acceleration of micromobility efforts during the pandemic, with streets closed to car traffic and bike lanes expanded. Micromobility Industries, a lobby group, estimates that **over 200 cities globally expedited their micromobility efforts over the past year**. Significant portions of London are being made car-free to reduce congestions and emissions as the city comes out of lockdown. Electric scooters are also being currently trialled in five British cities. Meanwhile, Paris is converting 50km of major city arteries into bicycle highways, while similar expansions are underway in Brussels and Milan (40km and 35km respectively). Elsewhere, such was the positive reception to Seattle's temporary closure of 30km of roads to through-traffic in lockdown, that this has now become permanent.

Consumers are also embracing the trend. Multiple sources suggest that purchases of bicycles and related equipment have at least doubled in the past year, while some vendors of electric bikes/scooters have reported a tripling in their sales relative to prior year figures. A recent study conducted by Lime, a leading player within the micromobility space, found that whereas just 6% of users said they had purchased a car, truck or motorcycle during the pandemic, 23% had purchased a bicycle, electric bicycle or electric scooter. 75% of people interviewed in London and New York – which do not currently have scooter share schemes – said they intended to ride scooters in the future, while 35% said they would use on a weekly or daily basis, implying it could become a regular part of commuting.

Both cities and consumers have already begun to embrace micromobility. The conversion of

Both cities and consumers have already begun to embrace micromobility

opportunity to reality will, however, not be linear. Consider first who pays for new infrastructure and how it is regulated. This debate encompasses appropriate cycle/scooter lanes as well as potential docking equipment. Many cities, particularly in the US, have historically prioritised cars over all other transport modes. In New York, for example, bikes allegedly out-number racks by a factor of almost 30 to 1 (per the New York Times). Further, dockless bikes and scooters remain a relatively novel concept and most cities do not have proper regulations in place for how programmes should run. While some cities are celebrating their successful launches, others are banning such companies from operating, citing safety concerns. Beyond this topic, there is the related issue of aesthetics. Parked/ abandoned bikes and similar do not really belong on pavements or streets and can creates hazards for other riders, drivers, and pedestrians. The aforementioned safety concerns should not be understated either. Electric bikes and scooters lack airbags and other safety features that vehicles would possess, representing a risk for users

involved in accidents. Furthermore, owing to their silent nature, they can be particularly dangerous for people with disabilities such as those who are blind and partially sighted.

None of the above is insurmountable. Solutions will likely require increased planning and coordination, typically between the public and private sectors, such as in cities like London and Hong Kong. Cities, of course, are not homogenous entities either and no one-size-fits-all approach exists. Some degree of trial and error will therefore be inevitable. Also, do not forget that the industry is still highly nascent. Most businesses operational in the space are less than five years of age. **Around $150bn has been invested in new mobility technology businesses over the past decade, with an estimated $6bn directly into micromobility start-ups during the five years** (per Pitchbook and McKinsey respectively). Out of the pandemic may come the investment opportunity. Not only have implied valuation levels for many start-ups come down (Bird and Lime's estimated valuations are an estimated one-fifth below peak levels), but the industry has consolidated (Bird has acquired Scoot, Lime acquired Jump etc.). With economies re-opening, interest in the space is likely to grow again.

Businesses that 'own' the customer relationship look best-placed to benefit. History would suggest that **those who control the software and hence 'own' the customer relationship will be best placed to benefit over the medium-term**. However, **almost all the businesses operational in the space currently are either private or part of bigger organisations**. Accurate and easily comparable information on users and usage is therefore hard to come by. Uber has a strong franchise in the space, having acquired Jump bikes in 2018 and then transferring it to Lime in May 2020 as part of a larger funding round. Uber has options to purchase Lime between 2022 and 2024 at a set price. Lime/Jump services are currently available in around 100 cities globally. Also watch for Bird (founded by ex-Uber executives), Spin (owned by Ford) as well as emerging European businesses such as Voi and Tier. In China, Didi Chuxing has developed a leading position, although many other players including Mobike, Hello Bike and Ofo are also present.

