مؤسسة دبي للمستقبل
DUBAI FUTURE FOUNDATION

FUTURE OPPORTUNITIES REPORT

THE GLOBAL 50

2023

'Shaping the future cannot be done by just waiting for it but rather by utilizing the latest technologies and knowledge tools and meeting its challenges starting from today'

— H.H. Sheikh Mohammed bin Rashid Al Maktoum

FOREWORD

As we progress into a new chapter, with limitless technological innovation, we begin to realise that long-term linear progressions are no longer common: the world has to deal with disruption and turbulence without notice across nations, cities and communities. Confronted with unexpected consequences, we begin to realise that the responsibility lies in our hands. In order to live the future that we want to see, we must be prepared to tackle its challenges and start shaping it today.

It is our responsibility to model, empower and encourage future generations to become agile and resilient, equipping them with future-proof skills and widening their scope of knowledge.

Our responsibility today is also to collaborate with others, promoting innovation and coordinated governance models to enhance growth, prosperity and well-being for all. Through togetherness, we become closer to opportunities and not only take a leap of faith, but a leap of knowledge towards the betterment of humanity.

History, with its revolutionary inventions and shifts in wealth, proves that human ingenuity can solve problems and lead the way for a better tomorrow. Each generation has made its own contribution in striving for the best.

But every once in a while, there needs to be a re-evaluation and when we spot a better approach to the future, we need to change direction. The goal is not to lament the past but to embrace the best of it and move beyond it by taking on new opportunities. Trust, foresight and adaptability are the qualities that will ensure the future we aspire to. Change and uncertainty are the only constants.

We must put in place robust systems for future generations to recognise and respond to change. We must also create capacities and processes that enable them to recognise and manage the impact that uncertainties and megatrends have on future societies, so that they can translate global challenges into opportunities, where creative and innovative solutions lie at the core of our prosperity, well-being and growth.

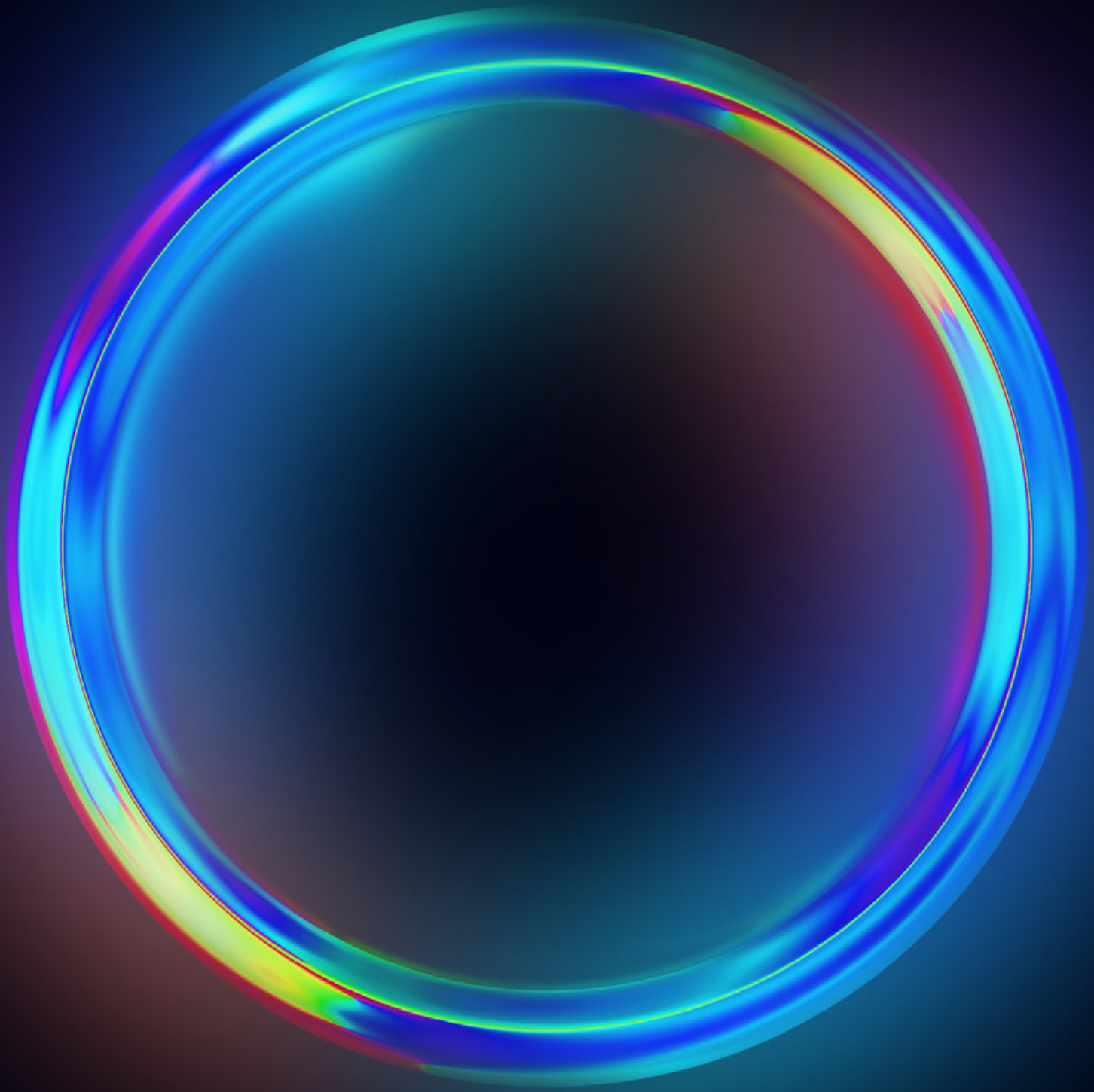
"In this era of drastic changes, it is the ability to respond to and overcome changing landscapes that will determine our battle not only for survival but also for excellence."

This year's **Global 50 report** provides an accessible framework to encourage thoughtful reflection about the future: a navigation tool in an era of quantum shifts. We share the uncertainties, assumptions and megatrends that will shape our future and present 50 opportunities offering inspiration and insight across five categories.

In this era of drastic changes, it is the ability to respond to and overcome changing landscapes that will determine our battle not only for survival but also for excellence. The key word here is innovation.

Mohammad Abdullah Al Gergawi

Vice Chairman of the Board of Trustees and
Managing Director of Dubai Future Foundation



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Societies Empowered 153

Empower societies by offering solutions to humanity's most complex and universal needs, optimising systems they rely on, safeguarding risks that could make societies more fragile in the face of crises and extending individual and collective potential for growth and development.

Transformational 194

The power to radically change ways of life by replacing the models that countries, communities and individuals live by. These new models enable individuals and communities to innovate and improve and aid the transformation of humanity to new digital and non-digital realities.

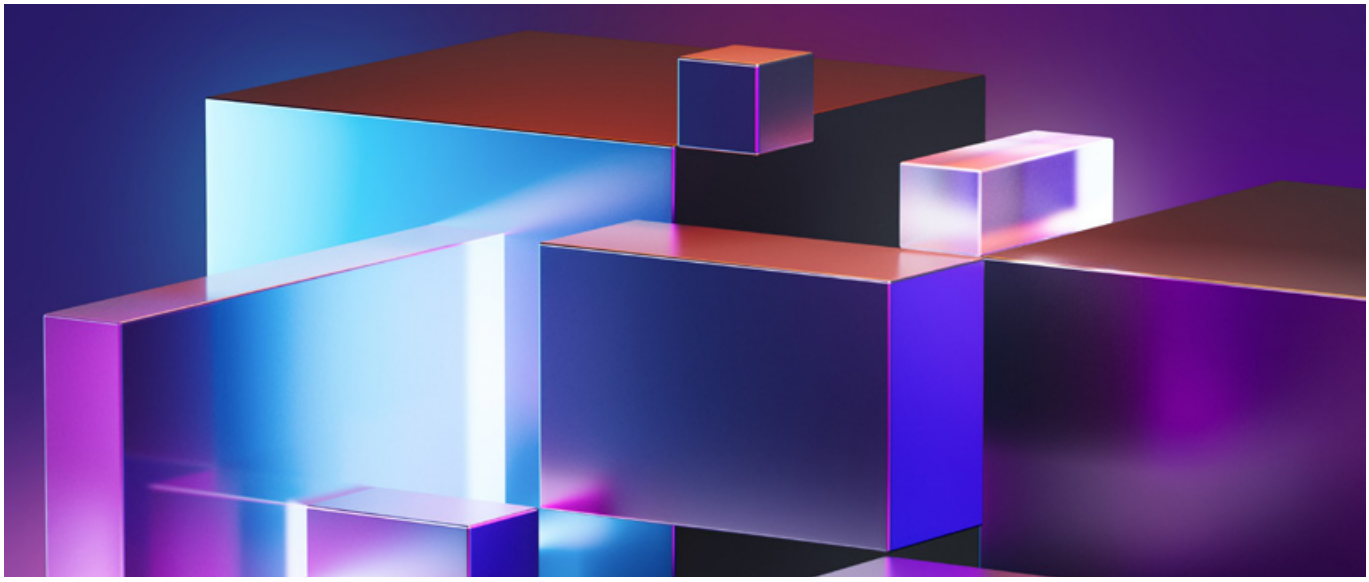
INTRODUCTION

The purpose of the Global 50 report is to promote growth, prosperity and well-being. By going through the creative process of imagining future possibilities, we are offering ideas and opportunities for a better tomorrow.

In **The Global 50** report published in 2022, we outlined our own view on the future. We listed 50 opportunities to motivate decision-makers in government, business and civil society to search for untapped potential. We wanted to describe in detail the era of quantum shifts (see box 2) and explore its varied opportunities. We defined the future as one where rapid changes occur within regions, nations, cities and communities. Sometimes shifts in our own perceptions may take place, expectedly or unexpectedly, suddenly, or gradually, in various extremes (Dubai Future Foundation, 2022).

We are repeating this formula in 2023. But this time we are diving deeper. Our vision of the future encompasses reflections on how our understanding of global uncertainties evolve together with takeaways on the assumptions and megatrends we view as relevant to how we navigate the future.

As you read through the 50 new opportunities this year, we hope that what comes to mind is what we envisaged when brainstorming ideas for the future: **the boundless potential of human creativity.** From one idea comes another. That is how humanity evolves. Most of us want a better life and, through the formulation of ideas focused on growth, prosperity and well-being, we hope that this year's opportunities will inspire greater accomplishments and innovations.



TODAY		
Growth is the increase in the total output of goods and services in an economy over time.	**Prosperity** is a life of dignity and stability. It is a life free from the threats of poverty or harm. It includes access to suitable employment opportunities and services such as education and healthcare. But human beings have a tendency to rapidly adjust their expectations.	**Well-being** today is defined by a good state of mental and physical health and feelings of life satisfaction. But the definition of well-being is always in flux.
TOMORROW		
Growth could go beyond economic factors, for example by accounting for negative impacts, to create a measure of net-positive growth.	**Prosperity** may encompass similar factors but set the bar higher. Prosperous societies may offer access to personalised education and healthcare services. They may seek to make available alternative means to earn a living, whether through employment, entrepreneurship or creativity. People will crave more life choices and a more supportive environment in which to make them.	**Well-being** could be more about feelings of self-realisation. Advances in medicine and technology could lead to a greater ability to overcome mental and physical health issues. There may be a renewed emphasis on positive social interactions and a sense of belonging conducive to self-esteem. This would place new demands and expectations on the state and society.

Box 1 Definitions of Growth, Prosperity and Well-being [a]

The opportunities shared in this report are not exhaustive; they present some of the **different pathways and approaches to growth, prosperity and well-being.** They offer possibilities for major advances in our quality of life while raising profound questions for society to resolve. Some opportunities will be more pertinent than others. Some contexts may have the conditions in place to share in the benefits, others may not. Equally, the risks relating to some opportunities might not be limited to those countries or businesses exploiting the opportunities directly: risks often travel faster than benefits.

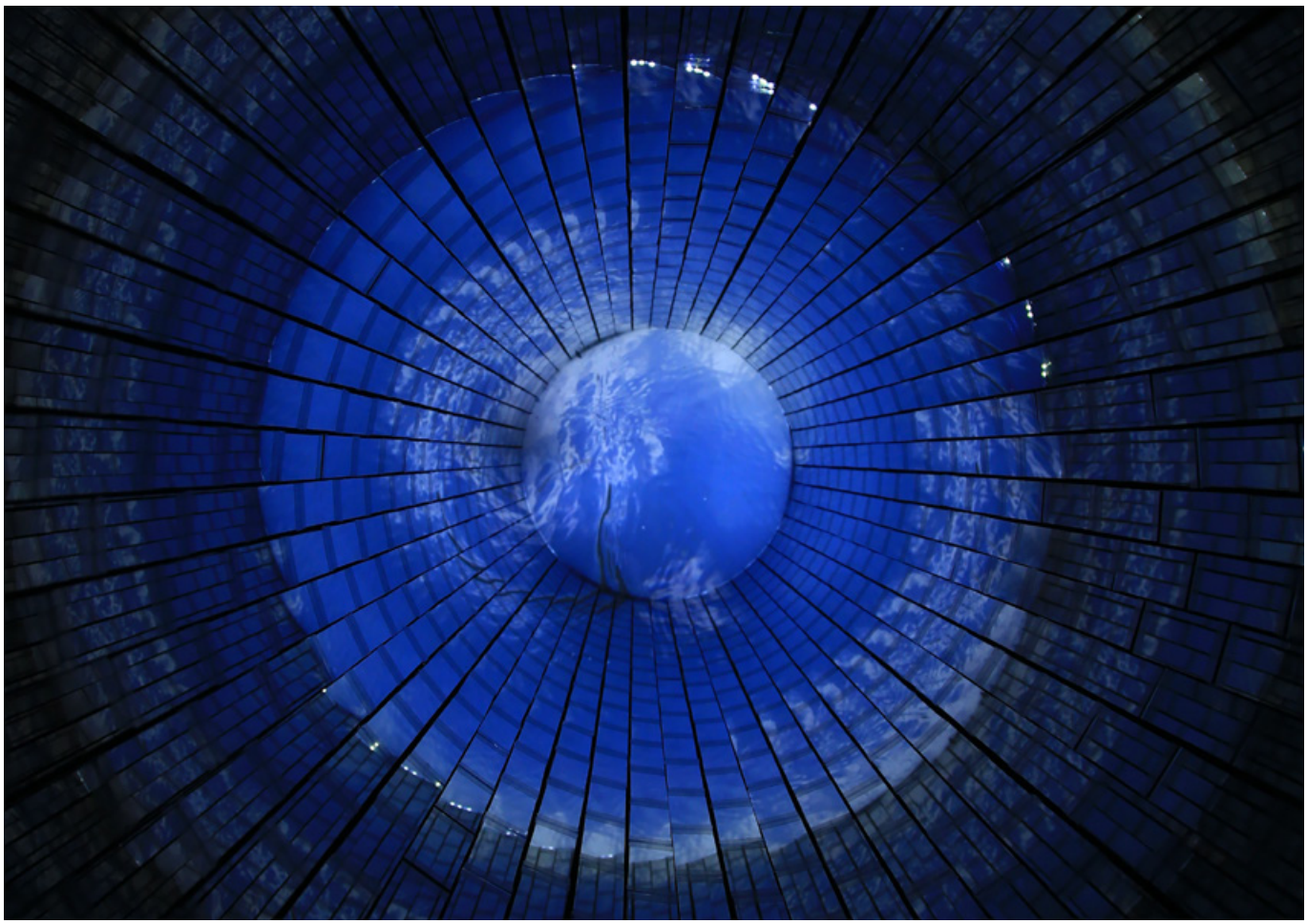
The next 50 years are set to bring both unprecedented challenges and vast new technological possibilities. However, some countries and societal groups will be better able than others to manage the uncertainties, meet the challenges and take advantage of the opportunities. **The purpose of this report is to shift thinking from 'What will happen in the future?' to 'How can we best prepare to improve or protect growth, prosperity and well-being?', whatever that future might be.**

a Slight adjustments to definitions in the 2022 Global 50 Report

OUR VIEW OF THE FUTURE

Our view of the future — when it comes to growth, prosperity and well-being — in the next 50 years is shaped by three interrelated aspects: **uncertainties, assumptions and megatrends** (Dubai Future Foundation, 2022).

While assumptions and megatrends are relatively stable and known, how the uncertainties will materialise is less so. On a continuum, uncertainties can radically distort socio-economic and environmental conditions and for each uncertainty, there is a range of conceivable outcomes. They differ from time to time and place to place and can have a dramatic impact on growth, prosperity and well-being. With assumptions, megatrends and other global trends, they are all interconnected and can have multiple implications for growth, prosperity and well-being.



UNCERTAINTIES

Uncertainties in science are bounded by conditions that provide explanations under a specific set of circumstances. These explanations are not influenced by the person making the observation and they remain unaffected if more people become aware of such a possibility (Scoones, 2019). **Social phenomena, however, are ultimately uncertain** and, especially in this era of quantum shifts, they cannot be controlled like physical phenomena.

We are entering an era of **'quantum shifts'** (Dubai Future Foundation, 2022). Indeed, we may already be in it. The term 'quantum' originates in quantum theory, where it denotes an abrupt transition from one energy state to another by atomic and subatomic particles. More broadly we use it to describe the rapid, disruptive and dramatic changes that we are starting to see in technology, business, government, medicine, culture and other areas.

Quantum thinking also embraces the concept of 'entanglement' (Wikipedia, n.d.), the idea that the behaviour of objects can be correlated even when they are remote from each other. This can be related to the intertwined complex relationships and interconnections that determine how the future may play out. Some forces can drive societies in opposite directions, while some innovations can enable them to move forward together in progress.

When such changes occur swiftly, we describe them as 'quantum shifts' or 'quantum leaps'. The message of this report is that many such shifts can be managed to have a positive impact if we only recognise the opportunities that lie ahead.

Box 2 Era of Quantum Shifts

In the social sciences, predictions cease to hold as soon as many participants or observers become aware of them. They act in response, either to take advantage of the prediction or to mitigate perceived risks. This means that predictions are valid only for a limited time, the length of which we cannot be sure of since we need to constantly factor in everyone's actions, not only those in the community of interest but also others around the world (Klemens, 2020).

Uncertainties are **highly systemic, with implications for multiple systems**. They are relevant at the global, regional and national levels. What's more, they are beyond the control of any one country or region. They are subject to events, such as economic downturns, that could drive them in any of several directions over multiple decades (Dubai Future Foundation, 2022). As uncertainties shift or as an uncertain event — or something for which we are not prepared – unfolds, we **think about the related effects and impact**. By thinking through **scenarios,** we can also think about our responses to these events.

While we cannot predict the future, we can explore how, in various extreme circumstances, uncertainties can influence work and life, in both local and global communities. The knowledge gained from this exploration allows us to manage the impacts that uncertainties may have on growth, prosperity and well-being – some of which are shared in this year's report. We also recognise that by **involving an extended global peer community in collaborative foresight**, we can explore futures while recognising that our involvement will also influence evolution towards a more favourable outcome, determining how futures are shaped.

COLLABORATION
A CONTINUUM FROM MULTILATERAL TO MULTIPOLAR

When it comes to collaboration and possible implications for growth, prosperity and well-being, more effective governance models would build trust and enable data flows – for example in global health data-sharing. New models would allow regions and cities to collaborate, promoting innovation, and coordinated governance models could enhance new trade flows and sustainable economic development. In contrast, a lack of collaboration results in interoperability problems, hindering innovation and slowing progress in areas such as scaling mobility or resource solutions. It can also mean failure to reach global agreement on ethical or scientific standards, leading to radical differences in health, wealth and the environment, in associated capabilities and in ideas about what it means to be human.

VALUES
A CONTINUUM FROM UNIVERSAL TO UNIQUE

When it comes to values and possible implications for growth, prosperity and well-being, countries and cities may actively promote inclusion and social cohesion, while education improves understanding and tolerance, enabling societies to become more diverse and innovative and to share and benefit from new values. In contrast, in the opposite sense, values may diverge about issues such as data privacy, health technologies and environmental stewardship, with value divisions damaging social cohesion and threatening social stability as neutral sources of information also erode.

TECHNOLOGY
A CONTINUUM FROM MULTIPLIER TO MASTER

When it comes to technology and possible implications for growth, prosperity and well-being, intelligent connected systems can improve access to services and quality of life, opening up new ways to realise human potential. Technologies can optimise mobility and resource usage, reducing costs and environmental impact, and new models of data protection will allow sharing for the common good. At the same time, technology may take a different turn as surveillance becomes all-encompassing, diminishing privacy and well-being. Automation and artificial intelligence (AI) may have impacts on society – at a minimum, reduced employment at all levels (from low to high skilled) – posing problems for incomes and distribution systems.

NATURE
A CONTINUUM FROM RENEWAL TO DEGRADATION

When it comes to nature and possible implications for growth, prosperity and well-being, new materials and engineering techniques can reduce waste and offer new solutions for food, water and energy. Reversing the degradation of lands and shifting to renewables and alternative fuels can reduce emissions while, at the same time, sustainable consumption becomes the norm. However, as cities lead the way on energy, waste and food and water security solutions, they also increase pressure on the environment through raised demands for food, water and energy. Climate change may force mass migration in the most affected regions. As important ecosystems degrade, creating a domino effect, rising ocean temperatures may impact on marine food chains and exacerbate weather events in terms of both frequency and severity.

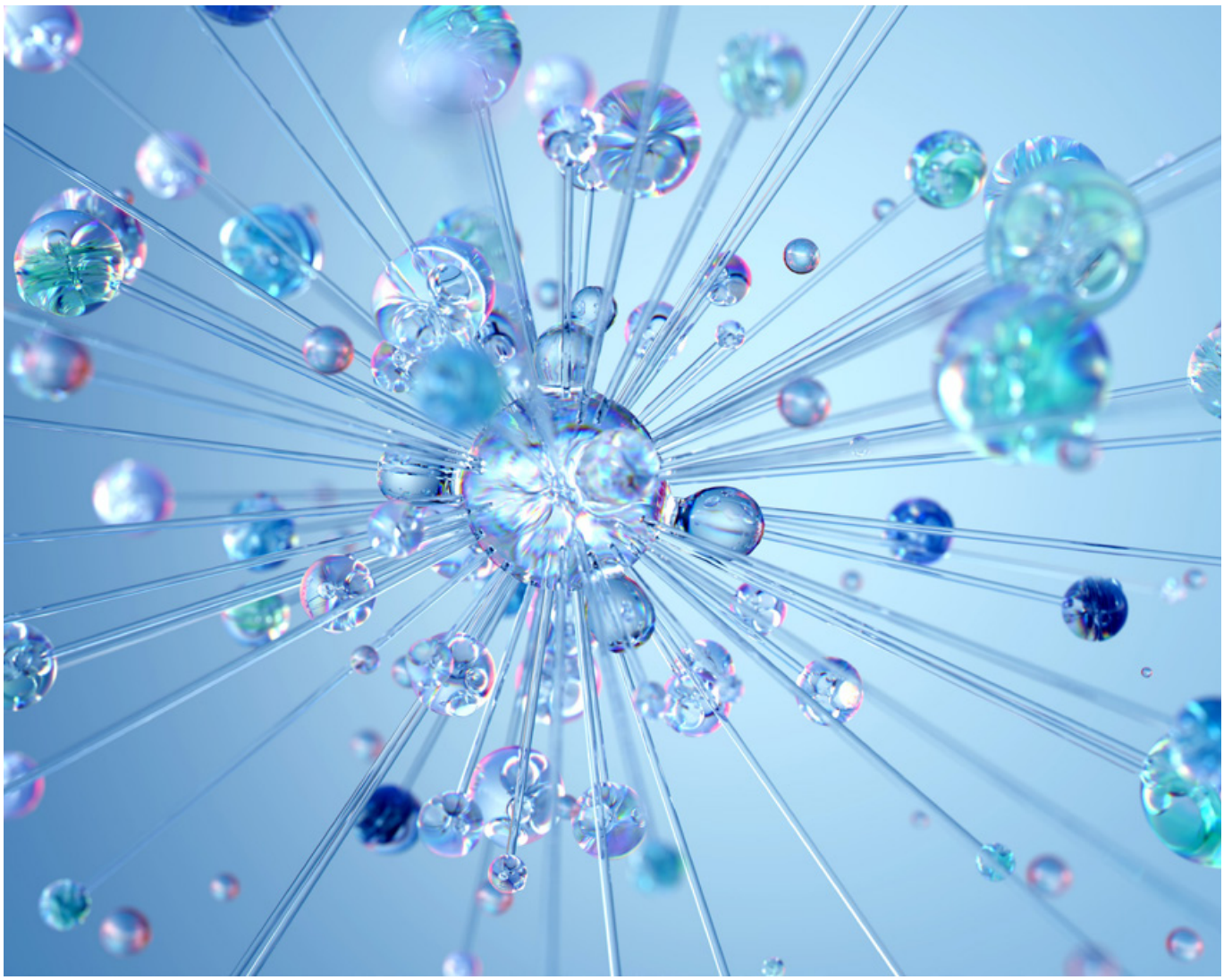
SYSTEMS
A CONTINUUM FROM FRAGILE TO RESILIENT

When it comes to systems and possible implications for growth, prosperity and well-being, AI's problem-solving capacity may enable systems to continuously adapt to contextual changes to achieve greater resilience. At the same time, novel forms of trade, manufacturing and markets may enable more flexibility. However, interconnected intelligent systems may create new vulnerabilities for critical infrastructure and for digitalised services, such as finance, banking and legal. If supply chain complexity grows more quickly than our capacity to mitigate risks (from cyberattacks to extreme weather events), interconnected, automated systems may become less stable.

ASSUMPTIONS

An assumption is a trend that we think is here to stay for a long time. Times change, but assumptions stay much the same. Even if external events, such as the COVID-19 pandemic, cause shifts, assumptions are expected to remain stable over time (Fergnani, 2021). Assumptions can be assigned probabilities. They can change direction but, unlike uncertainties, they tend to be predictable.

The Dubai Future Foundation views assumptions as guideposts that help us think about how social and technological change will shape the way we live. While this report shares four assumptions, others are mentioned in our supplementary report found online on *Navigating the Future for Growth, Prosperity and Well-being* (Dubai Future Foundation, 2023).



Assumption

LIVES WILL BE LONGER AND HEALTHIER

SIGNALS TO WATCH

- Average life expectancy and mortality rates
- Age distributions, proportion of population:
  - aged 5 and under
  - aged 65 years or over
  - aged 80 years or over

The assumption that lives will be longer and healthier is driven by the confidence that technology and better access to health services will improve our lives. Improvements in hygiene, nutrition and lifestyle will continue, particularly as we make improvements as we respond to climate change through innovation.

Some implications for growth, prosperity and well-being:

- Increased sharing of intergenerational wisdom[1]
- Longer careers and productivity
- New business opportunities to serve a growing population aged over 65
- Further innovations in healthcare to improve health and well-being in the older years[2]
- Increased risk of disease and disability with age
- Increased government spending on pensions, healthcare and social care
- Greater mental health concerns due to loneliness[3]

Assumption

CLIMATE CHANGE WILL PERSIST

SIGNALS TO WATCH

- Average global temperature
- Level of greenhouse gases in the atmosphere
- Climate change-driven poverty and migration, particularly in Sub-Saharan Africa and South Asia
- Water shortages and crop production levels
- Biome distributions and coral reef population levels

Driven by both human-caused pollution and natural causes, climate change will continue to be with us. Technological advances and global collaboration will not be enough to counter climate change. Global temperatures are expected to continue to rise. Emissions will continue to increase.[4]

Implications for growth, prosperity and well-being:

- Increased technological innovation to tackle complex climate change problems
- Changes in biodiversity due to warmer climates
- Increased poverty and migration due to rising sea levels and other climate change impact
- Food security issues due to desertification and land degradation
- Difficulties for humans, animals and plants to flourish due to climate change

Assumption

INEQUALITIES WILL CONTINUE

SIGNALS TO WATCH

- Average adult income and value of assets
- Total income levels in the richest and poorest 10% of the population
- Proportion of children not in full-time education
- Access to the internet, quality of connectivity

Inequality is expected to persist.[5] Incomes vary between countries. Access to technology and education is not universal. Discrimination, marginalisation and lack of legal rights continue to inhibit the flourishing of some minorities. Not everyone has access to the opportunities offered by urban environments or effective approaches to climate change. This accounts for why inequalities will continue.[6]

Implications for growth, prosperity and well-being:

- New innovative approaches to tackling inequality, including social entrepreneurship and social impact bonds
- A strengthened civil society sector
- Greater engagement and volunteerism with awareness of social inequality[7]
- Persistent intergenerational and community poverty with increased feelings of negativity and discouragement
- Increased crime and violence along with low trust of authority[8]
- Reduced life expectancy and access to water, education and healthcare

Assumption

TECHNOLOGY WILL CONTINUE TO ADVANCE

SIGNALS TO WATCH

- Supercomputing performance
- Information Technology (IT) and smart technologies market size and growth
- Global digital competitiveness
- Cost savings associated with technological advances in:
  - genomics and precision medicine
  - space travel
  - other sectorspopulation levels

Technology drives growth.[9] Increased investment, rising intellectual capital, new materials that make infrastructure cheaper and more sustainable: these are the factors that create shifts in wealth. With increased participation by small and medium-sized enterprises (SMEs) in technological innovation and easier access to renewable sources of energy, technology will continue to advance.