The car, of course, is not going to disappear overnight. Further, time will only tell if the best last-mile alternative ends up being electric scooters, dockless bikes or some new form of transportation yet to hit the streets. We expect some combination. **Micromobility will go multi-modal**. Watch this space.

19 April 2021

Businesses that 'own' the customer relationship look best-placed to benefit

Telemedicine: The Virtual Doctor Calls

Watch here

Executive summary: Healthcare is becoming decentralised, enabled by broadband and smartphones. The current pandemic has helped accelerate the inevitable. Telemedicine (or telehealth) represents an efficient solution to matching customer demand with physician supply, reducing the burden of inefficiency and cost inherent in legacy healthcare systems. Both patient and doctor feedback has been extremely positive, even if more still needs to be done. The growth opportunity ahead is significant, with some studies suggesting that not even 1% telehealth adoption has been reached yet across developed markets. Expect market growth rates in the mid-teens for the coming years. Against this background, start-up funding has accelerated (and may have topped $10bn in the US in 2020) although there are few listed ways of playing the theme currently. Teladoc appears to have an early lead.

Think of telemedicine as the decentralisation of healthcare, enabled by broadband and smartphones

When was the last time you went to see a doctor? Think about what a strange process it is. Typically, a patient develops symptoms, next visits a surgery, potentially infecting others while waiting for their appointment. The doctor then diagnoses the problems, usually from outwards symptoms and subsequently sends the patient home, perhaps with a prescription but often with the recommendation of watch and wait. In most cases the patient recovers, although sometimes a trip to hospital becomes necessary. **This model is evidently ripe for disruption with virtual healthcare, or telehealth/medicine, providing the solution**. The COVID-19 pandemic has elevated a rethinking of healthcare from being not just about choice and convenience, to one of necessity to protect both doctors and patients.

Healthcare provision needs rethinking: more than $1 in every $5 spent on US healthcare is either wasted or misallocated

Healthcare provision needs rethinking. How money is spent currently is highly inefficient, while populations are ageing, in the developed world particularly. Some studies suggest that **more than $1 in every $5 spent on US healthcare is either wasted or misallocated** (per the Journal of the American Medical Association). This matters when 28% of the US federal budget (or 17% of the country's GDP) is spent on healthcare annually. Consider that, even at a basic level, the average patient has to wait 24 days to schedule a doctor's appointment in the country's 15 biggest cities (per Doctors on Demand, a healthcare provider). The problems don't end there: if you do need treatment, medical error constitutes the third biggest killer in the US (data from the OCED). Perhaps this shouldn't be too surprising given that the World Health Organisation estimates that globally there will be a shortage of more than 7m healthcare workers; a figure that will rise to 13m by 2025. Overworked and under-resourced medical professionals are having to deal with increasingly elderly and more fragile populations too. Some 80% of people over the age of 65 have at least one chronic condition (per the New England Journal of Medicine), while 50% suffer from at least two.

Healthcare provision needs rethinking: more than $1 in every $5 spent on US healthcare is either wasted or misallocated. The good news is that there are solutions at hand. New technologies will create better outcomes and free up resources to help manage demographic pressures. Consider it **the decentralisation of healthcare, enabled by broadband and smartphones**. Under this world view, patients become more empowered as consumers and (some) care is shifted from the surgery/hospital to the home. The recent pandemic has served to accelerate this trend. A McKinsey survey of May 2020 showed that 76% of consumers said they were interested in virtual care, a massive jump compared to the 11% in favour a year prior. In a separate study (by Teladoc, a leading provider), 67% of patients said they want a virtual care doctor to partner with their existing services. Additionally, 80% of large companies in the US state that implanting virtual healthcare solutions is their number-one healthcare priority (per a survey conducted by the Business Group on Health). Viewed from the other perspective, 64% of healthcare providers now say that they are comfortable using telehealth services (again per McKinsey).