Implications for growth, prosperity and well-being:

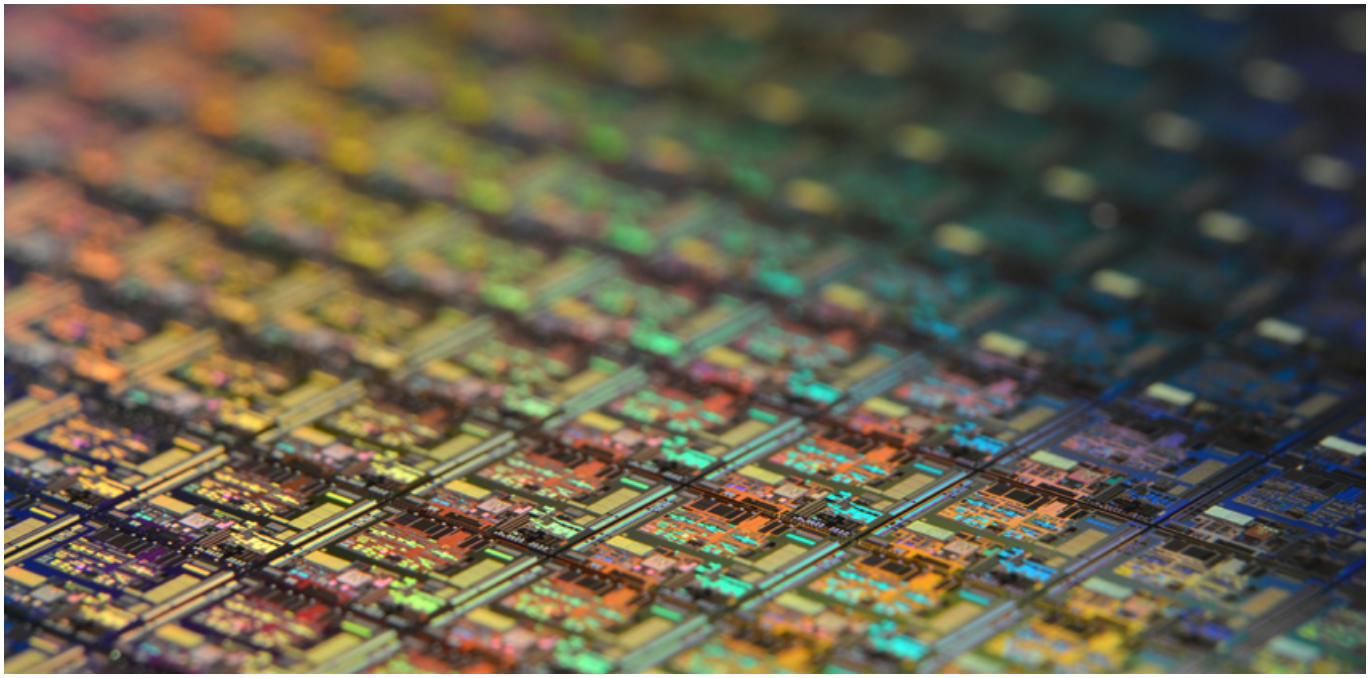
- Creation of new jobs in new areas of technological advances
- Faster transition to sustainable ways of living and production
- Improved connectivity across global communities and populations
- Improved connectivity and access to data, leading to better understanding and more research to solve global challenges
- Increased technological vulnerabilities and threats to consumer and individual privacy from ubiquitous data collection
- Possible negative effects on mental and physical health (isolation, anxiety, eye strain, poor posture, reduced sleep and less physical activity)[10]
- Loss of jobs from automation and AI

MEGATRENDS

As opposed to uncertainties and assumptions, megatrends are applicable over a shorter period of time. In our approach, **megatrends are research-led thematic paths that are expected to have a significant impact on economies and societies globally. They are anticipated to affect growth, prosperity and well-being either positively or negatively, with impacts extending over a decade or more.**

Megatrends may be defined in various ways; however, they are generally agreed to be complex, large and interrelated. Like the assumptions, the megatrends in The Global 50 give decision-makers a vantage point on what opportunities may materialise in the contexts of growth, prosperity and well-being. The megatrends may change, particularly as they intersect with the uncertainties, and new ones may become a priority. That is why, to enhance our foresight, we engaged with experts and conducted a desk-based review of annual trends and futures reports as research for The Global 50 report.

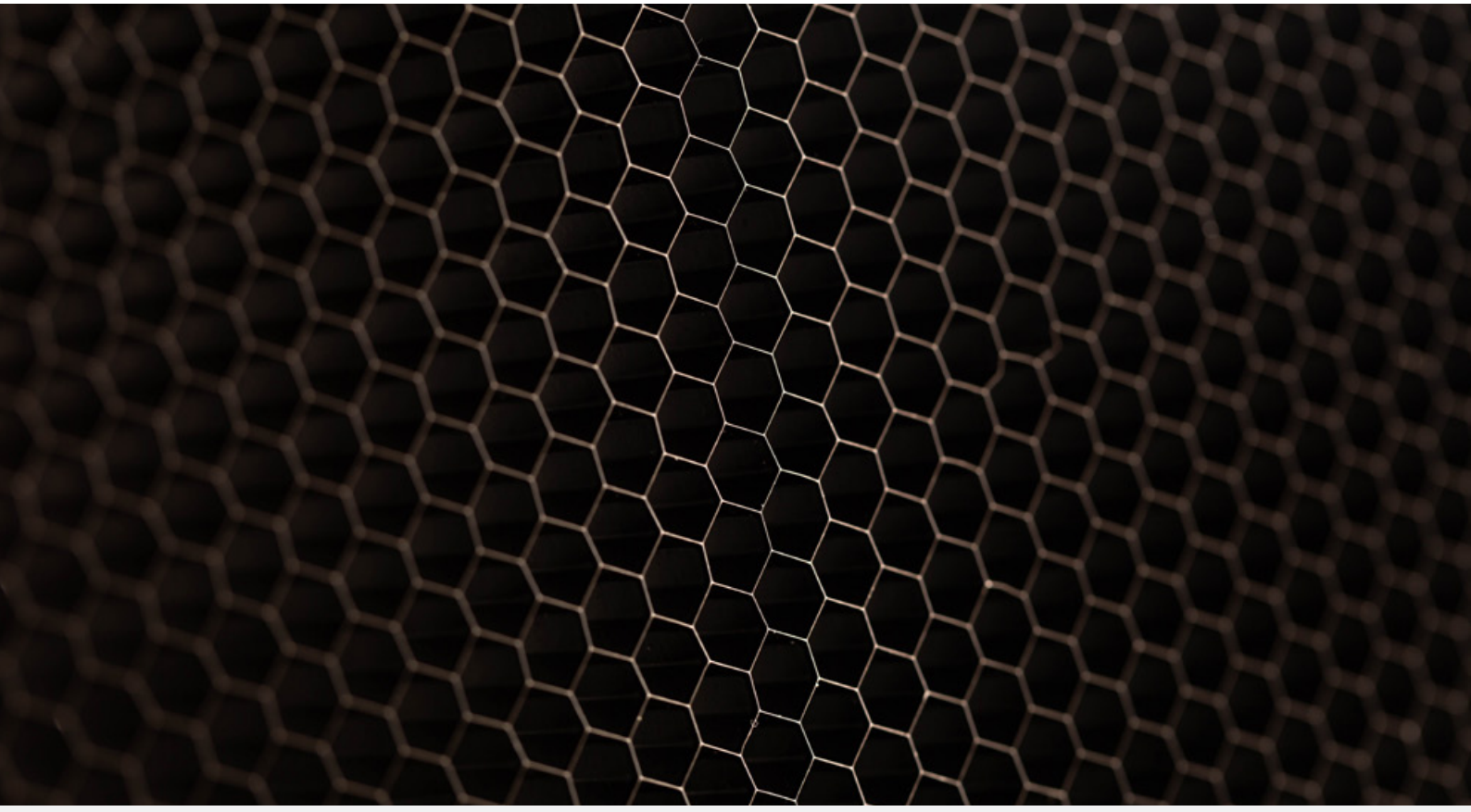
This section was informed by our own desk-based research and reflections on the megatrends. While they are presented individually, it should be kept in mind that their interrelated nature means that they overlap. Where we mention drivers, trends and signals, these are not exhaustive, and for each of the megatrends we provide a combination of some facts about the situation today and some forecasts for the future. We also share three areas of future opportunity in each megatrend that may be of interest to both decision-makers and individuals.



MEGATREND 1

MATERIALS REVOLUTION

Materials are fundamental to all products, foods, medicines and drinks that we consume on a daily basis. Driven by profound progress in advanced machine intelligence and nanotechnology, increased research activity and funding in the area of materials science, new opportunities are arising in the use of materials in almost all industrial, technological and consumer sectors.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Alternative Fuels
Graphene
Green Carbon Materials
Metallic Foam
Nanotechnology
Polymers
Responsive/Smart Materials
Self-Repairing Materials
Semiconductors
Synthetic Biology

AREA OF FUTURE OPPORTUNITY

SYNTHETIC BIOLOGY

The estimated direct economic impact of synthetic biology across industries is close to

$4 TRILLION

over the next 10 to 20 years

Deploying synthetic biology-based platforms outside lab settings could lead to minimal human intervention in various sectors such as agriculture, health and climate action.[11]

Through gene-editing technologies, micro-organisms can, in theory, make many things otherwise produced in factories. In synthetic meat production, half a gram of cattle muscle could create as much as 2 billion kilograms of beef.[12]

Synthetic biology could also address 45% of the world's current disease burden.[13]

The estimated direct economic impact of synthetic biology across industries — from health, bioeconomy, green economy, chemicals and others — is close to $4 trillion a year over the next 10–20 years.[14]

AREA OF FUTURE OPPORTUNITY

MATERIALS FOR CLIMATE CHANGE

There are many possibilities when it comes to new materials and climate change. Research in materials science made up just over 12% of research into carbon-capture technologies over the past 50 years (measured by number of published outputs), with silica, polymers, epoxides, graphene, porous carbons, nanotubes and nanoparticles emerging as promising areas for the future,[15] along with metal oxides.[16]

Metallic foams are compounds that combine the strengths of metals and light foams.[17] **Metallic foams as electrodes could enable a low-cost method of generating carbon-free hydrogen[18] and improve the performance of fuel cells.**[19]

For example, driven by demand for light vehicles and fuel-efficient passenger vehicles, East Asia will account for a significant share of the market for aluminum foams. The global market for aluminum foams is expected to grow at a compound annual growth rate (CAGR) of 4% between 2022 and 2030, reaching revenues of almost $62 million by 2030.[20]

The global market for metallic foams is expected to grow at a CAGR of 4.5% between 2021 and 2030, reaching a revenue of almost $133 billion by 2030.[21]

The global market for metallic foams is expected to reach revenue of almost

$133 BILLION

by 2030

$70 BILLION

graphene semiconductor market potential

$190 BILLION

global graphene market potential in 2030

AREA OF FUTURE OPPORTUNITY

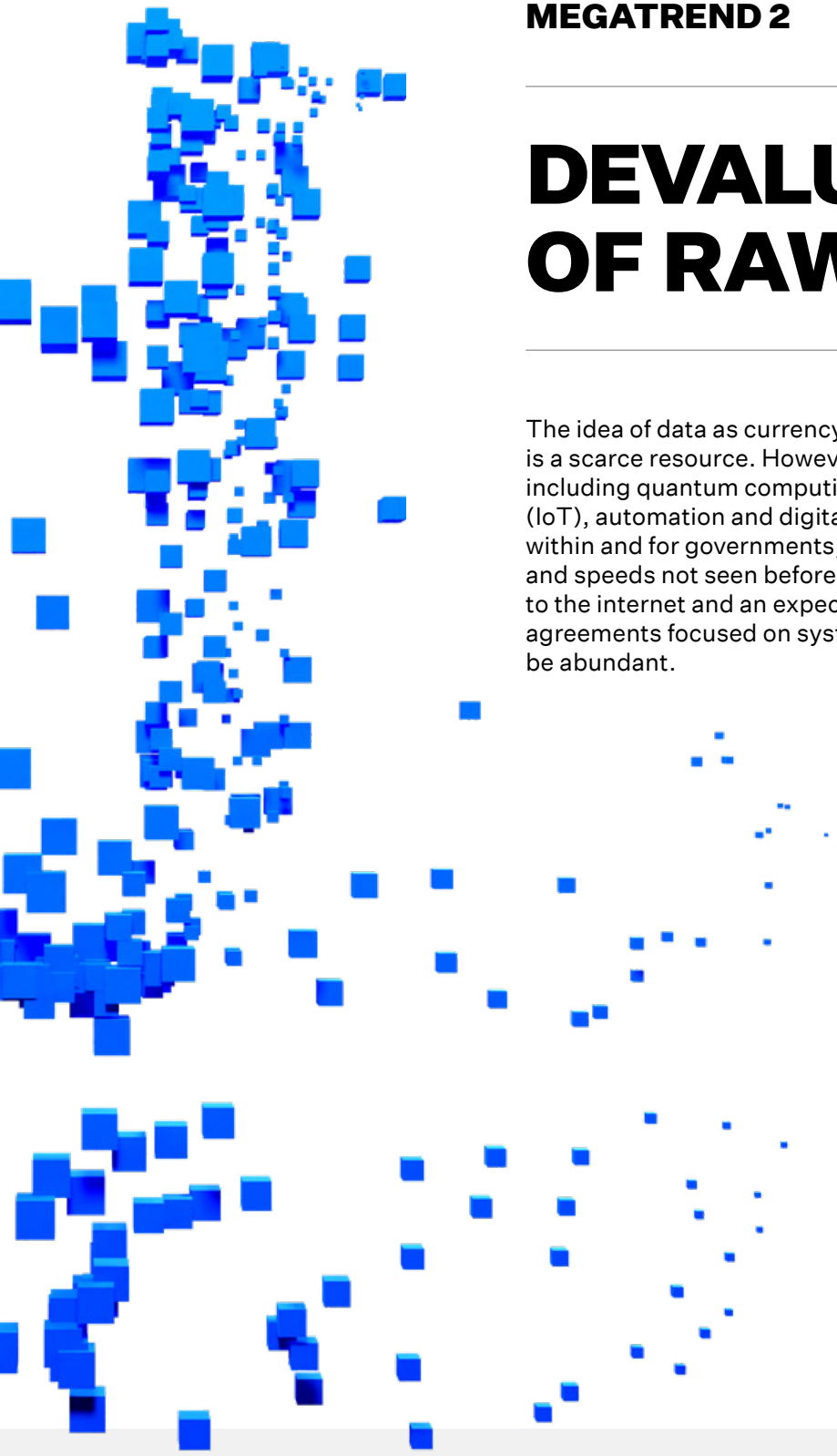
SEMICONDUCTORS

Semiconductors are the most fundamental building block of the devices we use, the cars we drive and the manufacturing and supply chain systems that provide us with food, packaging and medicine.[22]

By the end of 2022, the global semi-conductor chip industry was estimated to be worth some $600 billion in revenue and was concentrated in just a few companies in a handful of countries.[23]

Graphene, which may replace silicone as the main material in semiconductors,[24] is a nanomaterial that is carbon-based, highly conductive, light and not environmentally harmful.[25] Graphene has abundant possibilities ranging from sensors and energy storage to electronics and wearables.[26]

The global graphene market had an average annual growth of 32% as of 2020[27] and, with an estimated $190 billion market potential[28] by 2030, the graphene semiconductors market alone may be worth $70 billion.[29]



MEGATREND 2

DEVALUATION OF RAW DATA[b]

The idea of data as currency[30] gives rise to the notion that data is a scarce resource. However, driven by technological advances including quantum computing, blockchain, the Internet of Things (IoT), automation and digital realities, data will become more available within and for governments, businesses and society – and at volumes and speeds not seen before. Enhanced by 5G, 6G, increased access to the internet and an expected increase in the number of multilateral agreements focused on systems and data interoperability, raw data will be abundant.

KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Artificial Intelligence
Automation
Big Data
Cellular (5G, 6G) and Broadband Networks
Data Analytics
Data Trust
Digital Trade
Internet of Things (IoT)
Open Data
Quantum Computing

b Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

UNLOCKING VALUE WITH CROSS-BORDER OPEN DATA

Enhancing access to data and encouraging data-sharing creates value for data holders, and unlocks up to 50 times more value for the wider economy.[31]

Endorsed in 2019 by the G20 nations, Data Free Flow with Trust is a proposed guideline that is intended to boost data-sharing across countries.[32] 'Open data' could unlock more than $3 trillion annually across consumer finance, consumer products, education, energy, healthcare, oil and gas and transportation.[33, 34]

On average, data access and sharing may generate social and economic benefits up to 2.5% of GDP,[35] and broad adoption of open-data ecosystems could yield benefits up to 1.5% of GDP in 2030 in the European Union, the United Kingdom and the United States, and as much as 5% in India.[36]

'Open data'
could unlock more than

$3 TRILLION

annually across **consumer finance, consumer products, education, energy, healthcare, oil and gas** and **transportation**

AREA OF FUTURE OPPORTUNITY

BIG DATA ANALYTICS

Based on published academic articles in 2022, big data analytics has grown and will continue to grow through applications in healthcare, agriculture, human resources, construction, sustainable finance, supply chain management, hospitality, tourism and more.[37]

The global big data analytics market was worth $231 billion in 2021 and is expected to grow at a CAGR of 13%, reaching $550 billion by 2028.[38]

The United States is the largest market for big data analytics, with spending of more than $110 billion in 2021. Japan and China were the next two largest markets, with spending reaching around $12 billion each.[39]

The **United States** is the largest market for big data analytics, with spending of more than

$110 BILLION

in 2021

Japan and China were the next two largest markets, with spending reaching

$12 BILLION each

AREA OF FUTURE OPPORTUNITY

SYNTHETIC DATASETS

Vast data is needed to train machine-learning models. Datasets are scarce, costly to produce — in millions of dollars — and often contain biases that impact a model's performance.[40]

Synthetic datasets are artificially generated by an Artificial Intelligence (AI) algorithm that has been trained on a real dataset to produce new data with all the same characteristics as the original data but which cannot be recreated, avoiding associated privacy concerns.[41]

The global AI training dataset market is expected to reach a value of $8.6 billion by 2030. The market is anticipated to expand at a CAGR of 22% from 2022 to 2030.[42]

The **global AI training dataset market** is expected to reach a value of

$8.6 BILLION

by 2030

MEGATREND 3

TECHNOLOGICAL VULNERABILITIES[c]

Thanks to a number of developments – such as biotechnology, gene editing and new therapies in medicine and agriculture, ubiquitous digitisation and automation and the spread of IoT-enabled wearables – biological and technological vulnerabilities will be exploited with increasing severity and frequency. Vulnerabilities and associated threats will also become more complex as they begin to cross industries, technologies and geographies, more directly impacting every part of life and work.

KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Biotechnology
Cloud Platforms
Cyberbiosecurity
Digitisation
Internet of Things (IoT)
Malware
Quantum Proofing
Ransomware
Zero Trust
Cybersecurity

c Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

ARTIFICIAL INTELLIGENCE AND QUANTUM ENCRYPTION

The World's Largest Economies

1. 

2. 

3. 

if cyberattacks were a country and damage from cyberattacks its GDP

At the current rate of growth, damage from cyberattacks will amount to about $11 trillion annually by 2025, a 300% increase from 2015 levels.[43] If cyberattacks were a country and damage from cyberattacks its GDP, it would have the world's third-largest economy after the United States and China.[44]

The cybersecurity market was valued at approximately $220 billion in 2021 and is expected to grow at a CAGR of almost 9% between 2021 and 2026,[45] reaching up to $2 trillion.[46]

While AI can be leveraged to monitor network security and datacentres, providing timely alerts,[47] quantum cryptography can further enhance algorithms and resist ongoing cybersecurity threats.[48]

AI in cybersecurity market was worth almost $15 billion in 2021 and is estimated to reach $134 billion by 2030.[49] The quantum cryptography market is projected to grow at a CAGR of 26%, reaching $1.6 billion by 2026 (from $323 million in 2019).[50]

AREA OF FUTURE OPPORTUNITY

CYBERBIOSECURITY

Growing demand in synthetic biology and smart technologies will continue to raise cyberbiosecurity risks and increased risk of cyberattacks and these may be underreported because of a lack of detection capability.[51] One day, all it will take to create a threatening human pathogen is internet access and the ability to create synthetic DNA through advanced biotechnology.[52]

The precision agriculture — analytics-driven farming based on detailed data from sensors — market is expected to grow at a CAGR of 8% between 2022 and 2030, from $8.5 billion to $15.6 billion.[53] Currently, the average precision farm generates 500,000 data points per day; by 2036, this number will have grown eight-fold,[54] exposing the agricultural sector to further cybersecurity threats.

The global CRISPR gene-editing market was valued at $1 billion in 2021 and is predicted to reach $15 billion by 2030, increasing at a CAGR of 30%.[55]

The **average precision farm** generates

500,000 DATA POINTS PER DAY

By 2036, this number will have grown

8X.

AREA OF FUTURE OPPORTUNITY

CYBERSECURITY FOR SMALL BUSINESSES AND CHARITIES

A breach in a **hybrid cloud environment** costs an average of

$3.8 MILLION

half a million less than a breach in a **private cloud** and just over a million less than a breach in a **public cloud**

Cybersecurity laws, which also encompass data protection requirements, are the main way for governments to establish trust in technology. Many cybersecurity laws are managed through bilateral or multilateral treaties or agreements.[56] However, with limited or non-existent cybersecurity, small businesses and charities are more vulnerable to cyberattacks.

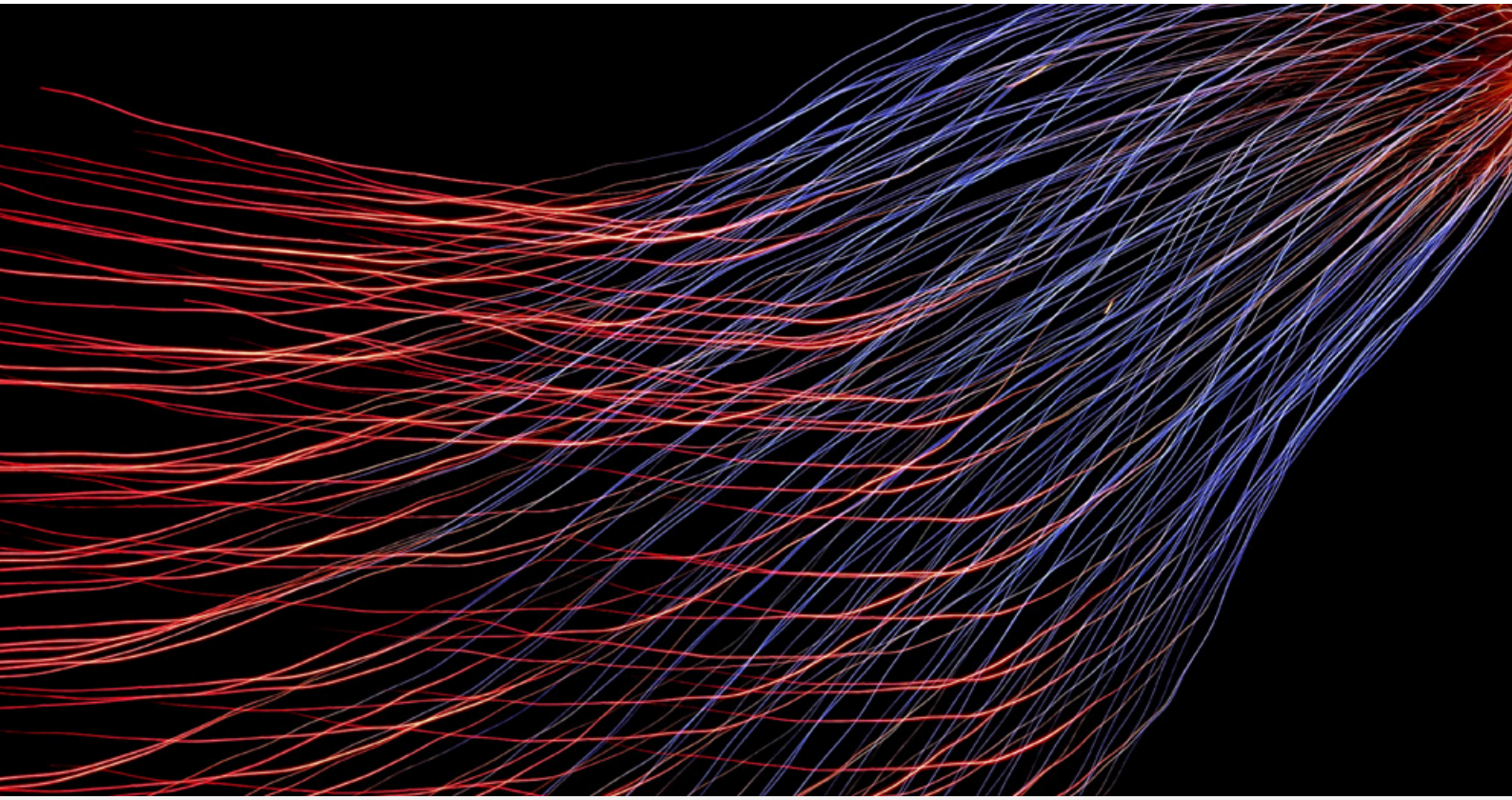
For example, in a survey conducted in the United Kingdom of over 120 charities revealed that only half were fully aware of the potential consequences of a cyberattack, one in ten said cybersecurity was not even on their boardroom agenda, and one in five said not a single employee was trained to identify a cyberattack.[57] As a result, and in the face of increasingly sophisticated and targeted cyberthreats, small businesses and charities will turn to cloud platforms.[58]

A breach in a hybrid cloud environment (at least two clouds – for example one private and one public) costs an average of $3.8 million, half a million less than a breach in a private cloud and just over a million less than a breach in a public cloud.[59]

MEGATREND 4

ENERGY BOUNDARIES[d]

Energy is imperative to everyday life today and will continue to be so in the future. Technological advances and the growing need for energy will drive exploration and innovation and the pursuit of new and alternative sources of energy. Novel materials and advanced machine intelligence will enhance the generation of existing sources of energy and their transmission and distribution to any place on earth or in space, pushing the boundaries of energy to levels previously unseen.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Battery Technology
Biofuels
Fission
Fusion
Hydrogen
Hydropower
Lithium
Metallic Foam
Solar Photovoltaics
Renewables

d Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

CLEAN AND RENEWABLE ENERGY FROM VARIOUS SOURCES

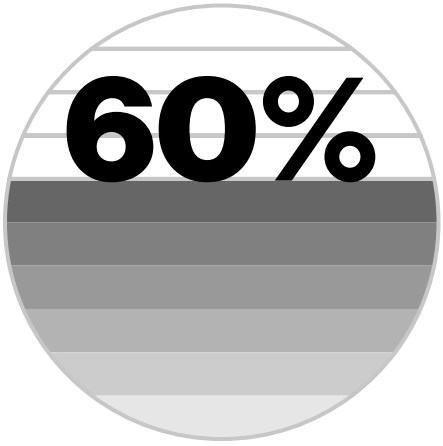
By 2026, the global capacity for renewable electricity will have increased by more than 80% since 2020, and by 2035, renewables will generate 60% of the world's electricity.[60] Two-thirds of the growth in global renewable electricity capacity in 2026 will be from wind and solar.[61]

As clean fuel, the production market for low-emission hydrogen – most of which is 'grey' (produced from natural gas) – was valued at $130 billion between 2020 and 2021 and is estimated to grow just over 9% per year until 2030.[62]

Small modular reactors (SMRs) as another alternative source of energy. They can generate about one-third of the capacity generated by traditional nuclear power reactors at a fraction of the size.[63]

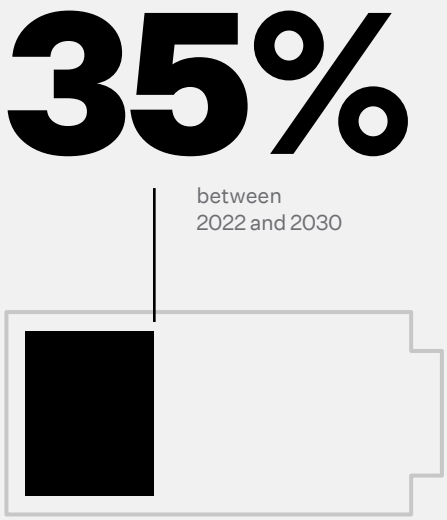
More than 70 commercial SMR designs are being developed around the world.[64] Canada, the United Kingdom and the United States have all signalled growing support for SMRs and the global market for SMRs is expected to be worth up to $300 billion per year by 2040.[65]

By 2035,
renewables will generate



of the world's electricity

The **demand for batteries**
will increase by



AREA OF FUTURE OPPORTUNITY

BATTERY TECHNOLOGIES

In 2030, almost every second car sold will be a battery electric vehicle (BEV). The demand for batteries will increase by 35% between 2022 and 2030[66]and demand for raw materials such as lithium, nickel and graphite is expected to increase fifteen-fold by 2030.[67] New materials, along with manganese and cobalt, will be key to advances in battery designs seeking lighter weight and better conductivity.[68]

China currently produces approximately 80% of the world's battery cells and components. However, as the European Union and the United States are — between them — poised to cover 40% of the world's demand for electric vehicles, efforts to grow localised battery supply chains are expected.[69]

Decarbonisation in the aviation sector will drive the use of alternative propulsion technologies based on batteries and hydrogen, with the operating range of electric aircraft expected to reach 400 km by 2035 rising to 600 km by 2050.[70]

AREA OF FUTURE OPPORTUNITY

SPACE ENERGY

Space-based solar power could be key to meeting the growing demand for energy and global temperature increases.[71]

In space, the sun's beams are around 10 times stronger as they are on earth. A single solar-power satellite could generate around two gigawatts of power, equivalent to six million solar panels on earth powering more than one million homes.[72]

While the cost and carbon dioxide emissions associated with launching solar panels into space are of concern, the carbon footprint of this approach, including the launch, is estimated to be 50% of that of land-based solar farms.[73]

A **single solar-power satellite**
would generate around

2
GIGAWATTS

equivalent to

6 MILLION
solar panels on earth

MEGATREND 5

SAVING ECOSYSTEMS[e]

Driven by resource scarcity, climate change and shifts in social values, environmental impact management will increasingly move towards the management of ecosystems[74] as opposed to reducing the environmental impact of a specific process, product or service.[75] Approaches will also be more interdisciplinary and future focused, taking into account both societal and environmental factors with the goal of conserving biological and ecological services and resources while providing for basic human needs.

KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Adaptive Management
Carbon Footprint
Ecological Economics
Environmental, Social and Governance (ESG)
Food–Water–Energy Nexus
Forests and Mangroves
Green Finance
Net Positive
Net Zero
Sustainable Smart Cites

e Slight adjustment to title in the 2022 Global 50 Report.

While

$1.2 TRILLION

is currently being spent annually to meet existing climate pledges, the number needs to be

4X HIGHER

to achieve net zero emissions by 2050

AREA OF FUTURE OPPORTUNITY

GREEN FINANCE

The value of the trade in green bonds — bonds financing environmental projects — could reach nearly $2.4 trillion in 2023, with the top three green bond issuers being China, France and the United States.[76] While $1.2 trillion is currently being spent annually to meet existing climate pledges, that number needs to be four times higher to achieve net zero emissions by 2050.[77]

Untapped, green finance for the countries in the Middle East – particularly those of the Gulf Cooperation Council, which have well-developed capital markets – could unlock up to $2 trillion in cumulative GDP contributions by 2030, could create more than a million jobs and could encourage foreign direct investment.[78]

Climate action and investment in the Middle East are expected to grow: Oman[79] and the United Arab Emirates have committed to net zero carbon emissions by 2050,[80] and Saudi Arabia and Bahrain by 2060.[81]

AREA OF FUTURE OPPORTUNITY

SMART SUSTAINABLE CITIES

More than 4.3 billion people, or approximately 54% of the world's population, live in cities today. This is expected to rise to 80% by 2050.[82]

Even though cities cover only 2% of the world's land surface they consume within them over 75% of the planet's material resources.[83] Increased urbanisation will more than double global material consumption, from 41 billion tonnes in 2010 to around 89 billion tonnes by 2050.[84] The wealthiest countries consume 10 times as much as the poorest.[85]

Low-carbon and resource-efficient cities can reduce these impacts.[86] While the global smart cities market is expected to reach a value of $7 trillion by 2030 (rising at a CAGR of 24% from 2022),[87] some cities will find it challenging to reach the goal of becoming truly smart[88] encompassing an ecosystem that balances affordability, inclusion, safety and sustainability.[89]

Even though cities cover only

2%

of the world's land surface they consume over

75%

of the planet's material resources

AREA OF FUTURE OPPORTUNITY

ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) MARKETPLACES

The global market for environmental consulting services is expected to reach

$43 BILLION

by 2026

As demand for ESG measurement, management and reporting services increases globally, associated services will also grow.

The global ESG software market is predicted to be worth $2 billion by 2030, up from $558 million in 2021 with a CAGR of 16%.[90] The global market for environmental consulting services was estimated at $32 billion in 2020 and is expected to reach $43 billion by 2026, growing at a CAGR of 5%.[91]

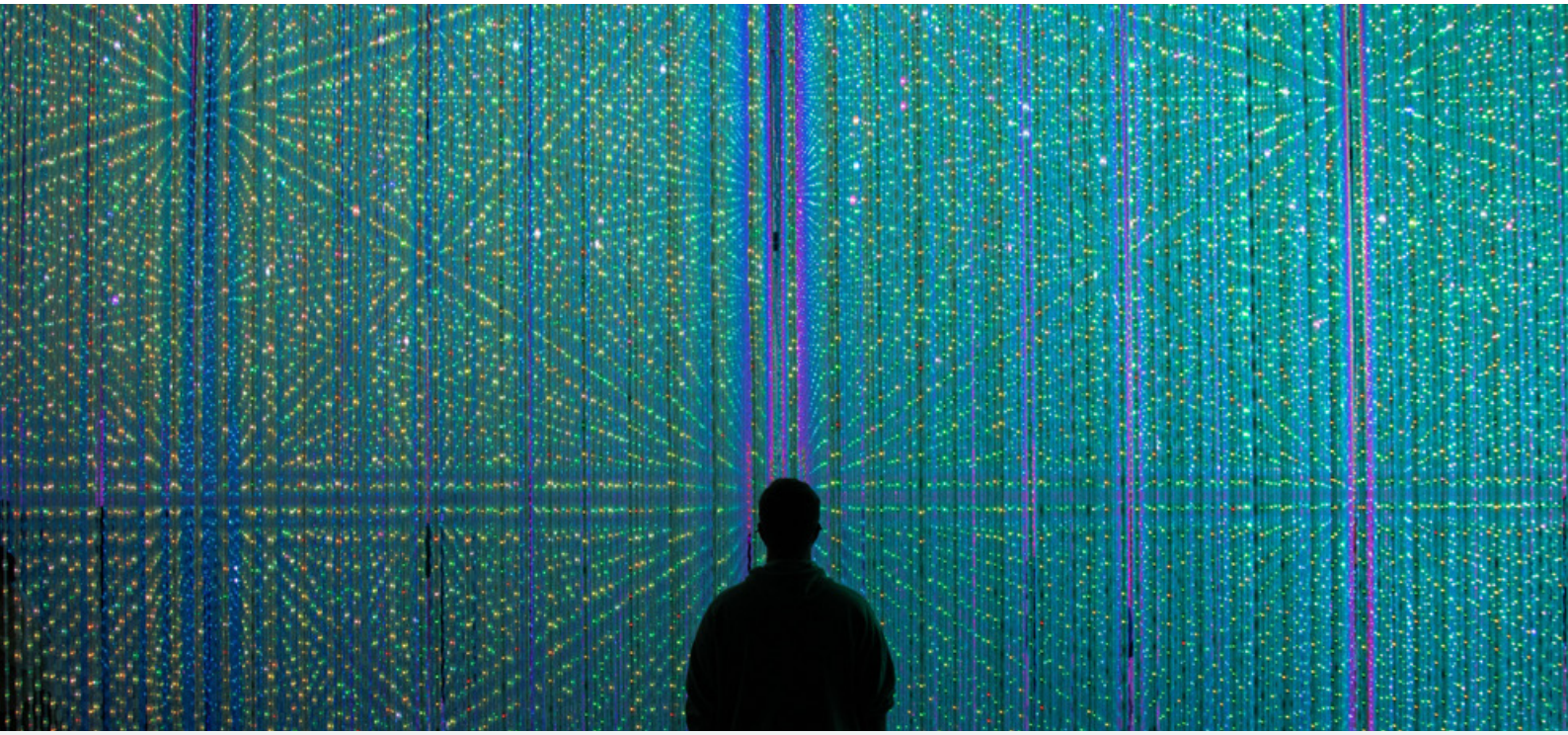
As of 2022, 140 countries[92] and more than 5,000 companies[93] have made net zero commitments. All are driving the development of data analysis, reporting and strategic advisory services to support them on their path towards ESG maturity.[94]

As ESG gains traction in the Middle East, a growing trend to disclose information about committees that oversee ESG is expected, with growing support to build effective structures and meet global reporting standards.[95]

MEGATREND 6

BORDERLESS WORLD - FLUID ECONOMIES[f]

A borderless world emerges from increasingly borderless transactions in finance, health, education, trade, services and even space. These activities are leading to the blurring of jurisdictional boundaries, changing liabilities and increased numbers of cross-border communities. With the pace of change being driven by advances in communications, computing and advanced machine intelligence, a borderless world will change the way we work, live and communicate.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

3D Printing
Cellular (5G, 6G) and Broadband Networks
Cryptocurrencies
Digital Economy
Gig Economy
Legal Transformation
Migration and Immigration
Non-fungible Token (NFT)
Remote Work
Robotic Surgery

f Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

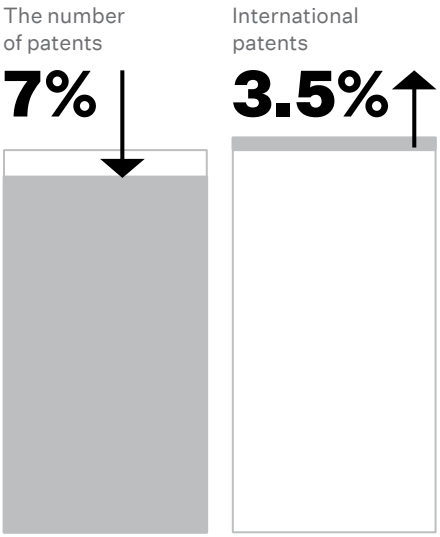
LEGAL TRANSFORMATION

Between non-fungible tokens (NFTs), cryptocurrencies, the gig economy, cybersecurity and the multisectoral digital economy more generally, dispute resolution will increasingly become complex and multijurisdictional.

As examples, the Singapore High Court recently ruled that residency was sufficient to establish jurisdiction in a dispute involving an NFT.[96] In the United Kingdom, courts will look beyond the employee status in a written contract and will instead look at actual working arrangements.[97] Various court rulings and the standards proposed in the draft European Directive on Platform Work[98] across the European Union have been addressing employment rights of those working through online platforms.[99]

Even patents are increasingly global. Since 2014, a total of 4.5 million international patent applications have been filed under the World Intellectual Property Organization's (WIPO) Patent Cooperation Treaty. These are in 10 languages, including 56% in English, nearly 17% in Japanese, nearly 10% in German and 9% in Chinese.[100] Only 200 are in Arabic.[101]

Even with a 7% drop in the number of patents published in 2022,[102] 272,313 international patents – nearly a 3.5% increase compared to 2021 – were published in 2022.[103]



Number of published patents in 2022 compared to 2021

Fully digitalising the economy in the Middle East and North Africa region (MENA) could lead to a rise in GDP per capita of at least

46%

over 30 years and increase

1.5 MILLION JOBS

in manufacturing

AREA OF FUTURE OPPORTUNITY

EXPANDING THE DIGITAL ECONOMY

The consumer produced goods sector produces more than 80% of greenhouse gas emissions and is responsible for various environmental impacts on biodiversity and natural resource scarcity.[104] As a result, it will be vital in the future for this sector to focus on sustainability and the complete re-engineering of supply chains[105] and find innovative ways to seamlessly get everyday products to consumers,[106] which could be enabled by expanding the digital economy.

The European Union has allocated about $129 billion[g] to reforms and investments in the digital economy, in areas including digital transformation, adoption of key digital technologies by businesses, AI, big data and deployment of fifth-generation (5G) cellular networks.[107]

Launched in April 2022, the United Arab Emirates' Digital Economy Strategy aims to double the contribution of the digital economy to the country's non-oil GDP — from just under 12% to 20% — within 10 years (by 2031).[108]

Fully digitalising the economy in the Middle East and North Africa (MENA) region could lead to a rise in GDP per capita of some 46% over 30 years, particularly in the lower-income countries of the region, and increase employment in manufacturing by 5% (equivalent to 1.5 million jobs).[109]

AREA OF FUTURE OPPORTUNITY

SUPRANATIONAL SOCIAL POLICIES

The average life expectancy around the globe is expected to reach 77 by 2050.[110] From security, education and work to health and well-being, people in a borderless world may increasingly seek borderless social services, including retirement and unemployment aid. This may make supranational social policies an area of future opportunity.

Pensions are the most widespread form of social protection around the world. Globally, almost 80% of people above retirement age receive some form of old-age pension; expenditure on pensions and other benefits for older people accounts for 7% of GDP on average.[111]

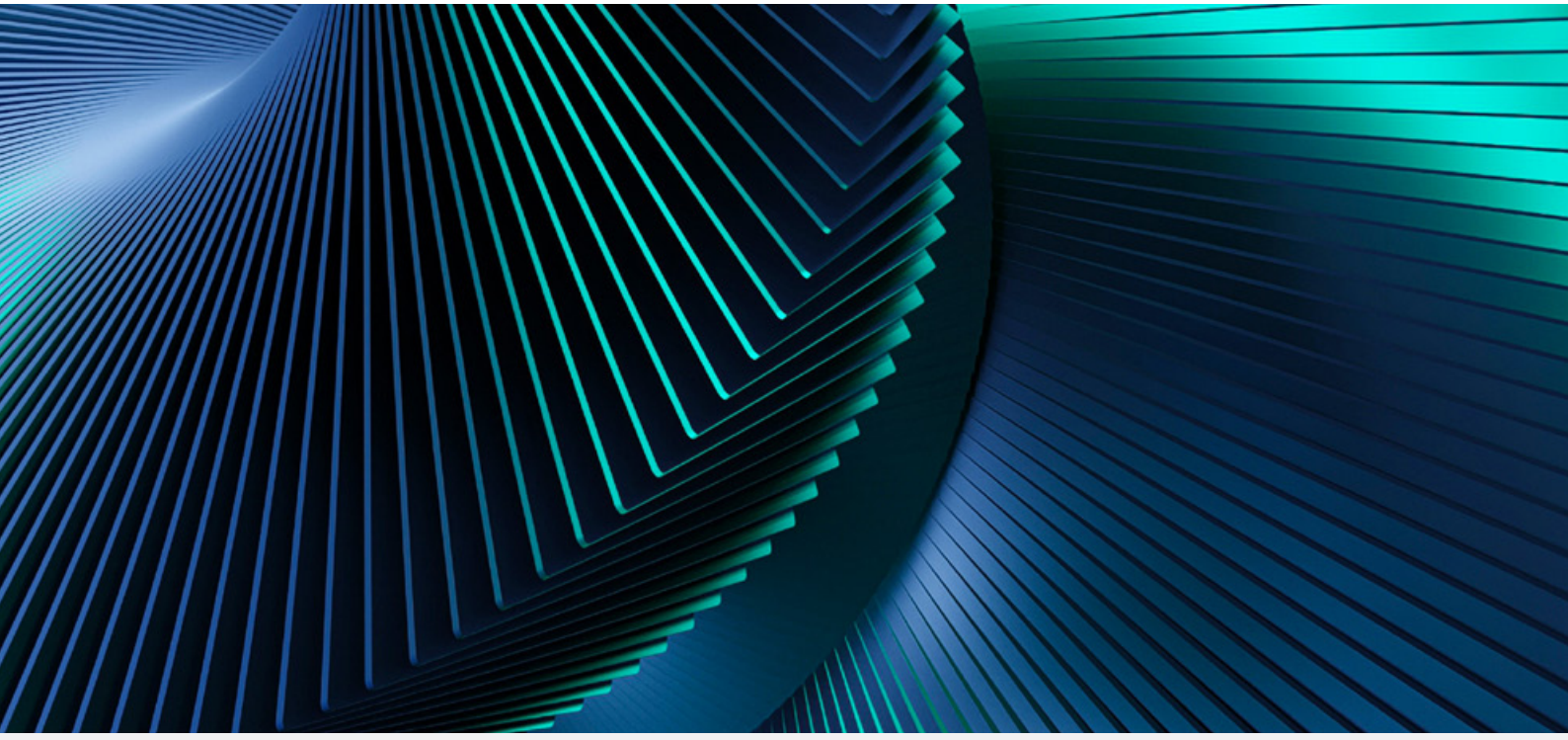
In an apparently irreversible move towards remote work,[112] three-quarters of professionals and entrepreneurs believe that remote work will be the new normal[113] and 72% of employers globally are considering or have implemented a policy enabling their employees to work from another location on a temporary basis. Surveyed by EY, **74% of employers globally are prepared to hire employees with hard-to-fill or critical skills and allow them to work from anywhere.**[114]

g Based on EUR–USD currency conversion rate on 11 November 2022.

MEGATREND 7

DIGITAL REALITIES[h]

Digital natives – those who have grown up with digital forms of entertainment, education and even communications – will naturally usher in increasingly virtual worlds where many 'real-world' tasks and behaviours can be replicated and even improved in 3D and 4D environments. The emergence and spread of 5G and 6G networks will enhance autonomous and Internet of Things (IoT) applications as they offer more reliable, cost-effective and secure high-speed connectivity. As quantum technologies become scalable and reliable, from quantum computing, communications and sensors, immersive experiences will start to feel like reality.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Cellular (5G, 6G) and Broadband Networks
Augmented Reality (AR) and Virtual Reality (VR)
Blockchain
Brain–Computer Interfaces (BCIs)
Cryptocurrencies
Digital Communities
Gaming
Internet of Things (IoT)
Metaverse
Wearables

h Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

IMMERSIVE TECHNOLOGIES AND WEARABLES

The global brain–computer interfaces (BCIs), or neural implants, market was valued at $1.5 billion in 2020 and is projected to grow at a CAGR of 12.5%, reaching $4.5 billion by 2030.[115] BCIs can help people control machines using their thoughts, and they are especially useful in helping people with paralysis to regain control of their limbs.[116]

Some companies are working towards this growing new industry that is considered to be in the experimental stage.[117] Including Neuralink's implantable brain–machine interface (BMI), which measures 23 millimetres in diameter and is 8 millimetres thick,[118] Synchron recently implanted a device into the brain of an individual with amyotrophic lateral sclerosis (ALS).[119, 120]

More relatable today when it comes to immersive technologies and wearables, and in the second half of 2022, global shipments of AR and VR devices continued to decline (by just under 7%) year on year compared to the previous two years.[121] Nevertheless, the long-term outlook is positive, with significant advances that could unlock scalability by reducing prices by more than 50%.[122]

The total value of the market for VR and AR headsets, smart home devices and wearables is expected to reach $543 billion by the end of 2025 from just over $370 billion at the beginning of 2022.[123]

The global brain-computer interfaces (BCIs), or neural implants, market is expected to grow at a **CAGR of 12.5%**, reaching

$4.5 BILLION by 2030

AREA OF FUTURE OPPORTUNITY

VIRTUAL PROTOTYPING

Enabled by a combination of advanced machine intelligence, advanced computing and even quantum computing, virtual prototyping runs numerical simulations to allow for enhanced simulation analysis either through a digital twin or independently.

Digital twins are indispensable in the auto and consumer electronics industries today. They can be integrated into research and design, used to simulate the production process, to plan and monitor supply chains and to improve reliability and repairs; they can even talk to each other – particularly when implemented across the supply chain.[124] In consumer electronics, manufacturers have reduced the amount of scrap by roughly 20% because of digital twins.[125] Virtual prototyping will expand into other areas as well: looking inside prototypes and processes in engineering; social policy design; and even environmental accounting and impact assessments.[126]

The market for digital twins in Europe may reach nearly $7 billion by 2025,[i] an annual growth rate of up to 45%.[127]

In consumer electronics, manufacturers have reduced **the amount of scrap** by roughly

20%

because of digital twins

AREA OF FUTURE OPPORTUNITY

'DIGITAL REALITIES' SOCIAL RESPONSIBILITY

Concerns have been raised about the impacts on our future well-being of combining technologies to create sophisticated and complicated immersive and personal experiences.[128] Concerns include: reduced human interaction and lack of in-person communication, reduced physical activity, increased abuse and harassment (types of cybercrime), greater development of dual and pseudo personalities with increased adoption of them in the home, high dependency on virtual spaces and data and privacy issues.[129]

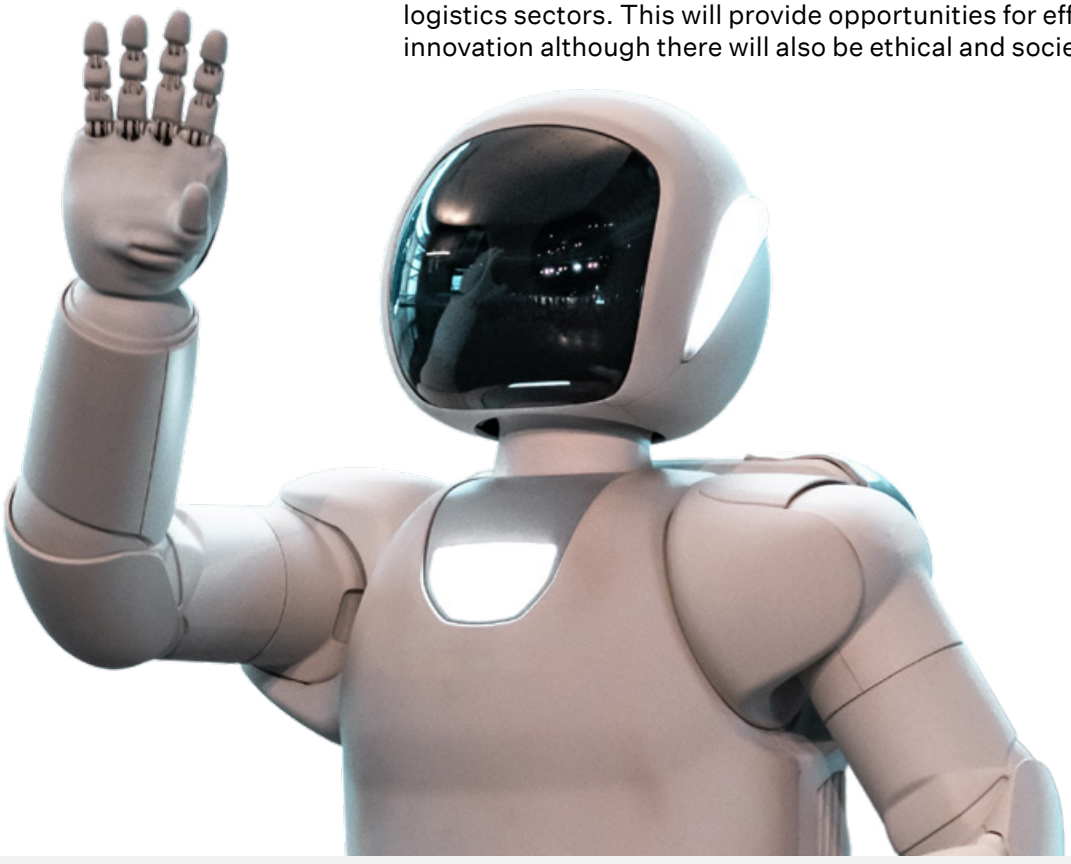
Drawing parallels with corporate social responsibly, thinking in terms of **'digital realities social responsibility'** would prompt opportunities to respond to these concerns[130] along with finding ways to reduce the environmental impact and energy consumption of associated technologies.[131]

i Based on EUR–USD currency conversion rate on 11 November 2022.

MEGATREND 8

LIFE WITH AUTONOMOUS ROBOTS[j]

A robot is a machine that can sense, think, act[132] and communicate.[133] Driven by profound progress in mechanical engineering design, materials science, advanced machine intelligence and advanced communication networks, robots will increasingly enter many – if not all – industries beyond the automotive, manufacturing and supply chain logistics sectors. This will provide opportunities for efficiency and innovation although there will also be ethical and societal challenges.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Automated Guided Vehicles (AGV)
Autonomous Robots
Biosensors
Collaborative Robots (Cobots)
Internet of Things (IoT)
Nanobots
Natural Language Processing (NLP)
Robot Skin
Service Robots
Social Robots

j Slight adjustment to title in the 2022 Global 50 Report.

AREA OF FUTURE OPPORTUNITY

COMPLEX AREAS OF DISCOVERY, BIG AND SMALL

In the sea, on land, in space and even within us, it is anticipated that robots will one day be found everywhere and in all sizes, helping humans – from archaeological sites to disaster zones to underground pipes.

To clean and maintain 10,000 coral fragments, three people would need to put in 4,000 hours of work. Whereas, a coral-farming robot such as 'Charm' uses automation and AI with robotic arms, camera and soft brushes to seamlessly clean coral.[134]

At the Chinese University of Hong Kong, scientists engineered a robot that behaves like slime mixed with magnetic particles that can be moved and controlled by external magnets. Squeezing through narrow spaces as small as 1.5 mm in diameter and grasping solid objects by wrapping around them, 'slime' could repair circuits and move around objects.[135]

Nanobots are robots whose size is measured in nanometres. While nanobots' primary use has so far been in drug delivery, other uses include the diagnosis of infection (by researchers at the Chinese University of Hong Kong), dental procedures (at the Indian Institute of Science), diabetes management (at Pennsylvania State University) and cancer therapy (at the University of Hong Kong).[136]

At the Chinese University of Hong Kong, scientists engineered **a robot that behaves like slime mixed with magnetic particles**, squeezing through narrow spaces as small as

1.5 MM

in diameter

1 MINUTE

of a surgical video is estimated to generate

25X

the **amount of data identified in a computerised tomography (CT) scan**

AREA OF FUTURE OPPORTUNITY

INCREASING HUMAN X MACHINE COLLABORATION

As humans, machines and algorithms increasingly work together,[137] robots will help nurses[138] and free up workers to take on more creative elements of their job.[139] Wearable robots will enhance people's physical abilities, allowing them to lift up to 91 kg at a time irrespective of their innate lifting ability.[140] Another example, is that of surgery.

Since the first telerobotic surgery in 2001, remote surgery has gained prominence. Robot-assisted surgery is designed be both precise and minimally invasive.[141]

The Da Vinci system is a popular minimally invasive robotic surgery approach. There are 60,000 Da Vinci systems in operation around the world and they have been used to perform 10 million surgical procedures. The system delivers 3D high-definition views (magnified 10 times beyond what the eye can see) and uses tiny instruments with a greater range of motion than the hand.[142]

One minute of a surgical video is estimated to generate 25 times the amount of data identified in a computerised tomography (CT) scan image enhancing both diagnosis and treatment outcomes.[143]

AREA OF FUTURE OPPORTUNITY

INTELLIGENT, SOCIAL AND SENTIENT ROBOTS

While AI and robotics are two separate fields, their integration into AI-powered robots is expected to grow over the coming decades.[144] Robots can be augmented with a variety of sensors – including cameras, vibration sensors, proximity sensors and other sensors that pick-up information from the surrounding environment – and together with AI allow robots to analyse and act upon situations in real time. AI is what makes robots intelligent.[145]

In the literature, social robotics comprises only 2.3% of the larger robotics knowledge base. However, rapid progress in social robotics research – aided by interdisciplinary collaborations, including the social sciences – will help advance the capabilities of social robots.[146]

With a third of Japan's population already aged over 65, the Japanese government is providing subsidies to help care facilities purchase social robots.[147] The global social robots market reached $2.6 billion in 2021 and is expected to reach $13 billion by 2027, expanding at a CAGR of 31%.[148]

The global emotion detection and recognition market was valued at $19 billion in 2021 and is expected to grow to $39 billion (at a CAGR of 16%) by 2026.[149]

MEGATREND 9

FUTURE HUMANITY[k]

Human potential is unlimited. With advanced machine intelligence, brain–computer interfaces (BCIs), technological developments in science and medicine and an increasingly borderless world, people's understanding and expectations of self-realisation, including work, education and what it means to thrive, will shift. Personal development, how individuals and communities innovate and communicate, and new definitions of self-esteem, autonomy and stability will bring forth new ideas about parenting, care, love, belonging, inclusion and community.

KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Brain–Computer Interfaces (BCIs)
Creative Economy
Future of Education and Higher Education
Future of Work
Ideation and Innovation
Mental Health
Personalisation
Self-Realisation
Digital Realities
Sharing Economy

k Slight adjustment to title in the 2022 Global 50 Report.