So what is telehealth? Put simply, it's a portmanteau combining telecoms/technology and healthcare. The term is used interchangeably with telemedicine too. Perhaps the best formal definition comes from the US Department of Health, which defines it as **the use of electronic information technologies to promote clinical healthcare and patient and professional health-related education**. Such services are typically provided using video communication technology but may also be provided using alternative audio and text-based media.

~$500 per patient is saved for every virtual healthcare visit relative to real world encounter. The main benefit of adopting telehealth services is that everyone wins: **customer demand is matched with physician supply**. Consumers typically lack access to high-quality, cost-effective healthcare at appropriate

~$500 per patient is saved for every virtual healthcare visit relative to real world encounter

sites of care. Telemedicine effectively brings healthcare services direct to consumers, extending the geographic reach and expertise of both physicians and healthcare facilities. This results in **major cost efficiencies: better staffing, reduced travel times (on both sides) and fewer or shorter hospital stays**. The largest study to-date on the topic (conducted by Veracity Analytics in 2019 and covering 2m people) highlights that an average of $472 per patient was saved under a virtual health scenario relative to a real world visit. The American Medical Association states that "studies have consistently shown that the quality of healthcare services delivered via telehealth is as good as those that are given in traditional in-person consultations." No wonder then that 84% of people who had a virtual medical consultation said they were able to completely resolve their concerns during the visit (per a JD Power 2019 consumer survey).

Against this background, **"telehealth is now being accepted as an essential service"**, per Amit Phadnis, the Chief Digital Officer at GE Healthcare. **Global virtual healthcare interactions probably exceeded 1bn in 2020** (per Forrester Research). The pandemic has had an inevitable effect in accelerating demand. McKinsey estimates that ~11% of US consumers used some form of telehealth service in 2019, a figure which had jumped to 46% during the peak of the pandemic (May 2020). Teladoc disclosed that on its busiest days during the past year, it was handling 15,000 video requests for telehealth services a day. Interestingly, demand cut across all age groups, cohorts and regions as well as medical reason. While some demand has inevitably dropped off as lockdowns started easing, **Teladoc's best estimate is that its virtual visit trend could stabilise at a level some 40%+ higher than pre-pandemic**.

It is not only in America that demand for such services has accelerated. Consider that in Japan – where the average age of both a doctor and a patient is higher than anywhere else in the developed world – telehealth adoption has jumped from 1% in 2018 to ~15% in 2020, despite generational resistance to technology (per the Japanese Medical Association). Although no publicly disclosed figures are available for the Chinese market, anecdotally, the country has spent large sums to drive the digital adoption of healthcare. Meanwhile, several smaller countries such as Estonia and Israel have embraced fully digital healthcare systems for some time.

Even if there is no consensus from analysts and consultants on exactly what falls under the broad umbrella of telehealth, the market has significant growth potential ahead. Most forecast a **15%+ CAGR for the global market through to the middle of this decade** (based on studies from the likes of Grand View Research, Markets and Markets and Polaris). Thought of another way, Teladoc says that it has ~70m patient relationships today in the US, which compares to the country's population of 320m. If you were to add in the international population of other highly developed countries, this results in an addressable market of ~1.1bn people, of which **less than 1% are covered currently**. McKinsey's study suggests that in the US alone, 20% of all Medicare, Medicaid and commercial outpatient, office and home health spend could be virtualised, equivalent to a $250bn opportunity.

Less than 1% of the addressable market for telehealth is covered today. It's important to

remember, however, that **there is a limit to what telemedicine can do**. It will never fully substitute for an in-person visit, lacking the ability to conduct a physical examination and a deeper inter-human connection based around non-verbal cues and the greater transmission of trust and empathy. Though telehealth is often pitched as a solution to improve access to healthcare for everyone, more than half (52%) of users say they encountered at least one barrier that made usage more difficult than anticipated. The most common hurdles were limited service, confusing technology requirements and lack of awareness about cost (per the JD Power consumer survey cited earlier). It is therefore crucial not only for regulators and insurers to create the appropriate framework for market development, but also better broadband access to be rolled out. Some 20m Americans – and often those most in need of healthcare – lack broadband access currently (per the FCC). Furthermore, in order to ensure greater adoption, matters such as the security and privacy of confidential data need to be considered as well as its sharing and the interoperability across different competing virtual solutions.

Despite these considerations, **increasing sums of venture capital are being allocated to healthcare technology start-ups**. Investors put a record $5.4bn into early-stage US healthcare technology businesses in the first six months of 2020, more than in any other six-month period dating back to 2010 (per Rock Health, a seed fund). Europe has also jumped on board, with an estimated 300+ deals occurring over the same period in 2020, equivalent to $2.6bn of funding (per Research Briefs). However, **there are currently few listed pure plays within the telehealth arena**. The industry remains highly fragmented, characterised not only by start-ups, but also by subsidiaries of larger players operating across the healthcare value chain. Businesses as diverse as Cerner, Cisco, GE Healthcare, IBM, IQVIA, Medtronic, Philips and Siemens Healthineers all claim to lay a stake in virtual healthcare provision. One study (by Becker's Hospital Review) lists over 260 telehealth businesses active in the US as of September 2020.

Increasing sums of venture capital are being allocated to healthcare technology start-ups. Teladoc is the largest player within the telehealth space. Listed in 2015 and capitalised at ~$41bn, it has an estimated global market share that is 4-5 times higher than its next closest rival. Services are delivered in more than 175 countries in over 40 different languages. Teladoc works with over 50,000 clinicians covering more than 450 sub-specialities. Over 14m virtual visits occurred across all Teladoc facilities in 2020, more than double the previous year's level. Also active within the US market is **Amwell**, which was founded in 2006 and listed in September 2020 (capitalised at ~$8bn). The business says that 150m potential patients currently have access to its telehealth plans. Further afield, investors can also gain access to two large listed plays in China. **Ping-An Good Doctor** claims to be the country's largest online health platform, while **Ali Health** is expanding into virtual care given its current position as China's largest e-pharmacy business. Ping-An Insurance and Alibaba respectively hold majority stakes in these businesses. Watch this space for more listings globally...

17 February 2021

Less than 1% of the addressable market for telehealth is covered today

Part Three: Appendices

Heptagon Future Trends Index

We have published 59 dedicated pieces on future trends since 2011, covering 51 unique themes (owing to their importance, data, cybersecurity, education, food innovation, robotics, transportation and water have seen dedicated update notes issued; in the case of data, twice). Below follows the complete list, sorted alphabetically, with the date of first publication too. As mentioned previously, our most recent notes spanning the past two years have been republished in this document. Every piece since inception is accessible via Heptagon Capital's website.

3D Printing	Coming soon to a printer near you (October 2012)
5G	Gee-whizz: the hype and the reality (April 2020)
Agriculture	We're all hungry for some agtech (February 2019)
Alternative meat	Beyond impossible (August 2019)
Artificial intelligence	The rise of the smart machine (April 2016)
Blockchain	No more middlemen (January 2018)
Cannabis	Green rush: the current investor high in cannabis (June 2019)
Car of the future	The long road to autopia (April 2015)/ The new transport revolution (February 2017)
Cashless society	Cash dethroned (May 2013)
CRISPR/ gene editing	Time for a DNA upgrade? (June 2017)
Cybersecurity	Watch out! The growing privacy invasion and cybercrime threat (April 2014)/ The next generation (September 2017)
Data	The data deluge (March 2011)/ Drowning in data (October 2012); Ten years on; the data deluge 2.0 (October 2020)
Decentralised finance	Demystifying DeFi (May 2022)
Digital currencies	At the tipping point? (February 2015)
Drones	Drones: now ready for take-off? (October 2022)
EdTech	Back to school (December 2013)/ New school rules (August 2020)
Energy storage	What if the sun always shone? The coming energy storage revolution (September 2015)
Food innovation	You are what you eat; health, wellness and food innovation (October 2014)/ Food's future; how to feed the world more intelligently (October 2021)
Fracking	(Almost) everything you've ever wanted to know about fracking… (September 2011)