The Dominican Republic, **Chile** and **Canada** were the **most innovative** with more than

1 IN 10 ADULTS

starting a business using technologies and procedures that were new to the target market in 2021

AREA OF FUTURE OPPORTUNITY

THE CREATIVE ECONOMY

Novelty, usefulness and surprise are all criteria that have been used to define creativity. As a complex phenomenon that has attracted increased research interest, creativity is as difficult – if not more difficult – to study as attention and memory.[150]

As we gain better neuroscientific understanding of the phenomenon, creativity will become more easily nurtured.[152] The creative economy could represent 10% of global GDP by 2030.[152]

Creativity enables innovation, increases productivity and fosters adaptability.[153] However, based on the average numbers of patents filed in the United States, creativity has been falling 4% per year since the early 2000s,[154] and in 37 of the 47 countries covered in the 2021 Global Entrepreneurship Monitor less than 1 in 100 adults started a new business with products or services that were new.[155] Canada, Chile and the Dominican Republic, were the most innovative with more than 1 in 10 adults starting a business using technologies and procedures that were new to the target market. Norway, Poland and Morocco were the least innovative, each with less than 1 in 100 adults doing the same.[156]

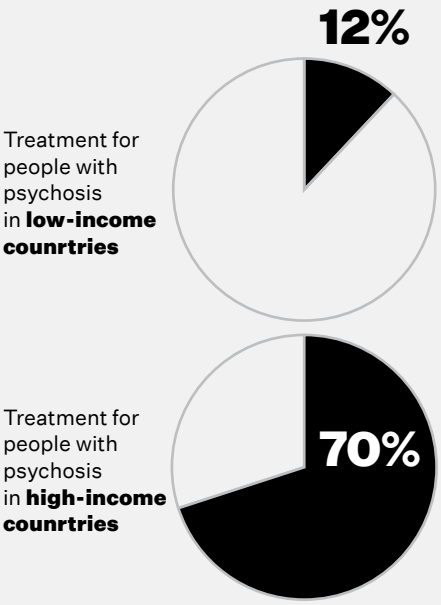
AREA OF FUTURE OPPORTUNITY

TECHNOLOGY FOR MENTAL HEALTH [I]

Even before the COVID-19 pandemic, only a small proportion of people in need had access to effective, affordable and high-quality mental healthcare. While 70% of people with psychosis are reported to be treated in high-income countries, only 12% receive mental healthcare in low-income countries.[157]

Increases in smartphone ownership and internet connectivity, as well as wearable devices, have made it possible to observe and analyse human behavioural patterns more comprehensively than ever before. In response, there are more than 10,000 apps in the Apple and Google Play stores that aim to address challenges in mental health.[158] In 2021, 11% of the $5.4 billion funding raised by US digital health companies went to start-ups focused on behavioural health, including services both for mental health and for substance abuse treatment.[159]

If novel mental health therapies could remove just 1% of the neurological and mental health disorders that are currently untreatable by 2045, the result would be nearly a $10 billion a year reduction in the disease burden worldwide.[160]



AREA OF FUTURE OPPORTUNITY

NEW DEFINITIONS OF EDUCATION

In 2021, the global youth unemployment rate was estimated to be just under

16%

more than three times the adult rate

Students will be expected to become partners or co-creators of their own learning, with anywhere and anytime learning that is customised and evolved in relation to grading and assessment.[161] Knowledge, education and learning will be reimagined in a world of increasing complexity and uncertainty,[162] and the need to manage workforce participation, education and knowledge will be critical.[163]

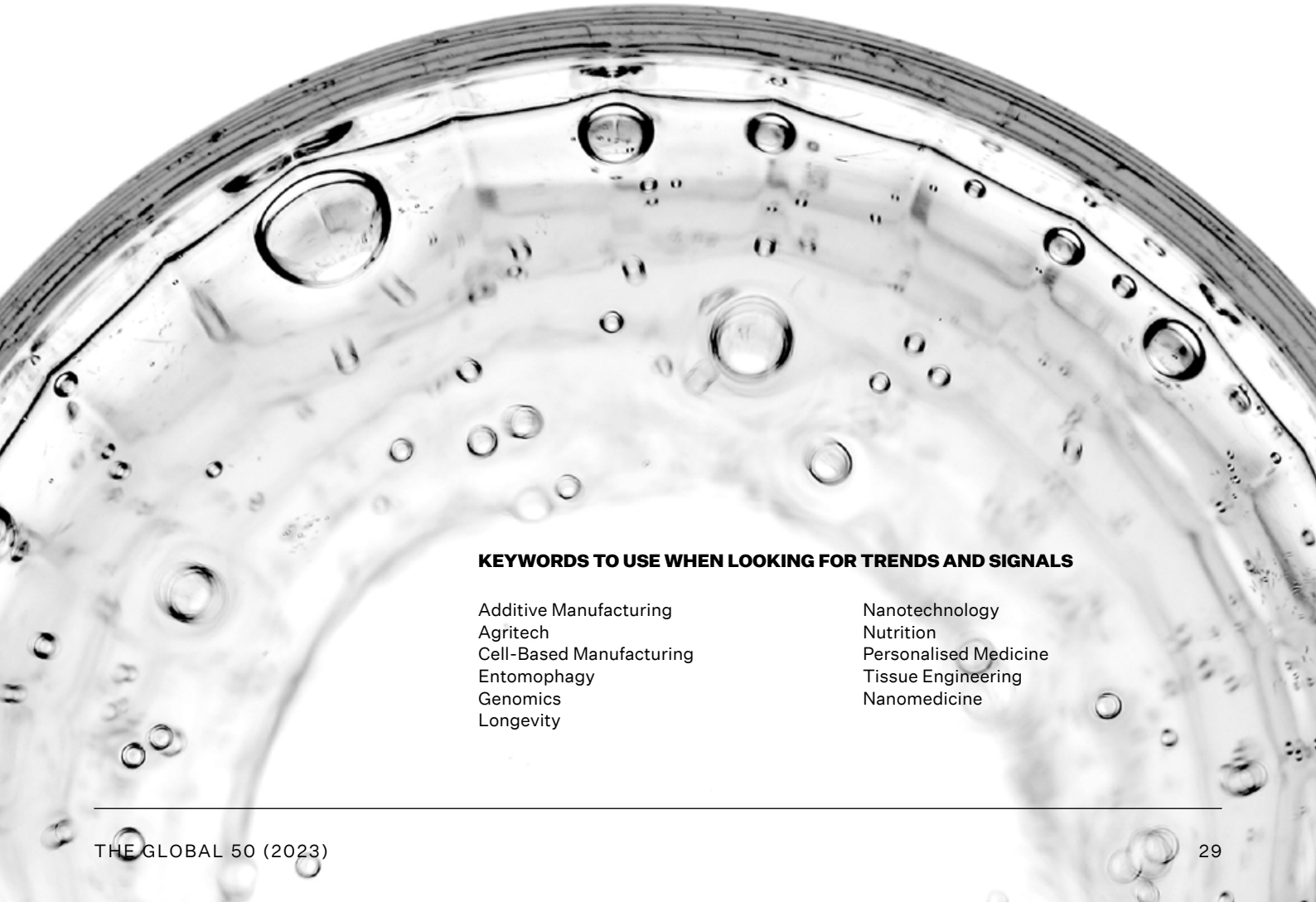
Further driving the future of education is future employment. In 2021, the global youth unemployment rate was estimated to be just under 16%, more than three times the adult rate.[164] Just prior to the Covid-19 pandemic, more than one in five young people aged 15-24 were not in education, employment or training, and in the 86 countries with available data for 2019, almost half of all young people aged 15–24 not in education or training were not employed.[165] Young people in the MENA region continue to find that the rising cost of living and unemployment present significant challenges.[166]

I Barring laws and regulations safeguarding patient privacy and data protection.

MEGATREND 10

ADVANCED HEALTH AND NUTRITION

Progress in advanced machine intelligence, nano- and biotechnology, additive manufacturing and the Internet of Things (IoT) will change both what we mean by health and nutrition and how they are experienced. Stemming from the unprecedented developments that will be required to respond to climate change, resource scarcity and the desire for longevity, this megatrend will improve health in both the younger and the older years. It will reduce, if not eradicate some, communicable and non-communicable diseases and enhance the sustainable use of and access to water and food.



KEYWORDS TO USE WHEN LOOKING FOR TRENDS AND SIGNALS

Additive Manufacturing
Agritech
Cell-Based Manufacturing
Entomophagy
Genomics
Longevity
Nanotechnology
Nutrition
Personalised Medicine
Tissue Engineering
Nanomedicine

AREA OF FUTURE OPPORTUNITY

ADDITIVE MANUFACTURING FOR FOOD

Additive manufacturing (3D printing) for food has many advantages, including unlimited design freedom, texture variety, waste reduction and time reduction – and potentially personalised nutrition in the future. The main challenges to address include the ability to print a variety of ingredients and nutrients, set printing models and associated parameters, and design printers that are adaptable to printable food options.[167]

The global 3D food-printing market is being driven by increased consumer demand for mass customisation and, more specifically, for customised food and nutrition. Another driver is technological advances in the ability of 3D – and one day 4D – printers to quickly prepare food that is suitably textured, nutritious and tasty. The global 3D food-printing market is predicted to surpass $1.6 billion by 2030, growing from $350 million in 2020 at a CAGR of 17%.[168]

The global **3D food-printing market** is predicted to surpass

$1.6 BILLION

by 2030

Entomophagy accounts for

1/3 of the diet of the world's population

The market is expected to grow

30%

between 2022 and 2026

AREA OF FUTURE OPPORTUNITY

DIVERSIFIED SOURCES OF FOOD

Between plant, cellular, fermentation and other (e.g. edible insects) sources, the market share of alternative proteins could reach 12% ($290 billion) of the total protein market by 2035, compared to 2% in 2020.[169]

More than one-fifth of global greenhouse gas (GHG) emissions come from agriculture. Cellular agriculture has the potential to reduce GHG emissions up to 96% compared to traditional agriculture.[170] In 20 years, 35% of global meat consumption will come from cultivated meats, with this market expanding at a CAGR of 41% between 2025 and 2040.[171]

Entomophagy – the practice of eating insect-based proteins – already accounts for a third of the diet of the world's population and can be an alternative to the intake of proteins from mammals and fish. The market was worth $1.2 billion in 2021 and is expected to grow at a CAGR of 30% between 2022 and 2026[172] where cultural practices permit.

In the Middle East and Africa combined, the plant-based meat and dairy products market was valued at $240 million in 2020 and is projected to achieve a CAGR of 6% between 2021 and 2026. Domestic brands that have launched vegan meat products include the United Arab Emirates-based Global Food Industries' Healthy Farm and Al Islami.[173]

AREA OF FUTURE OPPORTUNITY

PERSONALISED MEDICINE AND GENOMICS

Personalised medicine involves fitting treatment to individual characteristics. It could ultimately lead to a shift in the clinical treatment paradigm from a trial-and-error approach to one that enables the right drug to be prescribed for the right patient at the right time.[174]

Current medicine mainly uses a universal approach to diagnostics and prescriptions. Meanwhile, 90% of conventional medicines work for only 30–50% of patients.[175]

The projections are that personalised medicine could grow by 11% per year from 2020 to 2026 and be worth $142 billion globally,[176] with increasing demand for novel therapeutic drugs.

Personalised medicine could be worth

$142 BILLION

globally by 2026

NAVIGATING THE GLOBAL 50 REPORT

The primary aim of the Global 50 report is to support the formulation of new ideas and present various opportunities that may be worth pursuing. Coming up with new ideas is demanding, requiring multiple reiterations, particularly when thinking far into the future. The Global 50 offers specific pathways to explore the uncertainties, assumptions and megatrends and turn them into future opportunities worth pursuing for growth, prosperity and well-being.

We recommend that you look at all untapped potential. Ask yourself how uncertainties, assumptions and megatrends apply to your area of work. Do not ignore an opportunity just because it does not specify your sector. Be aware of how they might impact the direction of your organisation. Think about your stakeholders: how will they interpret the new ideas? How can you work with them to prepare or shape the future in this era of quantum shifts? More importantly, use the power of imagination and perspective to generate ideas that you may not have thought of previously.

Tips on using the Global 50 report when it comes to the process of formulating new ideas

- **REFLECT** on the uncertainties, megatrends and assumptions and think of the expected and unexpected, the favourable and unfavourable in your sector and area of work;
- **STUDY** whether more advantages lie in leveraging benefits and/or managing risks;
- **IMAGINE** how opportunities in one sector can be applied in yours;
- **THINK** of communities, nations and regions around the world who share similar vulnerabilities and opportunities;
- **CONSIDER** the impact on stakeholders and your role in managing the impacts;
- **KEEP AN OPEN MIND** and change your perspective; and
- more importantly, **USE YOUR IMAGINATION** to keep thinking of ideas.

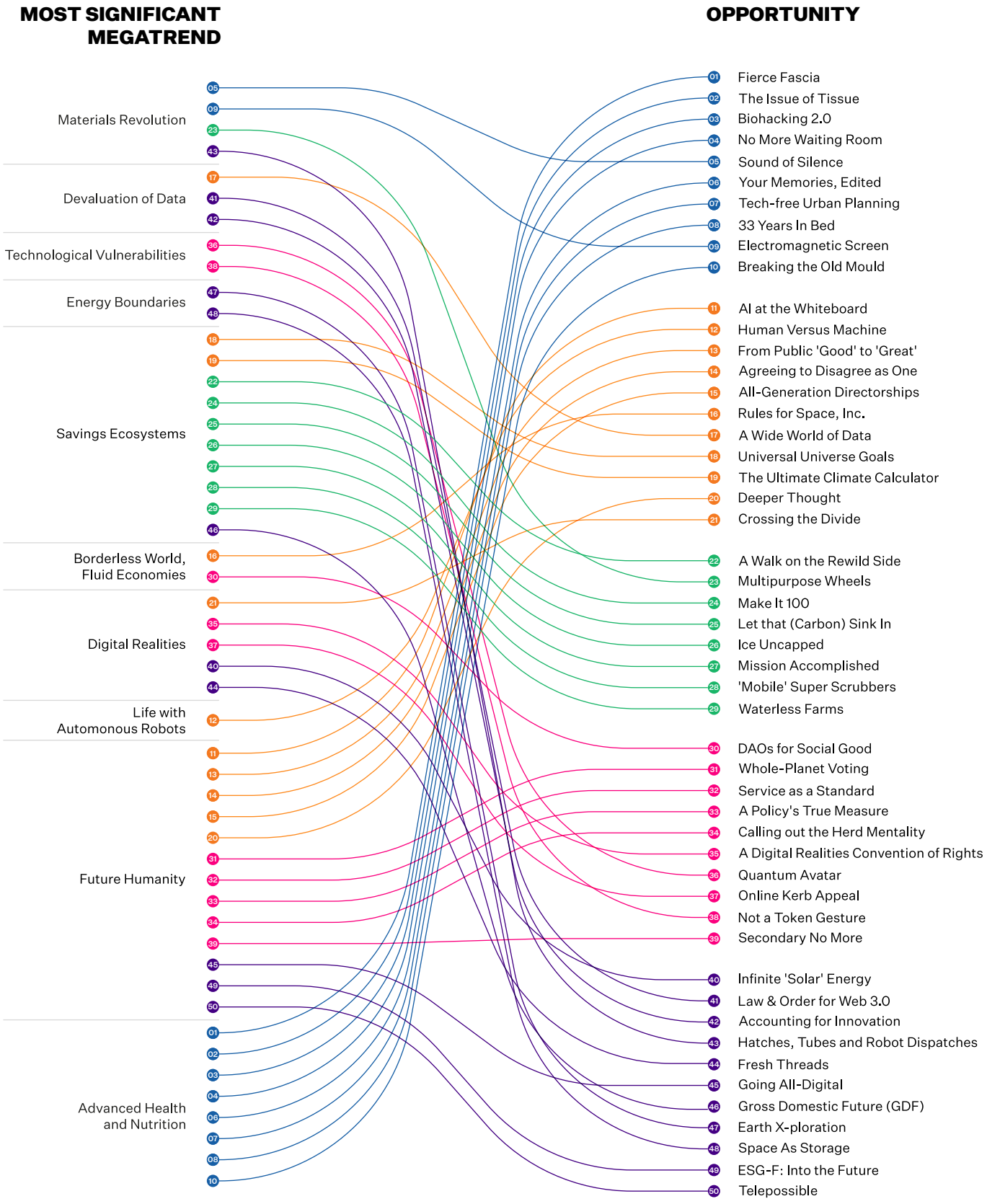
NAVIGATING OPPORTUNITIES

As mentioned earlier in the report, **the opportunities shared in this report are not exhaustive; they present some of the different pathways and approaches to growth, prosperity and well-being.** They offer possibilities for major advances in our quality of life while raising profound questions for society to resolve. Some opportunities will be more pertinent than others. Some contexts may have the conditions in place to share in the benefits, others may not. Equally, the risks relating to some opportunities might not be limited to those countries or businesses exploiting the opportunities directly: risks often travel faster than benefits.

Each of the opportunities presented includes a question for the future with a tagline that answers it driving further thinking. Each of the opportunities also includes trends and challenges observed today that make these opportunities relevant in the future along with a high-level assessment of the associated benefits, risks, most significant megatrend driving the opportunity and sectors that can impact or be shaped by the opportunity.

The trends, signals, benefits and risks mentioned within each opportunity are non-exhaustive.

OPPORTUNITIES MAP



HEALTH REIMAGINED

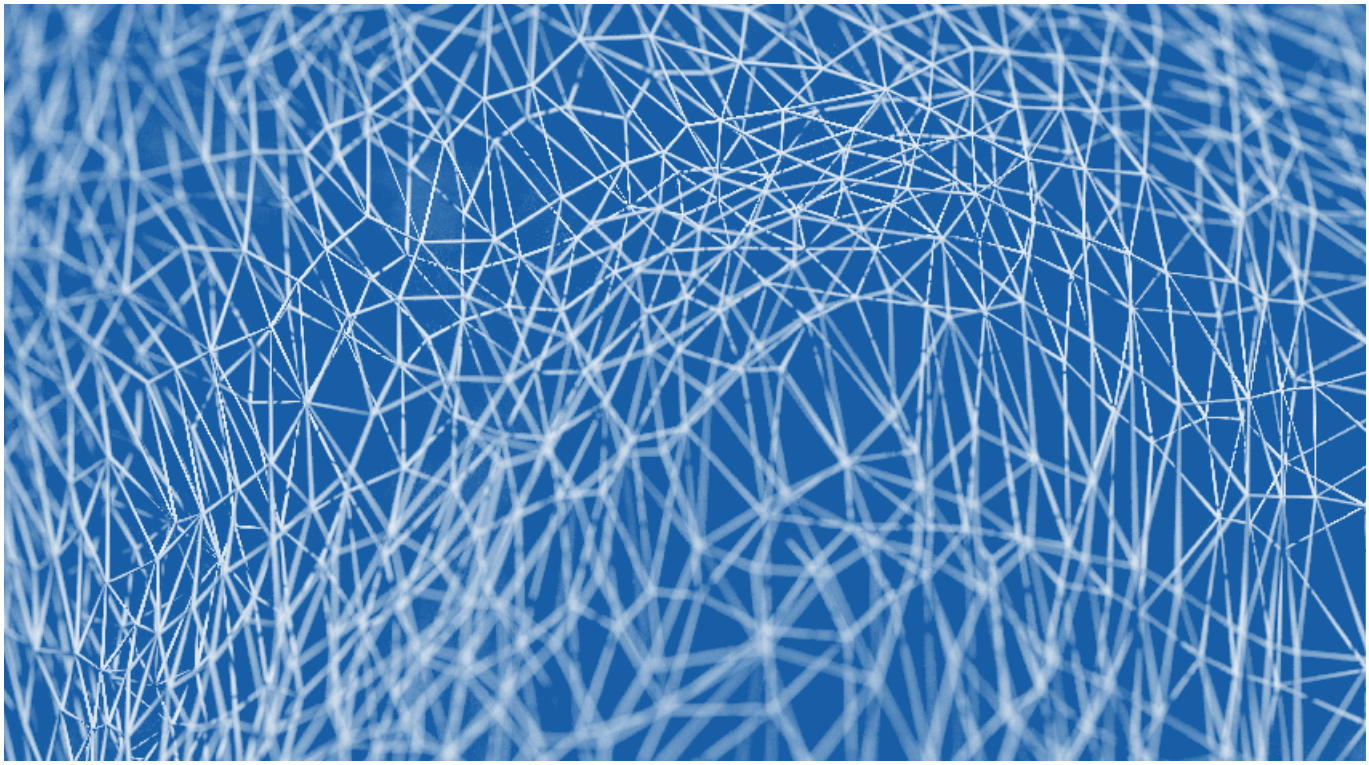
Redefine mental and physical health, support longer lives, drawing on both science, technology and nature towards better health and new ways to personalise access for individuals and communities everywhere.

OPPORTUNITY #1

What if we improved our natural internal armour?

FIERCE FASCIA

Gene therapies and advanced nutritional approaches boost the body's natural internal armour, scientifically known as the fascia, preserving biomechanical health over a lifetime.



MEGATREND
Advanced Health and Nutrition

TRENDS
Genomics
Longevity & Well-being

SECTORS AFFECTED
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Financial Services & Investment
Health & Healthcare
Insurance & Reinsurance
Materials & Biotechnology

WHY IT MATTERS TODAY

Longevity and more sedentary lifestyles are contributing to a rise in reported joint and back pain as well as migraines,[177] all of which are conditions that negatively impact quality of life.

Research has found that 42% of adults in Sweden with back pain take sick leave or disability payments, with productivity loss per person amounting to more than $13,000 during a 12-month follow-up period.[178] Globally, over 570 million people, i.e. 7.5% of the world's population, were affected by back pain in 2021.[179] Partially related to sedentary lifestyles, the annual economic burden of migraines in the United States is some $78 billion and the associated annual health service costs are between $8,500 and $9,500 per individual.[180]

Global healthcare spending – both public and private – is estimated to rise by nearly 5% in the period between 2020 to 2040, reaching a value of nearly $12 trillion by 2040,[181] and as populations become more urban and many jobs become even more sedentary, uncovering causes and how to prevent or treat 'aches and pains' is becoming more urgent.

OVER 570 MILLION PEOPLE

i.e. **7.5% of the world's population**, are affected by back pain across the globe

THE OPPORTUNITY

The fascia acts as the body's internal armour, protecting connective tissues, muscles, tendons and ligaments. Research is revealing the role it plays in preventing muscular and joint pain, even migraines,[182] and in maintaining biomechanical strength as we age.[183] Advanced medical technologies and understanding of the fascia could open new avenues for keeping it healthy, supple and strong throughout life, to preserve overall agility and strength and reduce joint pain.

Gene therapies and novel nutritional approaches can improve the resilience and efficacy of the fascia and radically reduce muscle, ligament and tendon pain and injuries. By boosting fascia health in younger people, these techniques can improve people's overall levels of fitness by facilitating exercise and recovery. In older people, fascia treatments decrease the stiffness, aches and pains associated with ageing, keeping older populations more active and in better health for longer.[184] The overall result is a lower cost burden on healthcare systems and greater lifelong productivity, health and well-being.

BENEFITS

Improved productivity, quality of life and well-being. Reduced costs to health systems.

RISKS

Over-reliance on fascia treatment, causing delayed treatment of other symptoms and potentially exacerbating associated diseases.

Global healthcare spending
is estimated to rise by nearly

5%

in the period 2020 to 2040
reaching a value of

$12 TRILLION

by 2040

OPPORTUNITY #2

What if we all held on to our stem cells?

THE ISSUE OF TISSUE

Long-term self-storage of an individual's stem cells become a standard of care, giving everyone the possibility of regenerating their own critical tissues throughout life.

MEGATREND
Advanced Health and Nutrition

TRENDS
Nanomedicine
Nanotechnology
Personalised Medicine

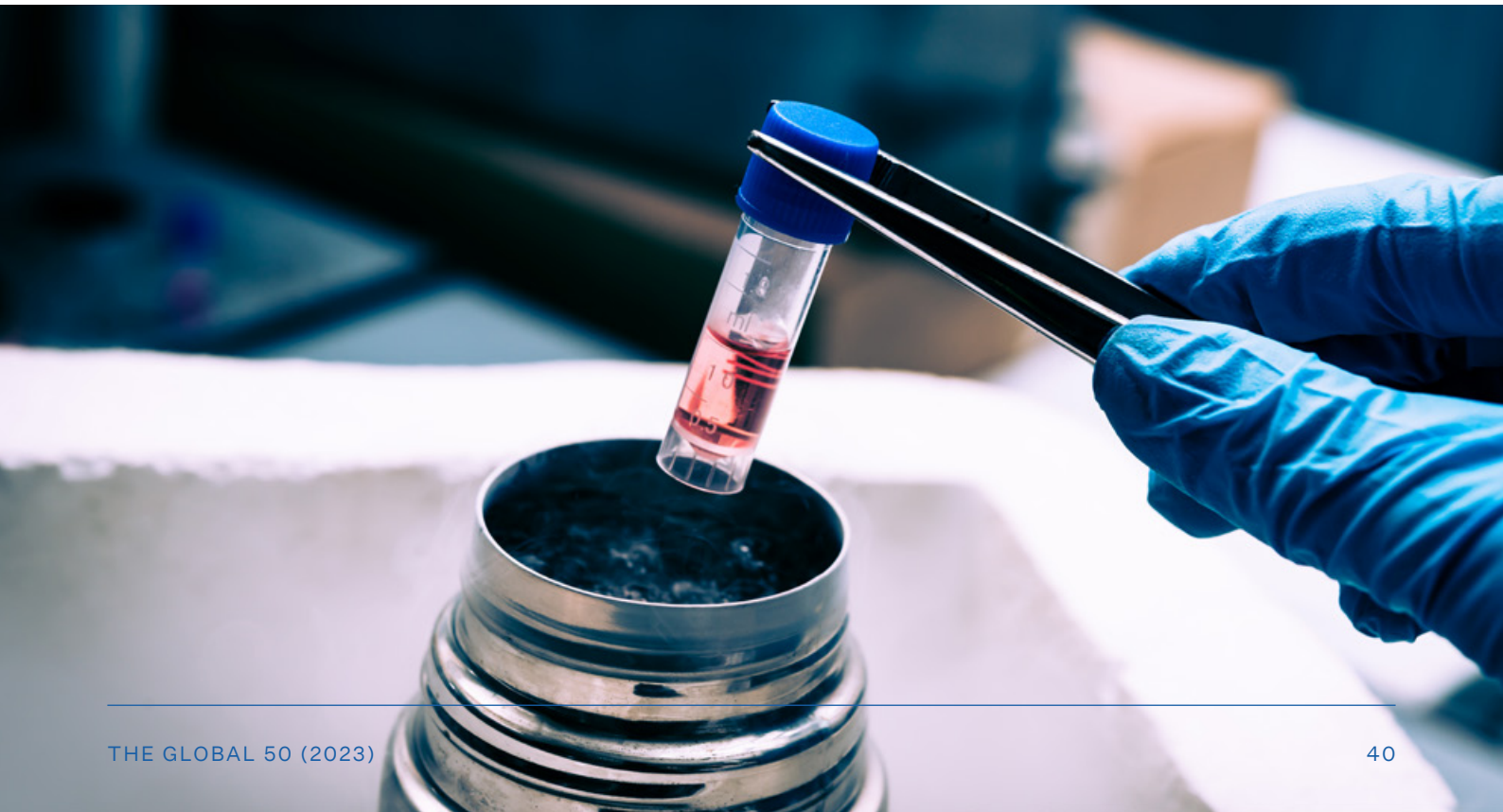
SECTORS AFFECTED
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Financial Services & Investment
Health & Healthcare
Insurance & Reinsurance
Materials & Biotechnology

WHY IT MATTERS TODAY

While there are many globally established cord blood banks that enable the storage of stem cells isolated from new-born tissues, the procedure continues to be optional for many parents. Based on the latest available data, parents banked cord blood in 30% of births in Singapore between 2018 and 2019; in contrast, in the United Arab Emirates and the United States, the level was around 3%.[185] Levels in other countries were 2.3% in Canada, 1.5% in Lebanon and 0.3% in the United Kingdom.[186]

As of 27 October 2022, the World Marrow Donor Association had registered just over 41 million blood stem cell donors, almost five times the number of donors registered two decades ago, and 811,000 cord blood units, almost seven times the number of units registered two decades ago.[187] An alternative source of stem cells is bone marrow. Most marrow exchanges took place within Europe; for cord it was within Asia, including the Middle East.[188]

Genetically, siblings have about a 25% chance of being perfect matches for each other, while the chances of finding a suitable match among unrelated bone marrow or cord blood donors from a public bank range from 29% to 79%.[189] As cord blood inventory increases by over 600,000 submissions annually,[190] Stem cells can be used to treat more than 70 types of disease, including immune system diseases, genetic disorders, neurologic disorders and some forms of cancer.[191]



THE OPPORTUNITY

The ability to regenerate genetically identical tissue from an individual's own stem cells opens the door to new and improved treatments for people with a range of chronic diseases and autoimmune conditions or accidental brain and other injuries. Future developments in stem cell nanotechnology will enable even better approaches and therapies targeting disease.[192] In addition, stem cells' pluripotency[193] means they can be grown into any type of tissue, making them, for example, an invaluable source of new organs without the risk of rejection, or a means of repairing tissue damage to retinas or the skin.