Future homes	How the house of the future may look... (July 2011)
Healthcare IT	Healthcare transformed: how IT can help save lives (April 2013)
Hydrogen	The missing element (June 2020)
Implantable technologies	The man-machine merger (September 2016)
Internet of Things	Connecting the unconnected (July 2014)
LED lighting	The light bulb moment (July 2013)
Liquified Natural Gas	A 'natural' solution to the world's energy needs (April 2011)
Longevity science	Who wants to live forever? (October 2019)
Metaverse	Welcome to the metaverse (September 2021)
Microbiome	Gut feeling (June 2018)
Micromobility	Disrupt the car, and rethink the city (April 2021)
Molecular diagnostics	Reinventing healthcare and the coming age of personalised medicine (November 2012)
Nanotechnology	Get ready for nanotechnology (September 2013)
Obesity	Fat profit potential: bulging bellies and growing obesity (April 2012)
Online retail	Just the tip of the iceberg (February 2014)
Peer-to-Peer lending	The P2P revolution: goodbye to the high street bank? (June 2015)
Pet economy	Digitalising dogs: the long-tail opportunity (June 2021)
Plastic pollution	Winning the war on waste (September 2018)
Power shortages	What happens when the lights go out? (May 2011)
Quantum computing	A leap forward (October 2017)
Rail renaissance	Full steam ahead! (October 2011)
Robotics	The robot revolution (July 2012)/ Robotics 2:0 – the rise of the service robot (April 2017)
Sharing economy	Get sharing! (February 2016)
Smart cities	Livin' for the city (April 2019)
Smart grids	Keep the lights on: make the grid smarter (September 2022)
Solar energy	Everybody loves the sunshine (January 2020)
Space	To infinity and beyond? The growing case for space (October 2018)
Synthetic biology	Food for thought? (November 2016)
Telemedicine	The virtual doctor calls (February 2021)
Virtual reality	Time to get real? (June 2016)
Water shortages	The curse of Coleridge (June 2011)/ Liquid data: digitalising the water sector (February 2022)
Wind energy	Winds of change (March 2018)

Heptagon Future Trends Blog

The *Future Trends Blog* was launched at the start of 2019. Since then, we have published almost 200 posts including over 40 so far in 2022. 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. 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.

Our Blog posts are published whenever we uncover pertinent insights and typically come out once a week. These may be accessed via Heptagon Capital's website and also via LinkedIn and Twitter.

Below follows a complete index of the pieces we have posted to the Blog so far during 2022. Blog post #29 ("What, no global warming?"), released on the hottest day of the year in the UK, has been our most commented upon and shared piece of the past 12 months. Climate change is, of course, just one of the significant themes on which we have written recently. Data, food innovation, robotics and automation (all in the broadest sense of these terms) have been the generally most-commonly discussed topics year-to-date.

Season 4

#1:	Gifts for all (7 January)
#2:	Food's fancinating future (13 January)
#3:	Virtual coffee with Head of IT (19 January)
#4:	Where did those five hours go? (26 January)
#5:	Why bother with humans? (1 February)
#6:	The identity arms race (9 February)
#7:	Keep on charging (16 February)
#8:	Just walk out (24 February)
#9:	Live from Big Data and AI World (3 March)
#10:	Bending the diabetes curve (15 March)
#11:	The boiled frog (16 March)
#12:	Badger, tortoise, dog (24 March)
#13:	Feed the world better (30 March)
#14:	Tailwinds, Headwinds too (7 April)
#15:	Where's the hype? (13 April)
#16:	Metaverse meals and more (19 April)
#17:	Data download in Docklands (28 April)