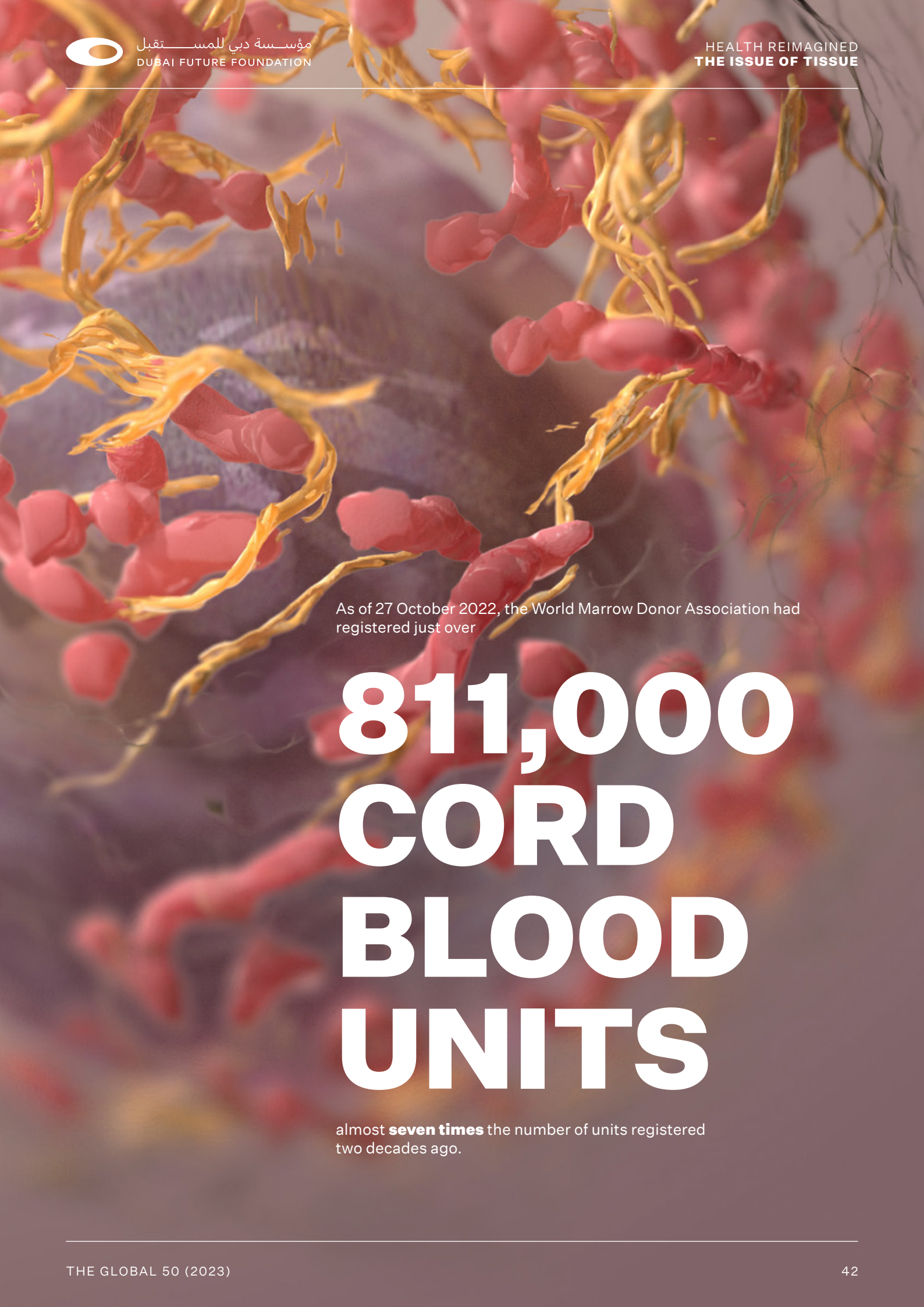
Cord blood extraction is a non-invasive procedure compared to other ways of gathering stem cells, such as bone marrow extraction. Therefore,and with consent, a requirement to store cord blood at birth – along with developments in stem cell isolation, harvesting and storage – may give individuals access to their own stem cells, stored in their own homes or elsewhere, and also give researchers access to stem cells for new applications in immunotherapies and in advancing precision medicine. Damaged heart muscles could be replaced, eliminating the need for pacemakers. Cancerous tissues could be removed and replaced with healthy tissue, and entire body parts could even be rebuilt using the same cell stock.[194]

BENEFITS

Improved health outcomes and quality of life, reducing care and health costs. Reduced misuse of and malicious damage to stem cell stocks.

RISKS

Inability to sustainably maintain cord blood banks and/or research with pressure for profitability and over-regulation. Low adoption due to perceived black market exchanges.



As of 27 October 2022, the World Marrow Donor Association had registered just over

811,000 CORD BLOOD UNITS

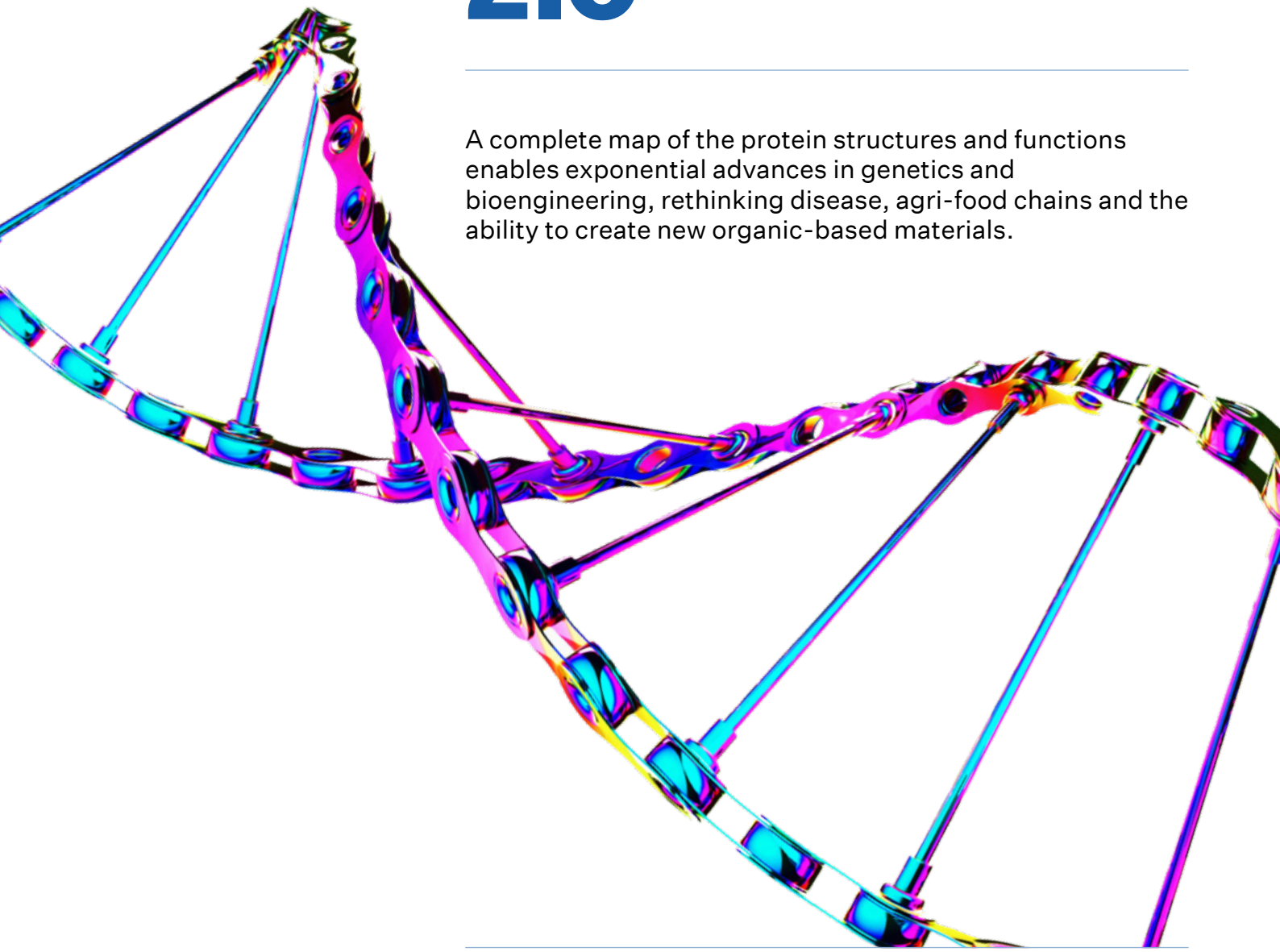
almost **seven times** the number of units registered two decades ago.

OPPORTUNITY #3

What if we could reprogramme proteins?

BIOHACKING 2.0

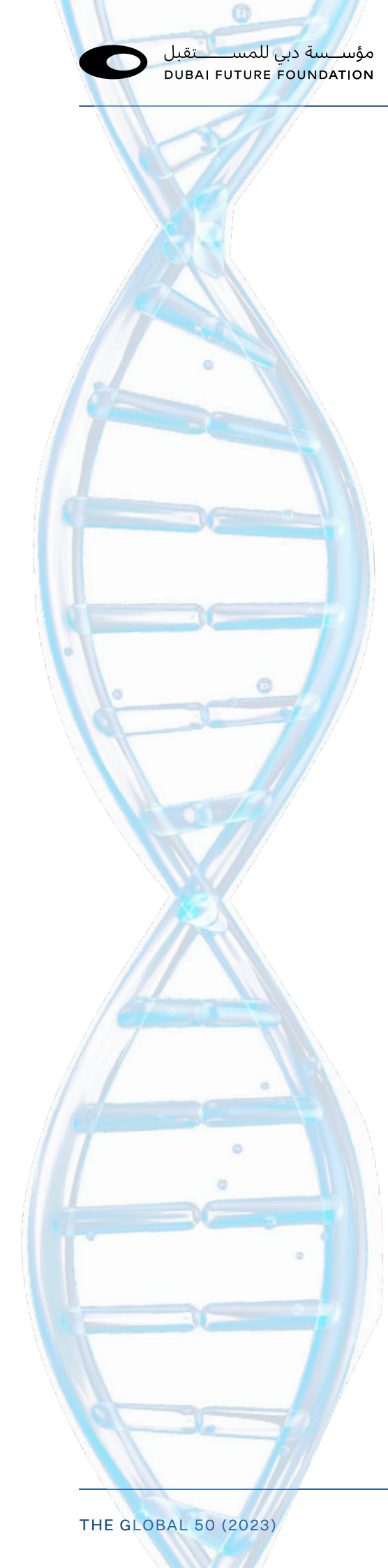
A complete map of the protein structures and functions enables exponential advances in genetics and bioengineering, rethinking disease, agri-food chains and the ability to create new organic-based materials.



MEGATREND
Advanced Health and Nutrition

TRENDS
Artificial Intelligence
Genomics
Proteomics

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Health & Healthcare



WHY IT MATTERS TODAY

The Human Genome Project was seeded with $4 billion in public funds, which has been converted into $700 billion worth of new economic activity as a result of sequencing the human DNA.[195] The Human Proteome Organization, an international consortium of research, government and business organisations, has uncovered just over 93% of the human proteome.[196]

While the number of proteins found in the human body is a matter of debate, most scientists agree on 20,000 but there could be more.[197] Types of protein include antibodies, enzymes, hormonal proteins, storage proteins and transport proteins with their many functions[198] and only a third of all estimated human proteins have been experimentally uncovered.[199]

A subsidiary of Google, DeepMind Technologies' predictive Artificial Intelligence (AI) model AlphaFold has now predicted the structure of almost the entire known human proteome. It has also predicted large portions of the proteomes of other organisms, including mice, maize and the malaria parasite.[200, 201] As a result, over 350,000 possible protein structures are currently catalogued, and this is expected to grow to 130 million structures, giving the potential to revolutionise the life sciences.[202] The proteomics-based market was valued at $17.5 billion as of 2019 and is projected to increase to $30.6 billion by 2025.[203]

Over

350,000

possible protein structures are currently catalogued, and this is expected to grow to

130 MILLION

structures

THE OPPORTUNITY

Now that the human genome has been decoded, advanced machine intelligence will continue to enable mapping of the human proteome[205] resulting in a complete catalogue of the various functions and structures of proteins.[206] This, combined with advanced protein engineering and editing techniques, enables the re-engineering or application of proteins' natural characteristics to defend against viruses, neutralise bacterial infections and even attack cancer cells through a simple procedure.[207]

While AI-generated protein structures will need to be validated experimentally,[208] uncovering the underlying mechanisms of which blood is transported, disease is triggered and how other organisms evolve and respond to their environments would be significant. This enables ways to fight disease, rethink agri-food chains and create novel organic-based materials and processes.[209]

BENEFITS

Exponential improvements in a range of health treatment possibilities and outcomes.

RISKS

Unintended consequences of engineering proteins, including increasing pathogenicity of viruses and designer toxins.[204]

The Human Genome Project was seeded with

$4 BILLION

in public funds, which has been converted into

$700 BILLION

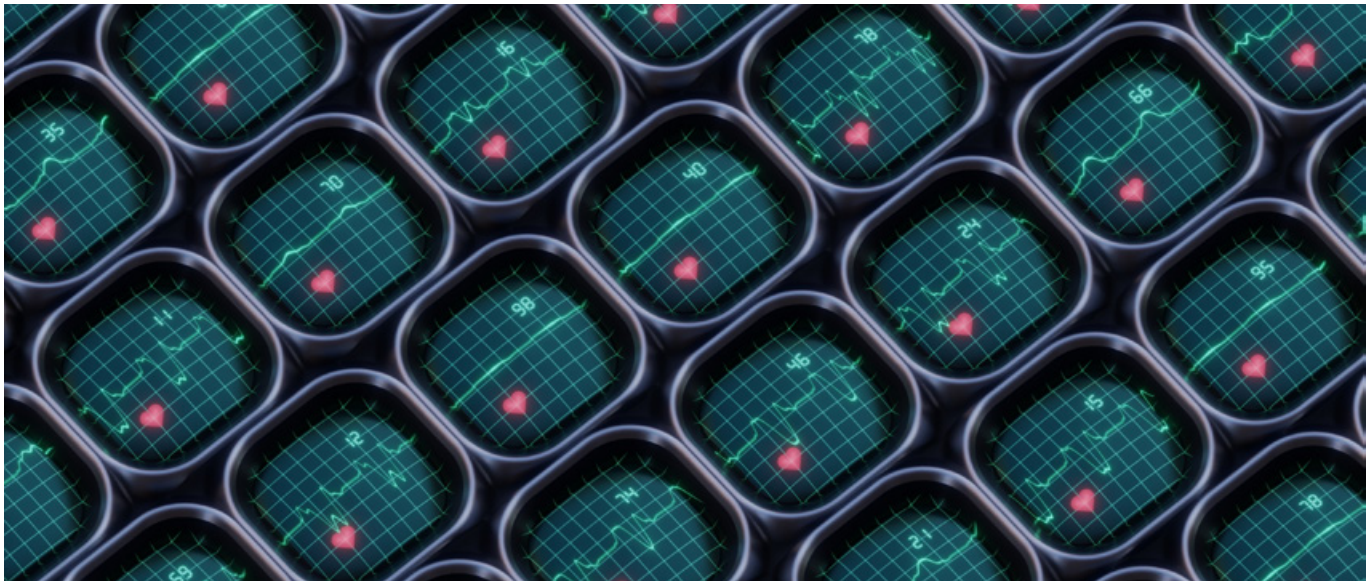
worth of new economic activity

OPPORTUNITY #4

What if the world's most disadvantaged had access to real-time diagnostics?

NO MORE WAITING ROOM

The costs of cutting-edge HealthTech drop, making optimal prevention, diagnosis and treatment accessible to more people around the world.



MEGATREND
Advanced Health and Nutrition

TRENDS
Genomics
HealthTech
Mobilising Innovation
Proteomics

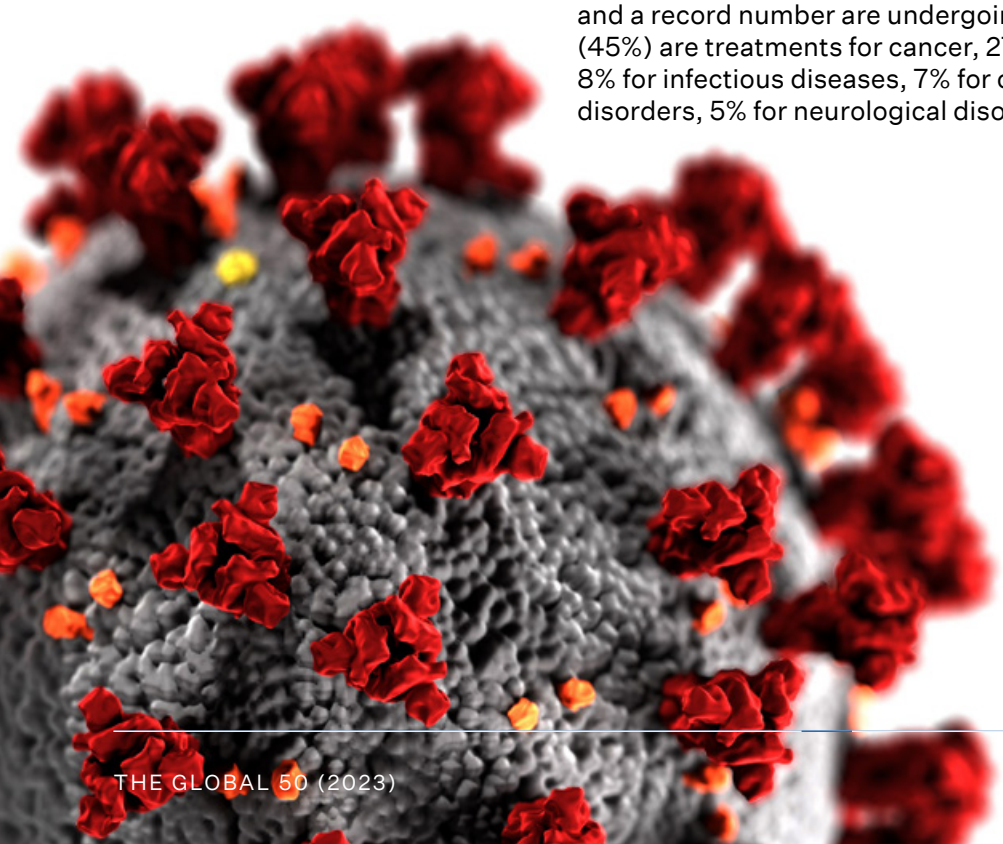
SECTORS AFFECTED
Materials & Biotechnology
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Financial Services & Investment
Health & Healthcare
Insurance & Reinsurance

WHY IT MATTERS TODAY

Health is a critical part of the United Nations' Sustainable Development Goals (SDGs), with all 17 SDGs being directly or indirectly related to health or contributing to its development in some form.[210] Shifts resulting from the COVID-19 pandemic have reversed the progress made since the adoption of the SDGs in 2015 and the poorest countries have seen their progress reversed by almost 10 years.[211] In about 90% of countries, one-third of health services were disrupted.[212] As countries try to address backlogs,[213] there is already a need to accelerate innovation and progress to ensure better healthcare progress worldwide.

The number of MRI scans, globally, increased by 31% between 2007 and 2018,[214] and Artificial Intelligence (AI) continues to play a key role in reducing the cost of medical imaging. Artificial intelligence is able to process data and identify anomalies in medical images more quickly than healthcare professionals alone, with the potential to improve patient outcomes by 30–40% and reduce treatment costs by 50%.[215] Since the first telerobotic surgery in 2001, remote surgery has also gained prominence, aided by the integration of new technology such as 5G, AI, haptic feedback devices, 3D printing and nanotechnology. In 2019, the 5G network enabled telerobotic spinal surgeries to be performed on 12 patients in different hospitals in six cities simultaneously.[216]

As they enable remote treatment of disease, the number of antibody therapies approved since 2010 has exceeded 100 in the United States and a record number are undergoing regulatory review.[217] Nearly half (45%) are treatments for cancer, 27% for immune-mediated disorders, 8% for infectious diseases, 7% for cardiovascular or haemostasis disorders, 5% for neurological disorder and 8% for other disorders.[218]



In about

90%

of countries, **one-third** of health services were disrupted due to the COVID-19 pandemic

THE OPPORTUNITY

Falling costs and high levels of automation, telehealth and telesurgery capacity will make cutting-edge care accessible and highly affordable around the world. AI, precision medicine and automation will revolutionise medical diagnosis, with possibilities ranging from more powerful and expensive medical imaging devices and diagnostic testing to rapid remote diagnostics, protein therapeutics and gene editing for personalised care.[219]

Diagnostics will be done through personal devices, removing the need for appointments and waiting times. Personalised treatment plans will be generated that draw on massive health databases, improving the efficacy of care and resulting in better outcomes. Fewer medical staff will be needed to treat more people, reducing the cost of health to public finances.

The global precision medicine market is anticipated to grow at a compound annual growth rate (CAGR) of 12% from $66 billion in 2021 to $147 billion by 2028.[220]

BENEFITS

Longer, healthier lifespans along with decreased pain and suffering and greater productivity and self-optimisation around the globe. Improved global growth, prosperity and well-being through support for the SDGs.

RISKS

Over-reliance on technology, leaving health systems vulnerable to cyberattacks and intentional or unintentional harm. Deliberate or accidental misdiagnosis. Unintended long-term consequences in protein therapeutics and genetic therapy, including increasing pathogenicity of diseases and viruses.

As they enable remote treament of disease, the **number of antibody therapies approved** since 2010 has exceeded

100

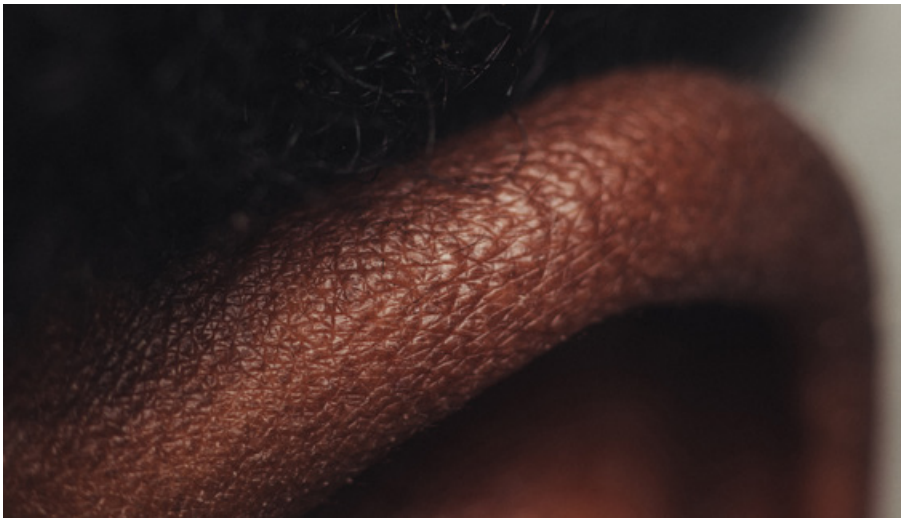
in the United States

OPPORTUNITY #5

What if cities went silent?

SOUND OF SILENCE

Advances in noise-absorbing materials and noise-cancelling technologies make the sound of silence — in cities — a reality, reducing stress and improving sleep.



MEGATREND
Materials Revolution

TRENDS
New Materials
Urban Design

SECTORS AFFECTED
Materials & Biotechnology
Automotive, Aerospace & Aviation
Communication Technologies and Systems
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Infrastructure & Construction
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

Noise that comes from aircraft, aeroplanes or construction work can become unbearable for people who live in cities. The urban population has been growing steadily with more people choosing to reside in cities than rural areas. More than 50% of the world's population resides in cities today, and this figure is expected to increase to 68% by 2050.[221]

A United Nations report recommends a permissible noise level for commercial areas with traffic of 70 decibels (dB). Prolonged noise at this level can cause hearing loss. The noisiest cities, all in Asia, are:[222]

1 Dhaka (Bangladesh) – 119 dB
2 Moradabad (India) – 114 dB
3 Islamabad (Pakistan) – 105 dB
4 Rajshahi (Bangladesh) – 103 dB
5 Ho Chi Minh City (Vietnam) – 103 dB

In the Middle East and North Africa (MENA) region the noisiest city is Damascus, Syria, at 94 dB.[223]

The World Health Organization recommends maintaining environmental noise below 70 dB over 24-hour periods to prevent noise-induced hearing loss.[224] For an 8-hour workday, 85–90 dB is judged to be an acceptable level of noise.[225]

Sleep can be affected by 30 dB, but busy roads emit noise at 70 dB and subways at 90 dB, while aeroplane take-offs register at 100 dB.[226] The major transformation in mobility from the increased use of electric vehicles is expected to have a positive impact on noise levels, since electric vehicles are quieter than diesel and petrol ones; however, the overall impact is expected to be low, particularly at high speeds, where other factors come into play, such as tyre and wind noise.[227]

THE OPPORTUNITY

Noise pollution in urban areas and workplaces is a source of stress and fatigue.

Reducing noise pollution plays a role in improving quality of life,[228] and, while further research is needed to explore the effect of noise on cardiovascular health, research has shown that there is some evidence linking noise to increased risk of heart disease.[229]

New materials offer the possibility of creating more peaceful neighbourhoods. New road surfaces can absorb the sound that comes from traffic, or roadside noise-cancelling materials can block sounds from reaching nearby buildings. Noise-cancelling equipment can transform construction sites making urban building sites less disruptive, enabling construction to continue 24/7 even in residential areas. Inside homes and offices, people can adjust background noise levels up or down using smart materials with acoustic controls.

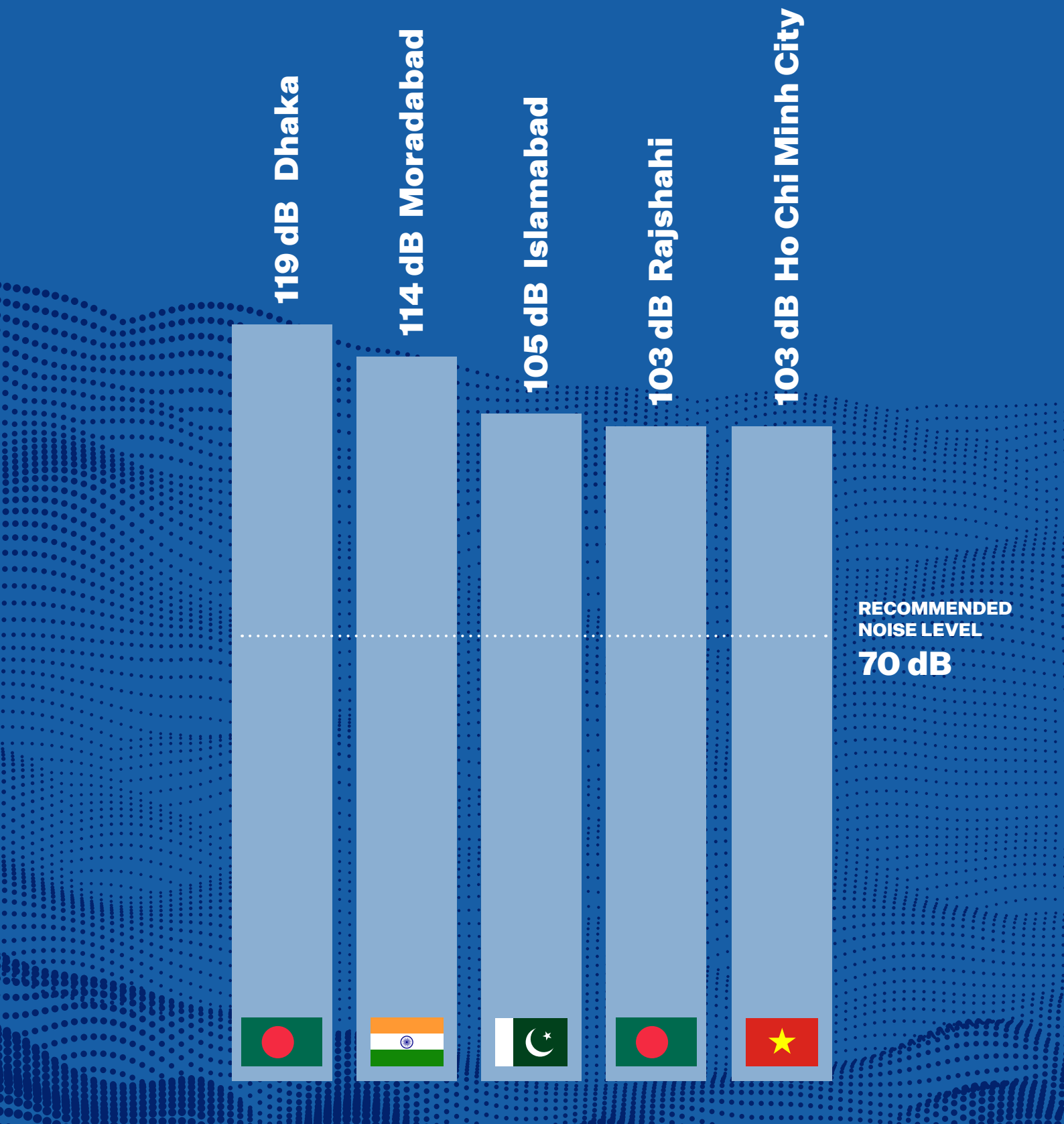
Scalable solutions for noise cancellation can be combined with innovative regulations to drive installations that significantly reduce noise levels to create quieter neighbourhoods.