#18:	Shop the future (5 May)
#19:	Sunshine in Munich (12 May)
#20:	On the road, part 1 (19 May)
#21:	On the road, part 2 (25 May)
#22:	The very long road ahead for electric vehicles (31 May)
#23:	The robot will see you now (6 June)
#24:	Follow the zebra (15 June)
#25:	Quantifying quantum (21 June)
#26:	The perfect pack (28 June)
#27:	The ethics of AI (7 July)
#28:	The $100 genome (14 July)
#29:	What, no global warming? (19 July)
#30:	A day in Silicon Fen (27 August)
#31:	Move it like the Swiss (2 August)
#32:	Art lesson (9 August)
#33:	Robo-taxis and the two key EV debates (31 August)
#34:	Back to school (2 September)
#35:	Food Forever (8 September)
#36:	Message to the planet (15 September)
#37:	Looking outwards (22 September)
#38:	Mission to the dataverse (27 September)
#39:	How cool is your data centre? (4 October)
#40:	Braziltech (11 October)
#41:	Rail reading round-up (20 October)
#42:	3D Tetris (25 October)

View Heptagon Future Trends on LinkedIn *and* twitter

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 Alex Gunz.

The Fund is managed in-house at Heptagon Capital, a London-based boutique investment firm, founded in 2005 with 45 employees and over $11.9bn 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: $125m**
- **Strategy AUM: $135m**

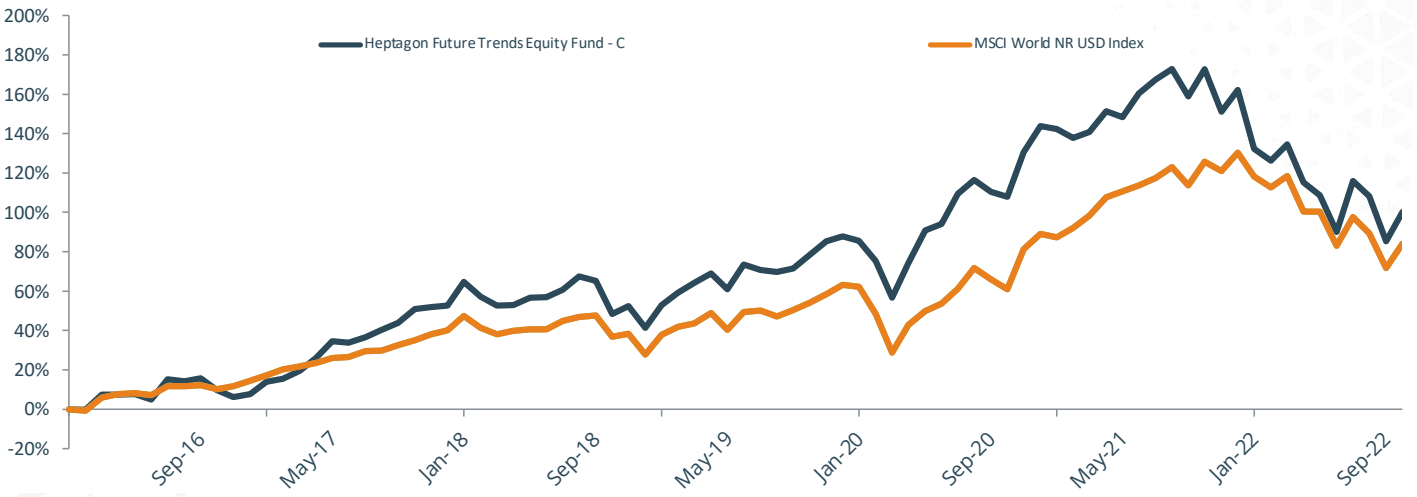
Strategy

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%).

Performance

The Fund has generated an annualised return of **10.2% vs 9.5%** for the MSCI World since inception.

- **Morningstar Rating:** ★ ★ ★
- **Morningstar Sustainability Globes:**



Sources: Bloomberg

All data as of 31 October 2022. **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 IE00BYWKMJ85.

Important Information

Past performance is not an indication or guarantee of future performance and no representation or warranty is made regarding future performance. This communication is for information purposes only. It is not an invitation or inducement to engage in investment activity.

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

Risk Warnings

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

SFDR

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

Authorised & Regulated by the Financial Conduct Authority (FRN: 403304)

Disclaimers

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