BENEFITS

Less noise-related anxiety. Improved mental health and sleep quality.

RISKS

Increased investment in noise reduction does not keep pace with ever-increasing noise pollution.



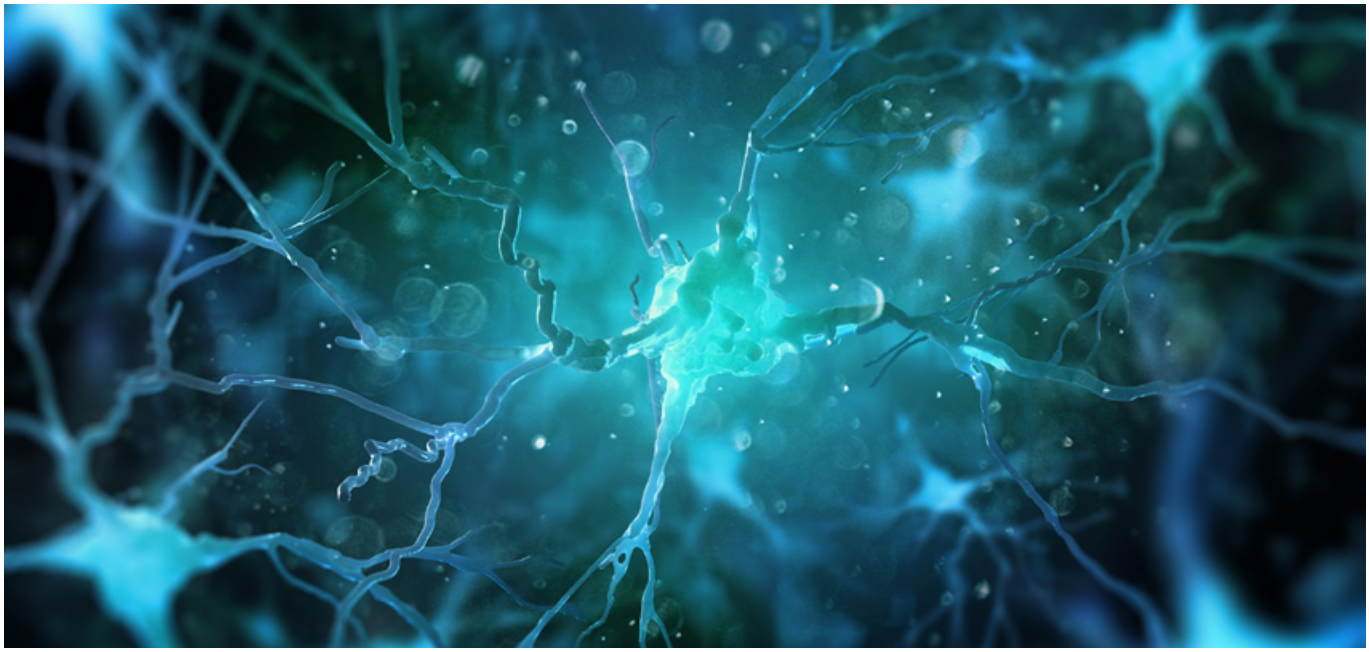
THE NOISIEST CITIES IN ASIA

OPPORTUNITY #6

What if we could protect our future selves from past trauma?

YOUR MEMORIES, EDITED

Advances in neuroscience enable the development of approaches to treat and erase past trauma enabling better life outcomes for trauma sufferers and their families.



MEGATREND
Advanced Health and Nutrition

TRENDS
Mental Health
Neuroscience

SECTORS AFFECTED
Data Science, AI & Machine Learning
Health & Healthcare
Immersive Technologies

WHY IT MATTERS TODAY

Traumatic events or experiences in childhood can have a long-lasting impact on individuals, resulting in learning, depression and even personality disorders.[230] Trauma shows up when people have difficulties regulating their emotions, difficulty concentrating and diminished creativity, leading to poor mental and physical well-being and poor educational and career outcomes.[231] This can also slow a country's economic and social development.[232]

Child maltreatment is often hidden and unreported. In the United States, at least one in seven children experienced abuse or neglect in 2021; in the previous year, 2020, 1,750 children died of abuse and neglect.[233] Globally, three in four children aged between two and four regularly suffer physical punishment and/or psychological violence at the hands of parents and caregivers. And one in five women and one in thirteen men report having been sexually abused by the age of 17.[234]

While research is not conclusive as to whether the impact of trauma can be passed down over the generations,[235] approximately 3.6% of adults (9 million people) are eligible for PTSD treatment in the United States.[236] Virtual reality exposure therapy (VRET) is being considered as a behavioural treatment for PTSD patients: the therapy aims to reduce a person's fear and anxiety to improve their quality of life by eliminating avoidance behaviour.[237]

Approximately

3.6% OF ADULTS

are eligible for PTSD treatment in the United States

THE OPPORTUNITY

We may not always be aware of repressed childhood trauma as our brain may have purposely covered it up[238] or it may have happened too early in our lives for us to recall. However, advances in both genetics and functional brain imagery are bringing greater understanding of how trauma affects brain chemistry, hormones and brain-activity responses to stress, such as changes in cortisol levels.[239] These offer a range of therapeutic approaches, such as neurostimulation to trigger memories or to desensitise the brain's reaction to them. More advanced approaches can selectively remove negative recollections and erase trauma-inducing memories, leading to more effective treatments started early on during childhood and adolescence.[240]

At the therapeutic level, better, faster interventions are becoming standard for survivors of trauma-inducing situations, making it possible to prevent the emergence of conditions such as post-traumatic stress disorder (PTSD). The results are improved quality of life, irrespective of whether the person was aware of the past trauma, and better life outcomes for trauma sufferers and their families.

BENEFITS

Improved quality of life, career and educational outcomes. Reduced impact of trauma on the wider family and community. Elimination of the impacts of trauma that may or may not be known. Ability to budget funds to other pressing public health problems.

RISKS

Unintended consequences of intervening in the brain functions involved with memory and recall. Potentially poor long-term effectiveness of treatment.

OPPORTUNITY #7

What if technology-free zones were part of urban planning?

TECH-FREE URBAN PLANNING

Establishing zones disconnected from devices and digital realities gives residents the freedom to unplug and recharge.

MEGATREND
Advanced Health and Nutrition

TRENDS
New Materials
Urban Design

SECTORS AFFECTED
Data Science, AI & Machine Learning
Immersive Technologies
Infrastructure & Construction
Media & Entertainment
Real Estate
Travel & Tourism
Government Services
Professional Services

WHY IT MATTERS TODAY

Worldwide, the number of active devices connected to the Internet of Things (IoT) is projected to triple, from 9.8 billion in 2020 to over 29 billion in 2030.[241] These devices commonly possess 'always-on' sensors, such as accelerometers, magnetometers, gyroscopes, altimeters or barometers, global positioning systems (GPS)[242] and many more, which can reduce comfort and mental well-being.[243]

People use technology for a variety of reasons, so not all screen time should be considered the same.[244] However, in 2021 the average person had 6 hours and 58 minutes of internet-connected screen time per day, an increase from 50 minutes per day in 2013.[245]

The average American has 7 hours per day of screen time and the figure in the United Arab Emirates is around 8.5 hours, while South Africans average almost 11 hours.[246] This trend is not limited to adults and includes young children. Almost half (49%) of children up to two years old interact with smartphones.[247]

Google Trends shows that global searches for 'digital detox' have nearly doubled since 2015.[248] Searching for 'digital detox' on Google gives more than 39.2 million results, 18.7 million of which were added since the beginning of 2019.[249, 250]

Businesses are using this opportunity to help their customers stay offline. Some examples include the Hold app, which incentivises people to stay off their phone by giving them the opportunity to earn rewards, and the Digital Detox Retreats website, which lists hotels and destinations that have no Wi-Fi, phones or TVs.[251]

In 2021 the average person had

6 HOURS AND 58 MINUTES

of **internet-connected screen time** per day

THE OPPORTUNITY

In a world where advanced connectivity is all around us, the deliberate creation of technology-free zones would be a paradigm shift for society and its citizens. Urban planners could intentionally help people who want to reduce the effects technology has on their routines, thought processes and emotions.

Designed to block communication signals and devoid of the integrated sensors and devices omnipresent in cities and homes, these spaces could be used to switch off – literally – and relax or to experiment with analogue ways of working. Pen and paper, non-AI-moderated discussion and brainstorming can exploit what research indicates about how we learn: that the brain absorbs and responds to information differently when the body is involved. For example, the act of writing something down helps us to remember it.[252]

Ubiquitous connectivity has its downsides – such as difficulty disconnecting from work completely and the inability to escape external stimuli such as screens – particularly as digital realities are expected to grow over time.[253] In addition to being a source of distraction, affecting concentration and recall, various forms of technology are actively intervening in our lives, from alarms and reminders concerning activity, sleep and calories to more intrusive examples such as remote work supervision and growing numbers of automated services and sensors.

The creation of technology-free spaces could encourage people to feel that it is acceptable to disconnect and experience the world without augmentation or prompting. These new urban zones could encourage people to interact with others without the mediating impact of a device.

BENEFITS

Greater well-being at the individual and personal level. Potentially, an economic uplift as these zones may boost creative thinking, focus and relaxation.

RISKS

People being unaccounted for as data from wearables become more prominent in policy-making and efforts towards safety.

Global searches for

‘DIGITAL DETOX’

have

DOUBLED

since 2015

OPPORTUNITY #8

What if we spent more time awake?

33 YEARS IN BED

Advances in circadian biology, neuroscience, the science of sleep and purpose-designed spaces enable higher quality rest and recuperation, leading to improved physical and mental health and a significant boost in productivity.

MEGATREND
Advanced Health and Nutrition

TRENDS
Digital Therapeutics
Longevity & Well-being
Neuroscience

SECTORS AFFECTED
Materials & Biotechnology
Education
Health & Healthcare
Media & Entertainment
Travel & Tourism
Professional Services

WHY IT MATTERS TODAY

Insomnia and disturbed sleep are increasing. We have noise and light pollution, shift work, 24/7 access to media, constant stress and conditions such as sleep apnoea.[254] Health problems, including weight gain, heart conditions and even certain cancers, have been linked to anxiety and poor concentration.[255] The result is a lower quality of life and well-being which reduces productivity at both individual and collective levels.

Up to 20% of employers worldwide use shift-working patterns to ensure 24/7 production or services.[256] People who used technology in bed before going to sleep scored lower on measures of sleep quality than those who did not.[257] Nearly half of the American adults polled in a sleep health study said they used technology in bed at least once a week and, staggeringly, 30% said they did so every day.[258] Nearly 21% of adults even said that they would check their device before going back to sleep if they woke up during the night.[259]

The sleeping aids market worldwide was valued at $64 billion in 2021[260] and is expected to grow at a compound annual growth rate (CAGR) of 7% per year by 2030.[261] The global wearable sleep tracker market is forecast to be worth $3 billion by 2028.[262]

In a typical lifespan, we spend about

26 YEARS

sleeping. We also spend **7 years just trying to sleep**. That adds up to

33 YEARS

spent in bed

THE OPPORTUNITY

On average, a person spends one-third of their life asleep. That means, in a typical lifespan, about 26 years are spent sleeping. We also spend seven years just trying to sleep. That adds up to 33 years spent in bed.[263] Advances in circadian biology have implications for the quality and quantity of sleep people are getting. As the field grows in importance, neuroscience, endocrinology and the use of external interventions could improve the way we get our sleep.[264]

Sleep patterns could be optimised by special diets and nano-doses of sleep-enhancing hormones.[265] Body monitoring devices can identify sleep pattern irregularities and suggest treatments to improve sleep.[266] Trans-cranial (i.e. through the skull) technology has the power to bring people into the most restful sleep state in an instant, making it possible to radically reduce the amount of time need for rest and recuperation.[267]

Focusing on creating the best conditions conducive to a good night's sleep— air quality, furniture,[268] windows, doors, paints and space more generally[269] — combined with technology, can result in optimal sleeping experiences.

BENEFITS

Improved physical and mental health. A boost in productivity and more time to practise hobbies.

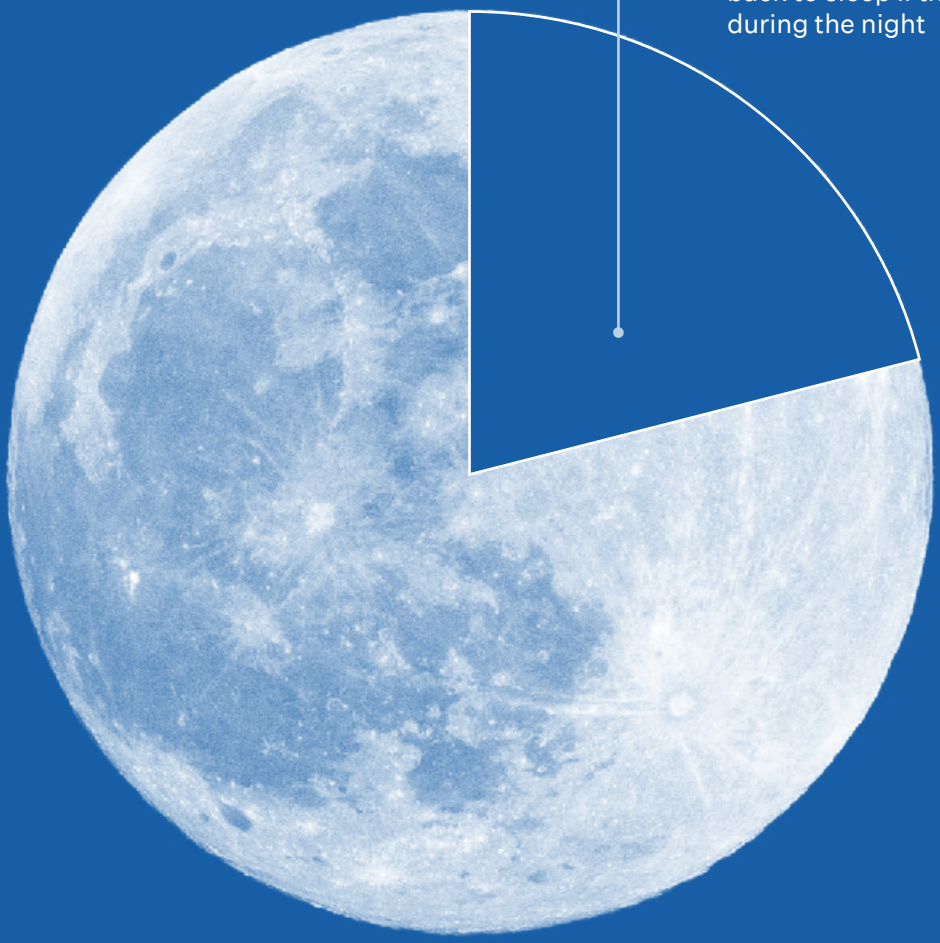
RISKS

Unforeseeable risks of interfering with sleep duration over extended periods of time, e.g. triggering mental health issues or physical conditions.

Nearly

21%

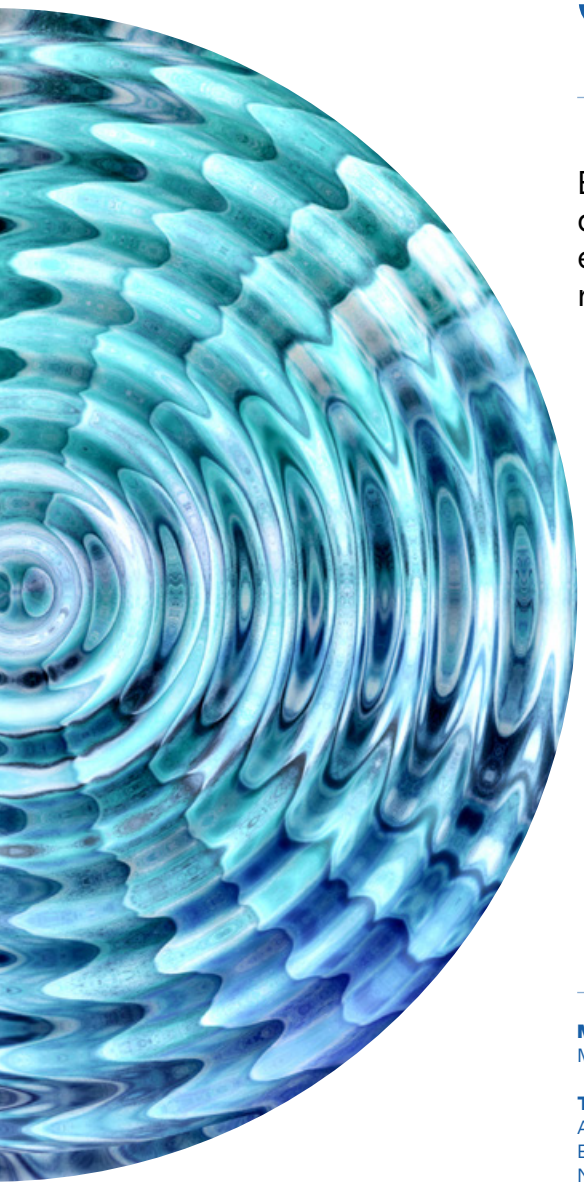
of adults globally said that they check their device before going back to sleep if they woke up during the night



OPPORTUNITY #9

How can we protect ourselves from the possibility of electromagnetic harm or disruption?

ELECTRO-MAGNETIC SHIELD



Between nanoengineering and the rapid and scalable development of new materials, we can create or evolve existing powerful shields to block electromagnetic radiation and interference.

MEGATREND
Materials Revolution

TRENDS
Advanced Connectivity
Electromagnetic Radiation
New Materials

SECTORS AFFECTED
Materials & Biotechnology
Automotive, Aerospace & Aviation
Communication Technologies and Systems
Cyber & Information Security
Data Science, AI & Machine Learning
Government Services

WHY IT MATTERS TODAY

There are natural and artificial sources of electromagnetic field radiation (EMF).[270] Natural sources include lightning and solar radiation, while artificial sources include microwaves, electric motors, mobile phones, radio and power lines.[271] Known as electromagnetic interference (EMI), not only can EMF potentially cause problems for human beings but it can also disrupt the proper functioning of electronic[272] and medical devices[273] and vice versa.[274,275]

To date there is no clear evidence proving that EMF can have lasting harmful effects on human beings.[276] But it does interfere with other technology. The number of artificial sources of EMI continues to increase, as does the number of essential electronic devices vulnerable to EMI. These include new driverless cars, aeroplanes, mobility and navigation systems and medical equipment such as magnetic resonance imaging (MRI) machines and implants.

The World Health Organization monitors legislation around the world relating to exposure to electromagnetic fields on its Global Health Observatory portal, last updated in 2018.[277] Most countries in Europe and Iran have legislation that mandates compliance, whereas the United States and South Africa make compliance voluntary. The majority of countries do not publish any data on this subject.[278]

However, the International Electrotechnical Commission provides guidance. It describes over 50 standards on electromagnetic compatibility that specify ways to measure emissions and set limits including testing techniques, levels and mitigation methods.[279]

The size of the EMI shielding market is estimated to be just over $8.5 billion. It is forecast to grow at a compound annual growth rate (CAGR) of 5.4% between 2022 and 2027.[280]

The size of the EMI shielding market is estimated to be just over

$8.5 BILLION

It is forecast to grow at a compound annual growth rate of **5.4%** between 2022 and 2027

THE OPPORTUNITY

Exposure to low-frequency electromagnetic fields may cause headaches, fatigue and feelings of anxiety. In extreme circumstances, exposure is considered a factor in the development of cancers and problems in pregnancy.[281] A combination of nanoengineering and the rapid and scalable development of new materials offers the hope that we can find ways to shield ourselves from any possible harmful impacts from associated EMF in the present and the future.[282]

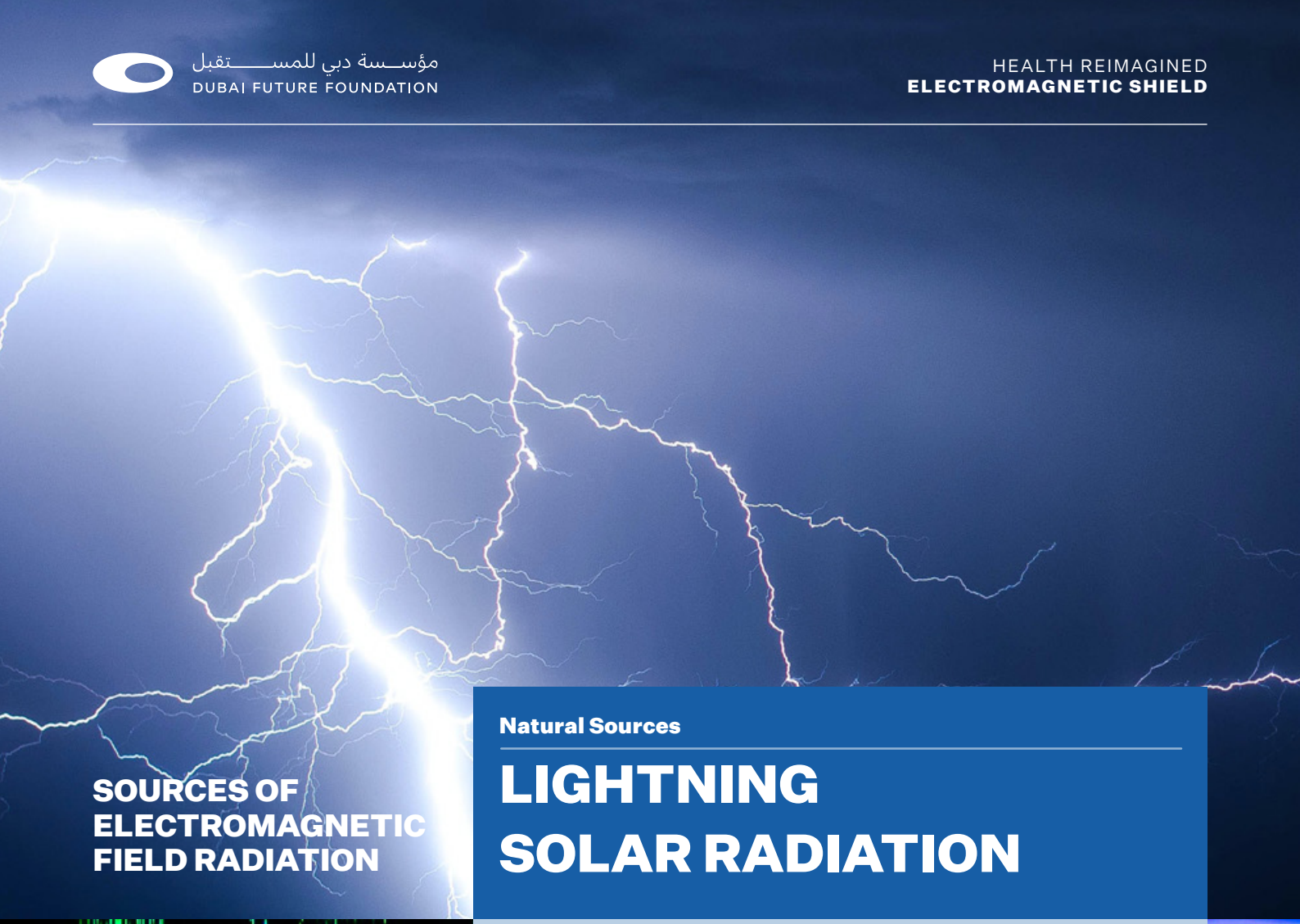
Nanoparticles and other new materials can replace or work in tandem with conventional methods of blocking EMI, such as Faraday cages,[283] EMI gaskets and carbon-fibre concentrated composites.[284] These technologies provide protection by absorbing electromagnetic energy and spreading it across conductive materials. Such EMI-cancelling materials can be used in miniaturised devices, including cardiac, cochlear and neural implants.[285] As the world becomes more dependent on powerful embedded systems, advanced EMI shielding through material science can prevent costly and potentially hazardous errors and outages.

BENEFITS

Protection of essential services. Reduction of the potential risk of harm to human health and the cost of outages.

RISKS

False confidence in electro-magnetic devices leading to exposure beyond sensible limits. A lack of global standards aiming to limit exposure to potentially harmful devices at source.



SOURCES OF ELECTROMAGNETIC FIELD RADIATION

Natural Sources

LIGHTNING
SOLAR RADIATION

Artificial Sources

MICROWAVES
ELECTRIC MOTORS
MOBILE PHONES
RADIO
POWER LINES

OPPORTUNITY #10

What if geriatrics was the new paediatrics?

BREAKING THE OLD MOULD

Geriatric medicine evolves into a flourishing field, as large and vital to society as paediatrics.

MEGATREND
Advanced Health and Nutrition

TRENDS
Future of Purpose & Work
Immersive Technologies & Wearables
Longevity & Well-being
Neuroscience
Internet of Things (IoT)

SECTORS AFFECTED
Materials & Biotechnology
Health & Healthcare
Immersive Technologies
Government Services
Professional Services

WHY IT MATTERS TODAY

Globally, life expectancy increased by more than six years between 2000 and 2019 — from approximately 67 years to 73 years.[286] At 72 years in 2022,[287] by 2050, life expectancy is expected to reach an average age of 77 years worldwide.[288] However, it is not just long life that one seeks, but long life in good health.

Referred to as health-adjusted life expectancy (HALE), the number of years in good health has also increased from approximately 58 years in 2000 to close to 64 years in 2019, i.e. almost 6 years.[289] However, this is due to declining mortality rather than reduced years lived in poor health.[290]

In 2018, the number of people aged over 65 officially exceeded those aged under 5.[291] In 2021, 10% of the world's population were over 65[292] and 25% were between 0 and 14 years old.[293] By 2050, the proportion of the population aged 65 or over will rise to more than double that of children under 5[294] amount to 15.5% of the world's population.[295]

By 2050, the percentage of **people aged over 65** will exceed **20%** in

6 OUT OF 22

MENA countries

The populations of more than half of the nations in the Middle East and North Africa (MENA) rergion will increase by more than a third (some by more than two-thirds) by 2025.[296] About 6% of the population of the MENA region is aged 65 or over, ranging from under 1% in the United Arab Emirates to 4% in Saudi Arabia and about 8% in Lebanon.[297] Nevertheless, improved health and declining fertility, excluding exceptional events, will result in an increase in people's median age; by 2050, the percentage of people aged over 65 will exceed 20% in 6 out of the 22 MENA countries and will range between 12% and 19% in 9 others.[298] The highest proportion of those over 65 will be in the UAE (28%), Bahrain (25%) and Oman (22.5%).[299]

The global geriatric care services market stood at just over $1 trillion in 2021 and is expected to increase to $1.8 trillion by the end of 2030, at a compound annual growth rate (CAGR) of 6%.[300] Today, the United States projects a shortage of nearly 27,000 geriatricians by 2025.[301]

THE OPPORTUNITY

As lives become longer and healthier, a combination of precision medicine, nanomedicine, neuroscience and advanced machine intelligence make the field of geriatric medicine lucrative for investment and a popular field of practice for students of medicine.

Digital realities[302] and advances in neuroscience[303] are helping medical students to empathise with an ageing population. In parallel, advances in nanotherapeutics,[304] the use of nanomaterials to improve the pharmacology of medicines and precision medicine are reducing the challenges doctors face in treating a multitude of diseases and ailments that older people experience. These advances would help optimise the delivery of medicines and avoid physician burnout. With room for innovation and a possible better professional future for themselves, medical students could choose to specialise in geriatrics and so contribute to boosting the proportion of people's lives lived in better health beyond 50% – a figure unchanged since 1960.[305]

BENEFITS

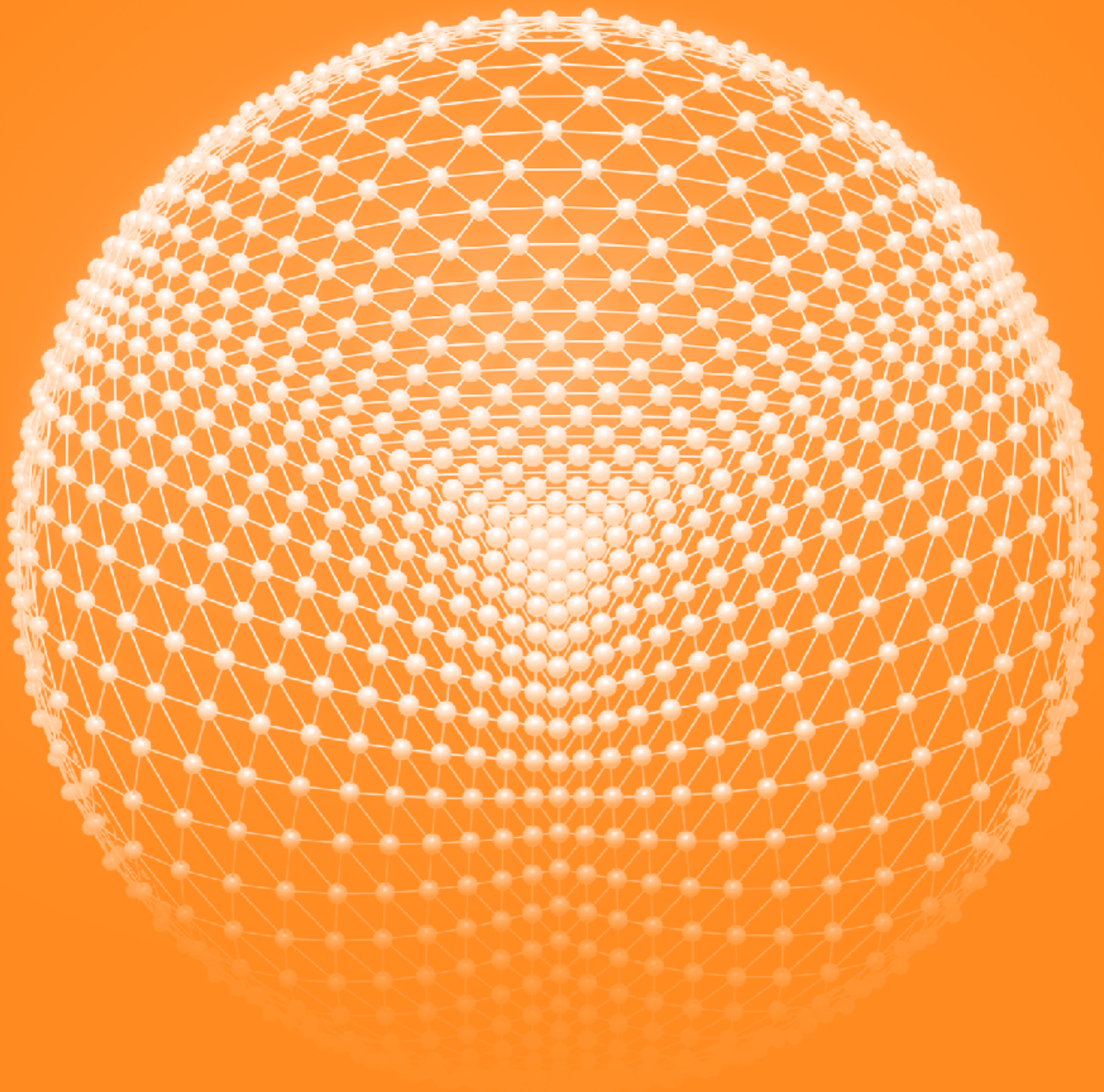
Better health and healthcare in later life. Reduction in the economic cost of care due to a healthier older population. Better mental health for older people and those who care for them. Ability of older adults to spend more on their basic needs as healthcare costs go down.

RISKS

Resistance to change and hesitancy in the medical industry about investing in elder care. Despite advances, better health in older years may not vastly improve.


Life Expectancy
77
YEARS
Average Age
72
YEARS
2022
2050

COLLABORATION ADVANCED



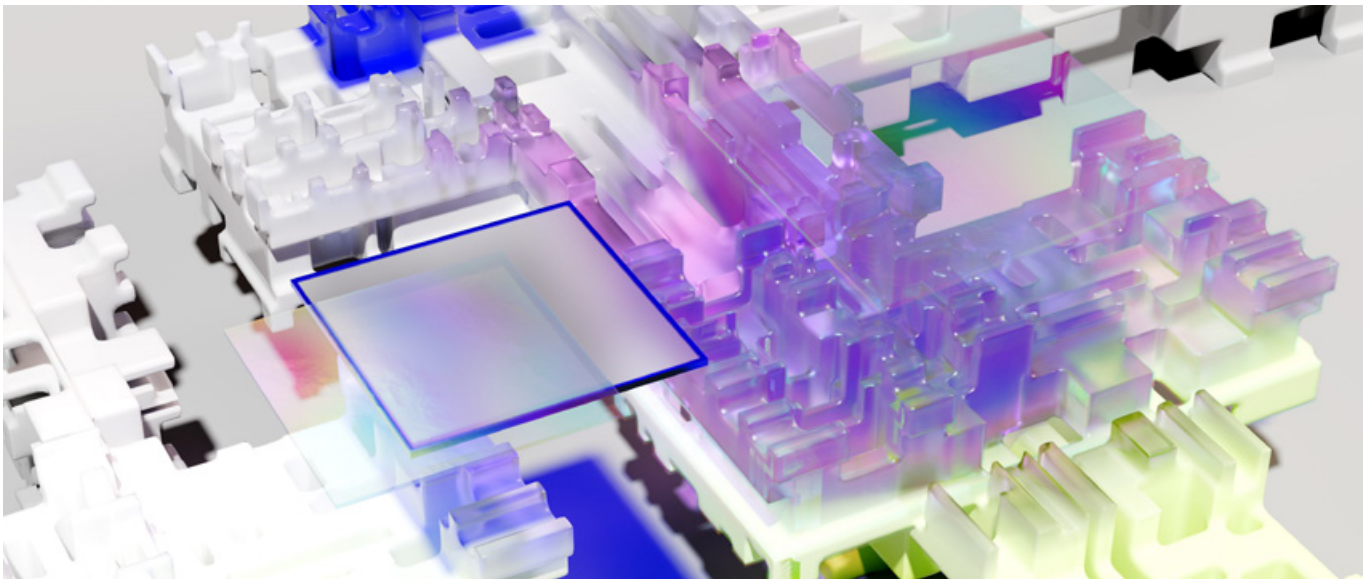
Enhance problem-solving, innovation and trust by redesigning collaborative structures and processes between humans – including across generations as well as between machines and between humans and machines.

OPPORTUNITY #11

What if machines could brainstorm ideas?

AI AT THE WHITE BOARD

Advanced machine intelligence identifies the innovations and business ideas that are most likely to succeed reducing volatility in venture funding and increasing innovation and growth.



MEGATREND
Future Humanity

TRENDS
Artificial Intelligence
HumanXMachine
Ideation, IP & Entrepreneurship

SECTORS AFFECTED
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Insurance & Reinsurance
Professional Services

WHY IT MATTERS TODAY

From healthcare, financial services and manufacturing to entertainment, energy and transport, Artificial Intelligence (AI) provides enormous opportunities. The biggest gains by 2030 are expected to come from product and service enhancements with increased personalisation, attractiveness and affordability over time.[306]

The AI market, including software, hardware and services, is expected to be worth $900 billion by 2026, with a compound annual growth rate (CAGR) of 19%. The category of AI applications, development and deployment currently has the third highest year-on-year growth, following IT and business services.[307]

Funding, whether from venture capital, public funding, donations or even social impact funds, drive innovation and scale up start-ups. There are over 1,150 unicorns (privately owned start-up companies valued at over $1 billion) in the world and at least 47 countries have one unicorn. The United States (612), China (174) and India (65) have the highest numbers of unicorns.[308] However, funding – and entrepreneurship – goes through peaks and troughs depending on the overall economic conditions. For example, in the third quarter of 2022, venture funding suffered an approximately 50% year-on-year drop amid fears of a recession and wider market turmoil.[309]

The AI market is expected to be worth

$900 BILLION

by 2026, with a CAGR of

19%

THE OPPORTUNITY

From small companies to major industries, selecting an idea to take to market can be an existential choice. For governments too, identifying a policy or service or how best to deploy funds is a challenge with society-wide implications. Technology can increasingly help with rapid prototyping and testing – but even that is a waste of resources if the end product, service or policy fails to draw demand or deliver value. Sometimes even the ideas themselves result in less change than originally thought.

Advances in machine intelligence and quantum computing can enhance predictive modelling of innovative products, services and business models with a high degree of accuracy. Algorithms can integrate billions of data points, allowing innovators and entrepreneurs to explore various approaches and product or service designs before taking an idea forward. Many more ideas can be explored this way than through traditional start-up and product development approaches.

The simulated results offer investors, regulators and other stakeholders transparent and detailed overviews of the likelihood of success and any potential risks. This could also mean some products can be fast-tracked for regulatory approval. Predictive modelling, for example, could help to identify pharmaceutical or financial products that offer significant immediate societal benefit during a time of crisis. Greater reliance on predictive modelling can help to reduce volatility in venture funding and increase innovation and growth.

BENEFITS

More efficient and effective allocation of time and capital with a rise in innovation, growth and entrepreneurial energy deployed to more new product ideas.

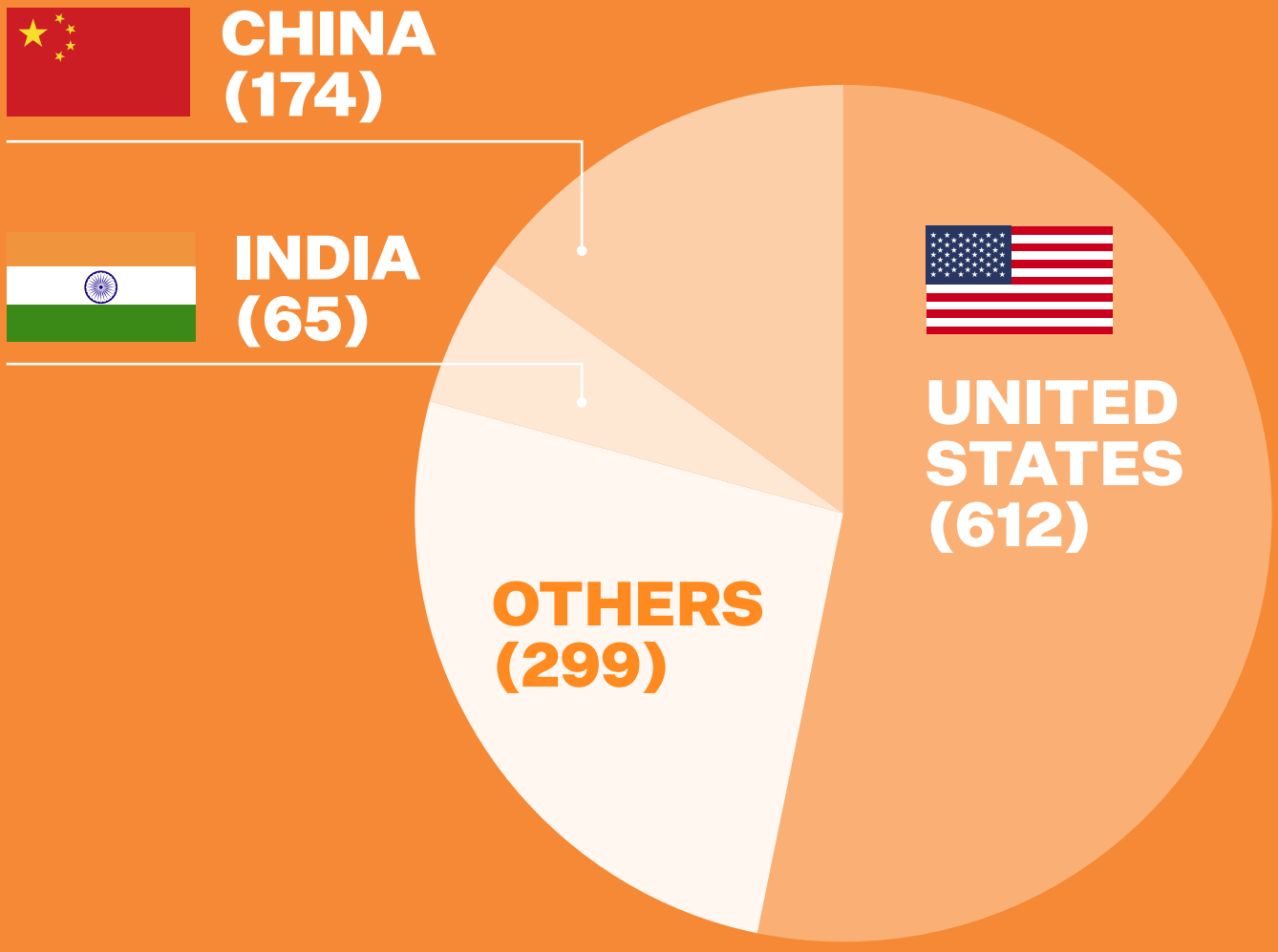
RISKS

Advanced machine intelligence missing possible ‘long-tail’ success stories, such as 3M’s Post-Its or durable fashion trends including Levi’s or Birkenstocks. Dependency on machines for ideas starts to limit human-sourced idea generation that cannot be captured through technology.

There are

OVER 1,150 UNICORNS

in the world and at least 47 countries have one unicorn.
The United States, China and India have the highest numbers of unicorns



OPPORTUNITY #12

What if the future of work was to challenge the machine?

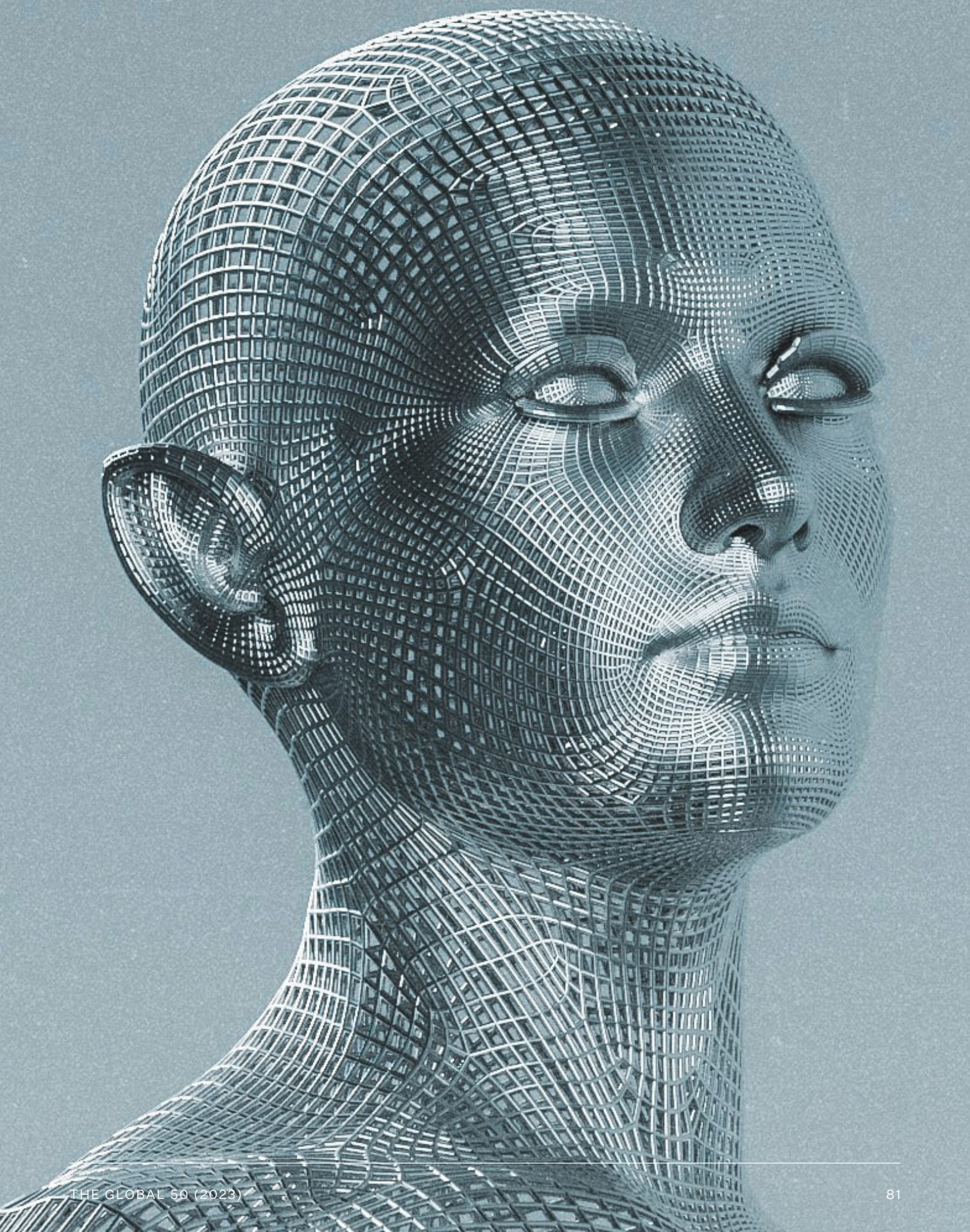
HUMANS VERSUS MACHINE

The value of human creativity and imagination grows into roles that intentionally challenge machines and counterbalance embedded Artificial Intelligence (AI) logic uncovering new areas for research, development and innovation.

MEGATREND
Life with Autonomous Robots

TRENDS
Artificial Intelligence
Future of Purpose & Work
HumanXMachine

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Insurance & Reinsurance
Manufacturing
Media & Entertainment
Travel & Tourism
Government Services
Professional Services



In a survey exploring global societal attitudes towards AI,

39%

of respondents agreed that **AI made them nervous** and

52%

believed that products and services using **AI have more benefits than drawbacks**, but only

50%

knew which types of products and services use AI

WHY IT MATTERS TODAY

Just over one billion jobs could be significantly changed in the next decade because of AI, automation and technological advances[310]. More specifically, the World Economic Forum's 2020 Future of Jobs Report[m] suggested that AI would replace 85 million jobs across the globe by 2025, counterbalanced by its potential to create 97 million jobs in the same period.[311] There is a strong consensus among experts and business leaders that most jobs will become automated in over 15 areas, including accounting, sales and data coordination.[312]

At the same time, society is depending on governments to put in place laws and regulations to guarantee the ethical use of AI. In a survey exploring global societal attitudes towards AI, 39% of respondents agreed that AI made them nervous and 52% believed that products and services using AI have more benefits than drawbacks, but only 50% knew which types of products and services use AI.[313] The pattern is the same in most countries. For example, in Saudi Arabia, people anticipate that AI will improve education, entertainment, shopping, safety and transportation by more than 80%. Similarly, those surveyed in Argentina, Chile and China, also expected the same areas to improve and also by more than 80%.[314]

As more businesses adopt AI, more of them develop ethical frameworks that take into account relevant laws and regulations.[315] In a 2021 PwC survey to executives in Japan, India, the US and the UK, one in five companies had an ethical framework in place for AI development and only 5% do not use AI in any way compared to 47% the year before. Such frameworks will continue to influence how money is invested in AI and address concerns about the reliability of AI applications over time.[316]

Five areas where AI is expected to have a transformative impact: in the home, in education and learning new things, in entertainment, in transportation and in shopping.[317] As recently as the 2022 FIFA World Cup, from the soccer ball and player's outfits to the stadium and surrounding area, with data fed from embedded sensors — up to 29 markers on players' bodies — AI was used to make calls on offsides and penalty shots, crowding and temperature regulation.[318]

By 2030, AI is forecasted to have added $320 billion to the economy of the Middle East and North African (MENA) region. This will be achieved by improving supply chains and enhancing trust in the nature, quality and quantity of goods purchased. It will improve back-office processes (invoicing, delivery and returns) and reduce the amount of working capital needed. The annual growth in the economic contribution of AI is predicted to reach between 20% and 34% per year across the region, with the fastest growth occurring in the United Arab Emirates and then Saudi Arabia.[319]

m Latest source on future of jobs and AI.

THE OPPORTUNITY

Advanced machine intelligence and automation are likely to mean that knowledge workers will seek new expression for their talents. With advanced machine intelligence fully embedded in daily life, achieving effective human oversight of these systems can prove to be difficult for even the most robust policies that govern trustworthy AI. By finding new roles, people can continue to use their skills and insight to influence societies and systems.

In the future, knowledge workers will be able to use their creative thinking to challenge machines uncovering new areas for research, development and innovation. Knowledge workers could also examine new perspectives and behavioural changes among smaller or fringe groups to prompt AI systems to include new or niche ideas in their analysis and results that may not otherwise be captured. This in turn could help to further improve fast-changing sectors – such as education, entertainment, transportation and shopping – that have been the most disrupted by AI.

BENEFITS

More creative and imaginative solutions emerging from people challenging the way AI is introduced. Enhanced prosperity and well-being, not just additional growth.

RISKS

Unintended consequences of people's unconscious bias influencing the development of systems and analysis. Tensions in emotive or sensitive areas, where people may oppose optimal AI-led strategies.

OPPORTUNITY #13

What if we had a new model for public goods?

FROM PUBLIC 'GOOD' TO 'GREAT'

Reframing the provision of public goods to a new model of Society—Public—Private (SPP) cooperation for public goods opening up new solutions in health, the environment and elsewhere.

MEGATREND
Future Humanity

TRENDS
Cross-sectoral Partnerships
Community-based Solutions

SECTORS AFFECTED
Agriculture & Food
Communication Technologies & Systems
Cyber & Information Security
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Utilities
Government Services

WHY IT MATTERS TODAY

Public goods are goods and services that every member of a community can use without exclusion and without impacting the ability for another member to use it fully.[320] While what constitutes public goods differs across countries, they are typically provided for by government and may include education, science, infrastructure, the environment, health,[321] technology and culture.[322]

Other than direct government spending, public—private partnerships have been used in the provision of public goods. Evidence from Australia, Canada, Portugal, Spain, the United Kingdom, Eastern Europe, Latin America and parts of Asia indicate that, when compared to traditional healthcare approaches, public–private partnerships reduce budget overruns by up to 60%, reduce construction delays by up to 70% and reduce overall costs by up to 25%.[323] However, such partnerships are complex, sometimes result in reduced quality of related services and face the same risks and concerns that are faced in the direct provision
of public goods[324] particularly when serving the poor.[325]

Cooperatives, a model of cooperation where people own and control an underlying business to fulfil common needs beyond just profits,[326] is often considered an alternative for the provision of public goods. There are 3 million cooperatives around the world and the largest 300 global cooperatives, more than half of which are located in Europe, had a total turnover of $2.2 billion in 2020 and accounted for some 10% of the world's employed population.[327] From agriculture and food (including fishing) to education, health, financial services and trade, cooperatives are generating value through their unique governance and core values while pursuing business innovation.[328]

THE OPPORTUNITY

Governments will increasingly continue to face significant costs and opportunities wherever it is necessary to upgrade public goods to both meet community needs and benefit from efficiencies in new technological innovation in health, education, infrastructure and other areas.

In the area of infrastructure, for example, new mobility patterns and solutions – such as hyperloops and fully autonomous road use – will require huge investments and a far greater range of collaboration and expertise than in the past.[329] There is also a pressing need for new and improved infrastructure in the face of rising urbanisation and a growing global population.[330] Worldwide, the requirement for infrastructure investment is estimated at nearly $4 trillion annually through to 2030, with the greatest demand in emerging markets.[331]

The rise of digital realities, distributed ledger technologies (DLT) and new models of governance and social contracts[332] could reduce the time and capital needed for public goods. Together with reframing public goods for outcomes beyond the provision of goods and services, a new model of Society–Public–Private (SPP) partnerships could be used for public goods.

Overcoming challenges in existing models of cooperation for public goods, the SPP partnerships could have economic objectives based on public benefit with socially oriented sets of principles and a shared identity among partners.[333] Governments, not-for-profits and corporate actors could come together and engage transparently and with less bureaucracy, using real-time information flows and Artificial Intelligence (AI) to support their decisions. Distributed ledger technologies would enable fully transparent monitoring and reporting of investments and budgets, increasing trust between the private sector, the public sector, residents and citizens.

BENEFITS

Improved planning and delivery of public goods at lower cost. Improved outcomes for residents and citizens.

RISKS

Failure to establish autonomy and independence from partners. Reduction of public revenues over time. Loss of public sector control over strategic assets.

The largest 300 global cooperatives,
more than half of which are located in

EUROPE

accounted for some

10%

in 2021 of the world's employed population

OPPORTUNITY #14

What if differing opinions could connect and improve business and society?

AGREEING TO DISAGREE AS ONE

Brain–computer interfaces (BCIs) and advances in brain-mapping techniques make the most of diverse human thought, promoting cooperation and tolerance, reversing fragmentation in societies and fostering cognitive diversity and the ability to have productive discussions.

MEGATREND
Future Humanity

TRENDS
Future of Purpose & Work
Generational & Cognitive Diversity

SECTORS AFFECTED
Materials & Biotechnology
Communication Technologies & Systems
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Health & Healthcare
Immersive Technologies
Government Services
Professional Services

WHY IT MATTERS TODAY

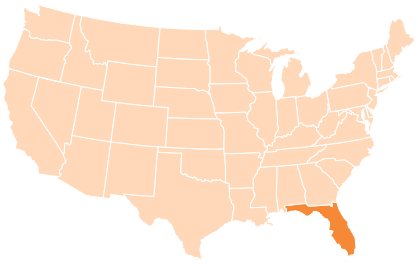
A McKinsey & Company report found that companies in the top quartiles for gender diversity and ethnic diversity on executive teams were 25% and 36% more likely (respectively) to have above-average profitability. Outperformance is more common when companies have ethnic diversity than when they have gender diversity.[334]

Integrating diverse views and experiences can contribute to more robust decisions and outcomes for organisations and communities.[335] In organisations, cognitive diversity in how people solve problems enhances innovation by 20% and reduces risks by 30%.[336] Purposely managing cognitive diversity can create high-performing teams, particularly when those teams are generating new ideas.[337]

This also applies in the boardroom. One study found that boards whose directors had a range of qualifications, skillsets and genders had enhanced cognitive diversity, and this contributed to increases in their firm's value and effectiveness.[338]

Miami, Florida, is the most diverse city in the world in terms of origin, with 58% of its residents being international immigrants. Second is Toronto, Canada – home to over 250 ethnicities and 175 different languages.[339] The residents of Dubai, in the United Arab Emirates, are made up of over 200 nationalities.[340]

MIAMI, FLORIDA



Most diverse city in the world in terms of origin, with

58%

of its residents being international immigrants

TORONTO, CANADA

Over

250

ethnicities and

175

different languages

DUBAI, UAE

Over

200

nationalities

THE OPPORTUNITY

Ultra-precise functional brain mapping combined with state-of-the-art transcranial brain–machine connectivity may open doors to a scientific form of 'mind-reading'. The result will be a highly nuanced understanding of how biochemical, genetic, physical and environmental factors shape how individuals experience the world and respond to negative and positive situations.

This knowledge can reshape our understanding of cognitive diversity (also called 'intellectual diversity'),[341] informing and improving our responses to the whole range of human views and behaviours. A deeper understanding of innate and acquired cognitive differences can improve the integration of diversity of thought into decision-making and promote cooperation and tolerance among groups with diverging views. This understanding can be used to rethink and inform school curricula, educational approaches, team-building and diplomatic and policy thinking.

Demographic diversity – including by gender, age and ethnicity – does not substantially increase cognitive diversity.[342] Nevertheless, as communities become more diverse through increasing migration and mobility, it may become more challenging to navigate differing views and values. Benefitting from these differences will be critical to a safe future.

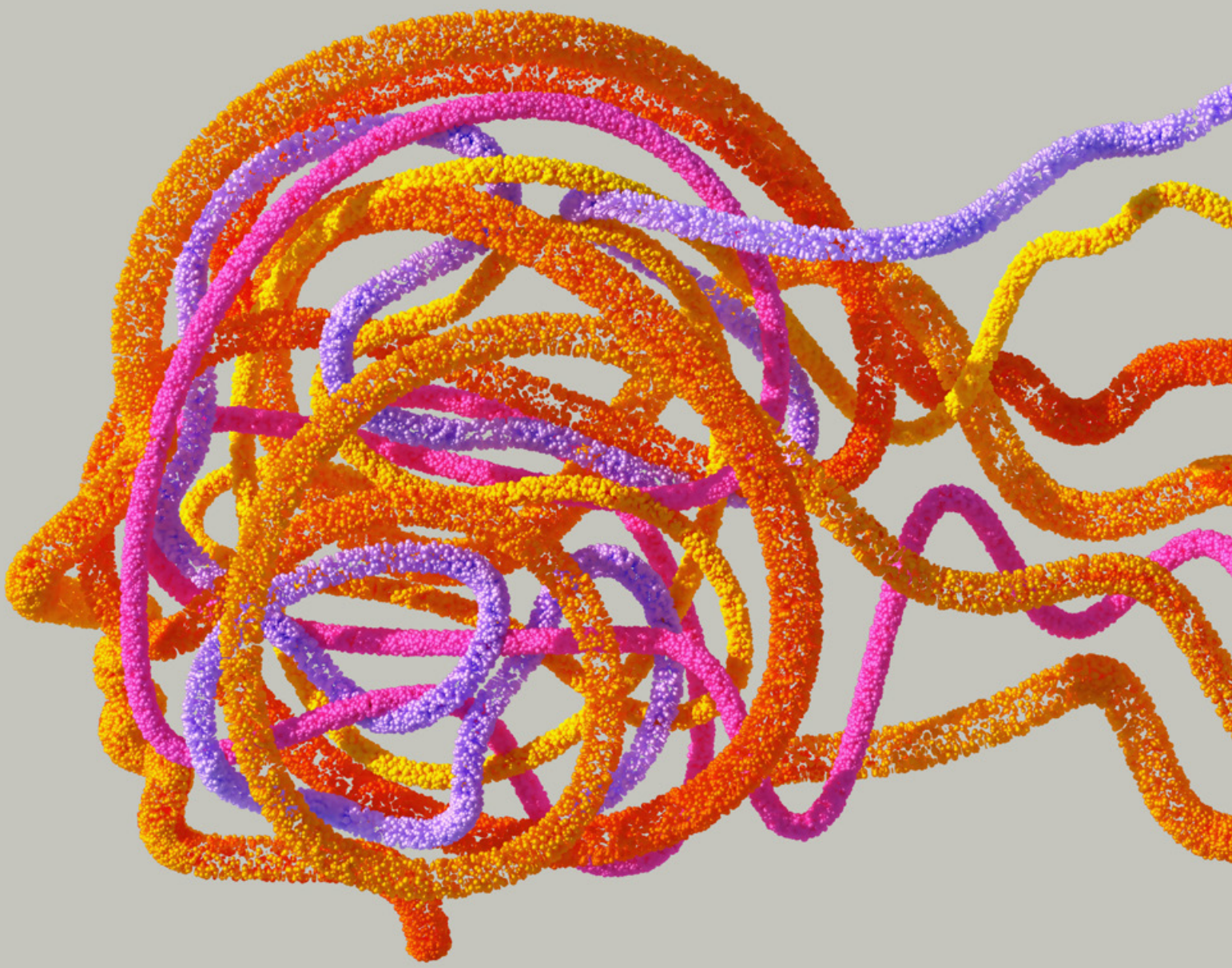
Improving our understanding of how our own brains work and the relationships between biochemistry, genetics, epigenetics and lived experience can offer a fresh perspective on both our common and our diverse cognitive traits and attitudes.

BENEFITS

Better ability to structure teams and groups so that diversity is leveraged. Enhanced outcomes across education and careers for everyone. Improved bonds within and across diverse groups and communities.

RISKS

An increased focus on cognitive diversity overlooking original business objectives and failing to meet strategic goals. Misuse of brain-mapping technologies to manipulate or repress individuals.



OPPORTUNITY #15

What if generational diversity was a must in the board room?

ALL-GENERATION DIRECTORSHIPS

Company, public sector and civil society boards of directors and trustees systematically include people of all generations as a principle of corporate governance embedded in all legal, regulatory and international standards.

MEGATREND
Future Humanity

TRENDS
Generational & Cognitive Diversity
Community-based Solutions

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

The global average age of a corporate board member has been rising in recent years and stood at nearly 60 in 2021.[343] In the United States, the average age of a member on the boards of the S&P 500 in 2022 was higher than the global average at nearly 63, with women directors making up 46% of new independent director appointments. In 2022, people aged 50 or younger accounted for 18% of new directors and 6% of all directors on the boards of the S&P 500.[344]

As the average life expectancy is expected to increase from 72 years[345] in 2022 to 77 years by 2050,[346] more experienced workers will want to work beyond retirement or opt for flexible retirement.[347] In parallel, young people aged between 15 and 24 currently make up close to 23% of the global population and this proportion is expected to grow to around 37% by 2050.[348] Young people aged between 15 and 29 make up 24% of the population in the Middle East and North Africa (MENA) compared to 19% in Europe.[349] By 2050, young people in the MENA region will account for around 23% of an increasingly youthful population[350] compared to 15% of a decreasing young population in Europe.[351]

THE OPPORTUNITY

Multigenerational workforces increase resilience and productivity in workplaces.[352] Even though there is a risk of conflict due to potentially vastly differing opinions, multiple generations can learn from each other and as a result come up with better solutions to problems.[353]

The inclusion of multiple generations on a board can provide greater insight into how an organisation's strategy might affect long-term prosperity and well-being for itself and the wider society. Including young people on boards brings increased legitimacy to their views, making their status as future stakeholders a real and present concern for strategic decisions. Equally, including people with more experience brings long-term views and outlooks of which those with less experience may not be aware, making potentially better decisions due to increased understanding of their potential implications.

By viewing issues through a multigenerational lens, organisations can avoid unintended consequences, such as negative environmental or social impacts and the direct and indirect losses and reputational risks that may emerge from them. The outcome could be more resilient companies with better growth prospects today and in the future.

BENEFITS

Greater diversity of thinking and long-term vision. Improved outcomes for business and society, and reduced risk of negative economic and social impacts of goods and services.

RISKS

'Multigeneration-washing' or 'youth-washing', where organisations try to broadcast their belief in older or younger populations by inviting them to join boards but without fully integrating them into decision-making.

IN 2022, WOMEN DIRECTORS MADE UP 46%

of new director appointments on the boards of the S&P 500

OPPORTUNITY #16

What if space traffic was internationally regulated?

RULES FOR SPACE, INC.

Using the analogy of air traffic control, an international space transport association defines and enforces ‘space traffic’ rules for safety and best practice for future growth in space transport and commercial development.

MEGATREND
Borderless World - Fluid Economies

TRENDS
Future of Space
International Collaboration
Legal Transformation

SECTORS AFFECTED
Automotive, Aerospace & Aviation
Communication Technologies & Systems
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Travel & Tourism
Government Services

WHY IT MATTERS TODAY

There are more than 70 space agencies around the world, of which 16 have successfully conducted a space launch and 7 have been able to probe extra-terrestrial locations – such as the Moon, Mars or deep space and more than a dozen additional national agencies are on the way, along with an increasing number of private space agencies, such as Blue Origin and SpaceX.[354] No fewer than seven missions are planned for 2023; from the United Arab Emirates, the United States, Japan, South Korea, Russia and India along with several from private companies.[355]

It is estimated that 85% of all known satellites, probes, landers, crewed spacecraft and space station flight elements launched into earth's orbit or beyond have been registered with the UN's Office for Outer Space Affairs (UNOOSA).[356] In the latest press releases from UNOOSA, 14,000 satellites had been launched[357] and 11,000 satellites could be orbiting the earth.[358]

The global space industry could generate $1 trillion in revenue by 2040.[359] That is just over double the size of the space economy in 2021, estimated at $470 billion,[360] which is partly driven by more attractive investing in the space economy as the cost of launching a satellite has gone down from $200 million to about $60 million via reusable rockets, with the potential to decrease further to $500,000 via mass production.[361]

The global space industry could generate

$1 TRILLION

in revenue by 2040

THE OPPORTUNITY

Space, as a new economy, has multiple stakeholders and is covered by various non-binding global regulations and treaties, some that have limited signatories and do not cover commercial interests.[362]

While UNOOSA promotes responsible development in space and outer space activities, fostering international solutions to problems will be important.[363] Space will see the arrival of more sectors in the future, spanning transportation, food, energy, mining, tourism, science and more.

An international space transport association – with a multilateral agreement – could play a valuable role in accelerating the benefits of space-related opportunities. Such an organisation could make development in space safer and more cost-effective and reduce technological risk and human error in this complex area. The association could ensure common language and agreement on the interpretation of changing terms.[364] This can help to resolve disputes about how the space economy can be developed.[365] It can also facilitate the process of defining vertical limits in outer space beyond national and international airspaces.

Increased space traffic provides numerous opportunities for learning and tourism, but with these activities come a greater risk of accidental or malicious damage. As earth's orbits are more frequently used for transport (of both people and goods), research and technological applications, there will be more need for transparency and oversight. It will be important to consider who and what is transported, when and what trajectories and orbits are used, how the increase in space debris is managed and how to preserve space for future generations.

BENEFITS

Increased safety and security while enabling economic growth through space travel and exploration.

RISKS

A lack of collaboration among public and private actors.
Unfair lobbying efforts by well-capitalised special interest groups.

14,000 SATELLITES

have been launched, and

11,000 SATELLITES

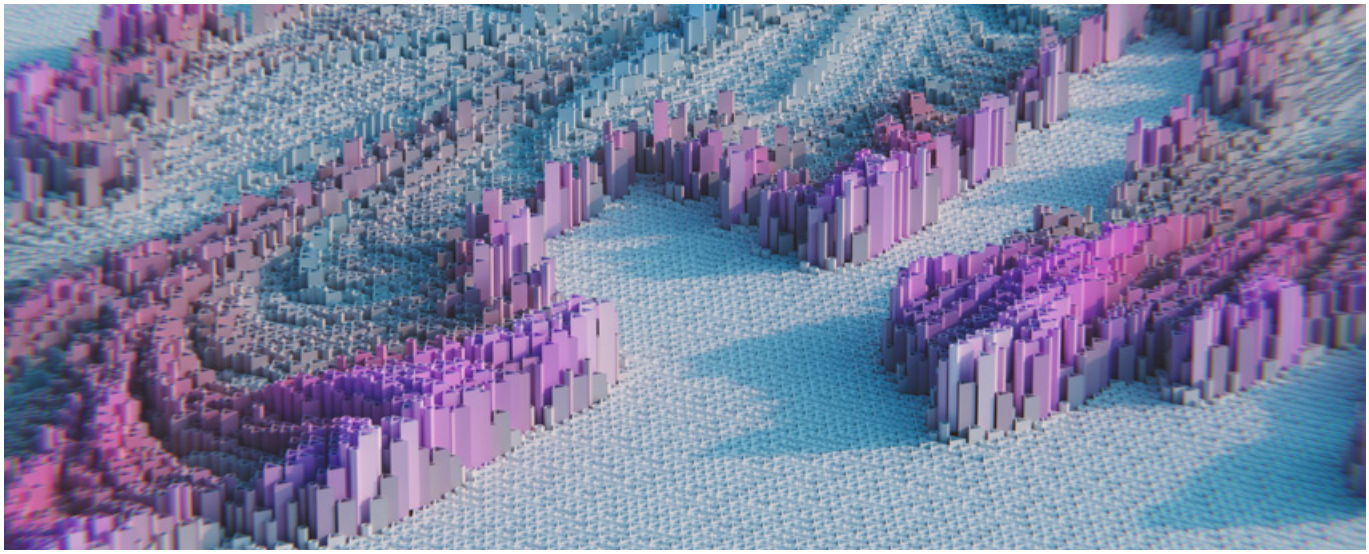
could be orbiting
the earth

OPPORTUNITY #17

What if comprehensive data was a public good?

A WIDE WORLD OF DATA

Enabled by incentives for data-sharing, a secure platform is set up where entrepreneurs, researchers and policy-makers can share and access vast aggregated and anonymised user datasets and related analysis, which aids global innovation, learning and discovery.



MEGATREND
Devaluation of Raw Data

TRENDS
Artificial Intelligence
Distributed Ledger Technologies (DLT)
Ideation, IP & Entrepreneurship
Open Data

SECTORS AFFECTED
Materials & Biotechnology
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Insurance & Reinsurance

WHY IT MATTERS TODAY

In 2021, around 2.5 exabytes (1 exabyte = 1 billion gigabytes) of data[n] were being generated daily and, with the Internet of Things (IoT), this number is set to grow exponentially to 175,000 exabytes[o] per year by 2025[366] and a yottabyte of data per year, i.e. 1 million exabytes, by 2030.[367]

In a worldwide survey of academic researchers, 80% of the respondents stated that data should be made openly available as a standard practice.[368] In contrast, however, researchers are more inclined to share their research data where it is likely to have an impact on citations (67%) and the visibility of their research (61%), rather than where it might be of public benefit (56%).[369]

In the business world, open data supports innovation and growth by revealing opportunities for companies to build new services, identify savings and improve their operations.[370] However, only an estimated 6% of businesses globally use, access and share data to attain business benefits.[371] Even when they do collect data, only 38% are in a position to extract value from it to inform their decision-making.[372]

Over the next decade, 70% of the new value created in the economy will be based on business models that rely on digitally enabled platforms.[373] While cross-border data flows are key to the growing digital economy, legislation – such as the European Union's General Data Protection Regulation (GDPR) and other data privacy laws coming into effect[374] – will continue to change how and what data is accessible by both the public sector and private businesses.

The Organisation for Economic Co-operation and Development (OECD) has been exploring government access to private data integral to the global digital economy.[375] It recognises that open data can unlock new social value, enabling better policies.[376] Agreed in October 2021, the OECD's 'Recommendation of the Council on Enhancing Access to and Sharing of Data' includes the first ever set of principles on how governments could access cross-sectoral data while protecting the rights of individuals and organisations.[377]

In the Middle East and North Africa (MENA) region, datasets covering national censuses, government budgets and international trade data are available but only two-thirds are available online.[378] Dubai Pulse is an example of a portal in the United Arab Emirates where transactional and economic data pertaining to entities within the government of Dubai are accessible and available for analysis.[379]

n 2.5 quintillion bytes, converted to exabytes. Just over 900 exabytes per year.
o Converted from 175 zettabytes.

THE OPPORTUNITY

A central shared, aggregated, anonymised dataset could accelerate progress across many fields and sectors. Allowing broader access to data, even if just within borders, would open up new avenues for research and innovation. Supported by advanced machine intelligence and possibly distributed ledger technologies, local and international agreements on data-sharing and advances in cybersecurity would ensure anonymisation in the aggregation of user data from private, public and research organisations.

Initially, the repository could include user data shared through mobility, learning, e-commerce and digital services. These sources could then expand over time to include data points relating to health, wearables and the living world, including plants and the environment more generally. This wealth of data would spur developments in advanced machine intelligence and powerful predictive Artificial Intelligence (AI) models, enabling real-time simulation of impacts and generating innovation and growth opportunities in fundamental and applied research and also in entrepreneurship.

BENEFITS

Faster, more accurate modelling in research and innovation. More of a level playing field for actors in the public and private spheres.

RISKS

Exploitation of data (even aggregated data) to identify individuals for criminal or malicious purposes, unless extremely advanced security measures are implemented.

Only an estimated

6%

businesses globally,
access and share data to attain
business benefits

OPPORTUNITY #18

What if we adopted Space Development Goals (SpDGs)?

UNIVERSAL UNIVERSE GOALS

A set of universal goals acts as a call to action to protect space and ensure that all who want to access it can do so without unduly increasing debris or space pollution and safeguarding space for generations to come.

MEGATREND
Saving Ecosystems

TRENDS
International Collaboration
Future of Space

SECTORS AFFECTED
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Cyber & Information Security
Data Science, AI & Machine Learning
Energy, Oil & Gas, & Renewables
Financial Services & Investment
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Government Services
Professional Services

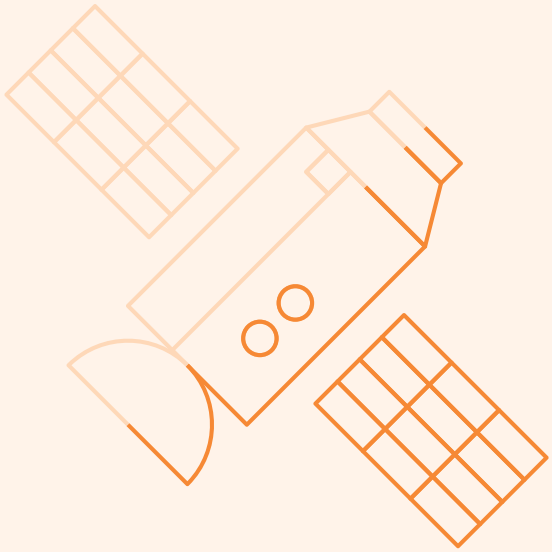
WHY IT MATTERS TODAY

The United Nations Committee on the Peaceful Uses of Outer Space was established to prevent or reduce the creation of space debris.[380] A set of space debris mitigation guidelines were endorsed by the General Assembly in 2007 but these are not legally binding and have not been adopted by UN member countries. [381]

Meanwhile, there has been a striking rise in the number of satellites being launched into space. Satellites are providing increasingly accurate and important data for a host of tasks and activities, including communications, earth observation, navigation and GPS, military support and weather prediction. Estimates project that, by 2030, close to 990 satellites will be launched every year[382] compared to an average of 230[383] per year in the previous decade.[384]

Out of potentially 11,000 satellites[385] circling the earth, only around half — 5,465 — as of May 2022, are operational.[386] The countries and bodies that are at the forefront of the satellite industry include the United States, China, Russia, the United Kingdom, Japan, India, the European Space Agency, Canada and Germany. In 2021, among the 30 countries with the highest numbers of satellites launched into space, the United Arab Emirates stood in 20th position tied with Saudi Arabia, Switzerland and Taiwan, each with 14 satellites in orbit.[387]

The market size for global space debris monitoring and removal reached $866 million in 2021 and at a compound annual growth rate (CAGR) of 7% it is expected to almost double, to $1.5 billion, by 2029.[388]



Out of potentially 11,000 satellites circling the earth, **only around half** —

5,465 SATELLITES

— as of May 2022, are **operational**

THE OPPORTUNITY

As space becomes busier, humanity risks repeating mistakes made concerning the earth's environment by introducing objects into space that ultimately threaten the safety of craft, crews and possibly even the earth itself. Legally binding goals to keep space pollution to a minimum and to find ways to safely collect and dispose of large debris would enable safer space operations for generations to come.

The exploration and exploitation of space could offer humanity a novel source of solutions and resources. Examples include new ways of medical diagnosis, testing new materials for improving solar cell performance, radiation protection and concrete manufacturing, biomining for new minerals and testing biomedical devices to aid re-design, under new conditions that are impossible to achieve on earth.[389]

However, in the long term, these possibilities will result in a build-up of abandoned and disused equipment and other forms of space pollution. Some chemicals used in space technologies burn up, potentially depleting the ozone layer and harming the environment, when they re-enter the atmosphere.[390] Defunct satellites and other debris can present hazards to space exploration, with the liability for orbital debris particularly challenging in the case of smaller pieces of debris whose origins may not be known.[391]

Besides risks of injury or damage because of space debris re-entering the earth's atmosphere,[392] space debris also poses a critical threat to the launch of new satellites and has the ability to harm satellites already in orbit. It also presents a risk to infrastructure, such as spacecraft and space stations. If enough debris ends up in orbit, it could ultimately lead to the 'Kessler syndrome' scenario, in which there is a self-generating cascade of ever-increasing collisions, rendering some orbits unusable.[393]

BENEFITS

A safer space environment with greater collaboration among actors, contributing to growth. Mitigation of risks associated with falling space debris onto earth.

RISKS

Adoption and/or enforcement of goals too late to prevent a significant build-up of space debris. Deployment of space pollution rules to prevent certain actors using certain orbits or to block them from launching satellites.

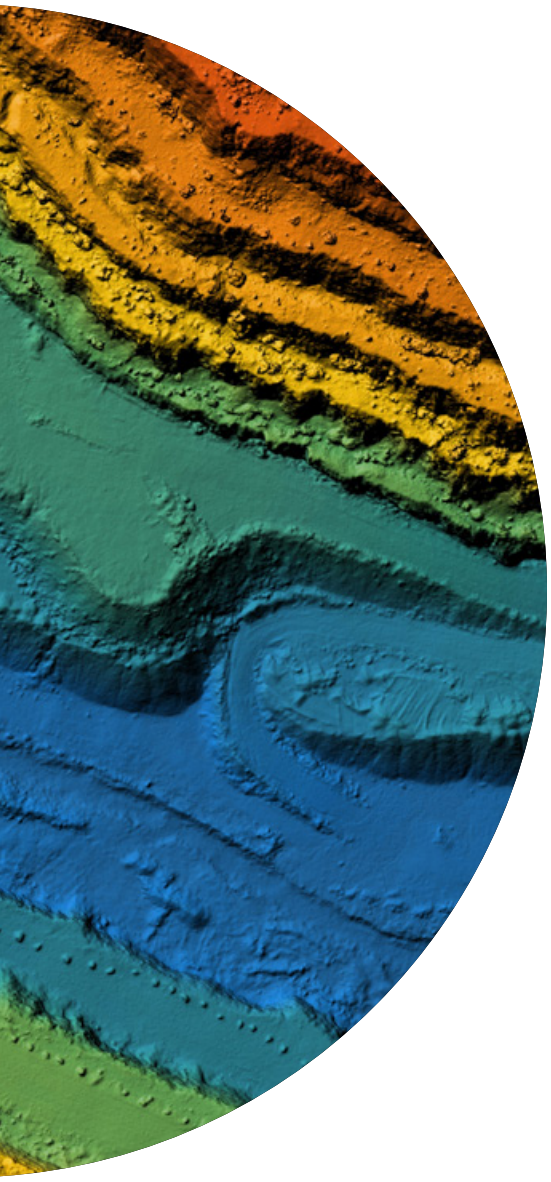
By 2030, close to

990 SATELLITES

will be launched every year compared to an average of **230 per year** in the previous decade

OPPORTUNITY #19

What if we built a digital climate catalogue?



THE ULTIMATE CLIMATE CALCULATOR

Going beyond the carbon footprint, a digital climate catalogue allows governments, businesses and even individuals to calculate their environmental impact in real time. Fully automated, this valuation system reveals the likely impacts of potential policy and investment choices.

MEGATREND
Saving Ecosystems

TRENDS
Artificial Intelligence
ESG & Beyond GDP
Internet of Things (IoT)
Net-zero

SECTORS AFFECTED
Agriculture & Food
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas, & Renewables
Financial Services & Investment
Health & Healthcare
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Metals & Mining

WHY IT MATTERS TODAY

Climate change will affect all areas of life, and the consequences of inaction are well documented. For example, some species face extinction with every degree of increase in temperature, and severe water shortages could lead to the displacement of 700 million people globally by 2030.[394] The Middle East and North Africa (MENA) region is one of the driest in the world, with 12 of the most water-scarce countries located in the region.[395]

Approaches to assigning an economic value to nature vary, based on context, theoretical perspective and approach to uncertainty and complexity.[396][397] Back in 1997, researchers defined 17 categories for ecosystems – ranging from gas and water regulation to pollination, waste treatment, recreation and food production – and estimated the value of the entire biosphere to be an average of $33 trillion per year.[398] In 2011, the value of earth was estimated at $5 quadrillion (quadrillion = a million billion).[399] In 2022, it was estimated that every dollar invested in the restoration of degraded land yields $7–$30 in returns from job creation and carbon capture.[400]

Climate change also threatens health as projections reveal 250,000 additional deaths will occur annually between 2030 and 2050 due to climate-sensitive diseases such as heat stress, malnutrition, dengue, malaria and diarrhoea. This will initially cost societies up to $4 billion annually, with the amount likely to increase in the future.[401]

Mostly in North America, and capturing more than 45 million tonnes (Mt) of carbon dioxide per year particularly through natural gas processing plants,[402] the global carbon-capture and storage market was valued at just over $3 billion in 2021.[403] With aspirational climate targets and associated government and non-government incentives, the market is expected to grow to a $55 billion per year market by 2030.[404]

Carbon markets are in an early stage of development in some major Gulf Cooperation Council (GCC) countries. The United Arab Emirates and Saudi Arabia have committed to achieving net zero emissions by 2050 and 2060 respectively.[405]

The Internet of Things (IoT) holds much promise when it comes to the environment and the possibilities for linking technology to a catalogue of earth's data. The technology is already applied to monitoring livestock,[406] water quality in fishponds[407] and environmental compliance.[408] Globally, the number of IoT connections grew by 8% in 2021, reaching 12 billion points. By 2025, 27 billion connected IoT devices are expected to be active.[409]

THE OPPORTUNITY

The capacity to build more accurate predictive models allows for the building of a digital whole-earth catalogue that would be able to demonstrate how decisions would affect the environment immediately and over time. IoT and advanced machine intelligence could be employed to build more accurate models and reports using data inputs from ultra-high-definition satellite imagery, atmospheric and bioacoustics (animal and marine life sounds) sensors and DNA technologies (to track soil and insect health). All of this data would feed into a self-updating global model of human–environment interaction resembling an ecological digital twin.

Businesses, governments and communities could forecast the effects of their infrastructure usage, upcoming projects or changes to their operations or supply chains in terms of their impact on local and global ecosystems. Going beyond the carbon footprint,[410] the digital whole-earth catalogue would capture changes in the value and flows of natural assets. It would calculate – in real time – the costs, benefits and economic impacts of investments and behaviours affecting air quality, greenhouse gas emissions, water and biodiversity. This would enable efforts to go beyond economic growth and address climate risk.[411]

BENEFITS

The possibility of comparable measurements through a common metric and model(s) available to all. Potential to reveal new sources of value and revenue streams.

RISKS

Undervaluation or overvaluation of certain forms of capital in relation to climate impact. Incorrect picture of progress through distorted metrics.

Globally, the number of IoT connections grew by

8% in 2021, reaching **12 billion points**

By 2025,

27 BILLION

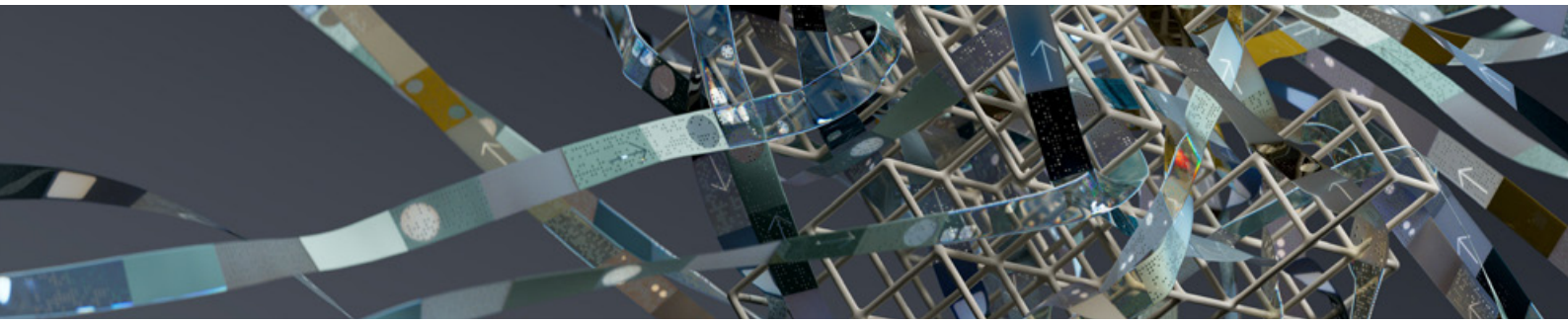
connected IoT devices are expected to be active.

OPPORTUNITY #20

What if knowledge was effortlessly shared?

DEEPER THOUGHT

Shaped by advances in brain–computer interfaces (BCIs) and advanced machine intelligence, knowledge sharing becomes cross-disciplinary, cross-geographical and cross-generational, with ever increasing speed and minimal effort, shaping the future of knowledge.



MEGATREND
Future Humanity

TRENDS
Artificial Intelligence
Brain-Computer Interfaces (BCI)
Future of Purpose & Work
Quantum Technology

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas, & Renewables
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

As demonstrated during the COVID-19 pandemic, interruptions to learning can occur and may do so again in the future. As generations come and go, our understanding of how knowledge is acquired and disseminated may also change.

Social media, messaging applications and video-conferencing tools were vital during the pandemic. Social media sites saw an increase of 61% in web traffic during the first three months of the pandemic and video-conferencing calls increased five-fold; as a result, social media platforms were seen to be complementary to learning with peers regardless of geographical location or time.[412] Yet, half of the children in a third of low-income countries did not participate in remote learning during COVID, which is concerning given that the percentage of 10-year-olds who cannot read or understand a simple story by the end of primary school is 53% in low- and middle-income countries and up to 80% in the poorest countries.[413]

In higher education and research institutions, journal articles are key to learning and the development of new knowledge. While the global research publication market contracted to nearly $27 billion in 2020 as a result of the pandemic, it is forecast to regain its pre-pandemic (2019) position of $28 billion by 2023.[414] The United States accounts for 40% of the global revenue in the scholarly publishing market, followed by the Asia Pacific region at 29%, Europe at 26.5% and the Middle East, Africa and other parts of the Americas at 4.5%.[415] Some 70% of journals worldwide cover science, technology and mathematics and 30% cover social science and the humanities.[416]

Related to article publications, on average, peer reviewers complete from five to – surprisingly – over a thousand reviews of draft articles in a year,[417] and 10% of reviewers are responsible for half of peer reviews.[418] Globally, the total time reviewers spent on peer reviews in 2020 amounted to 100 million hours or 15,000 years, and this work is rarely compensated financially.[419] Monetary estimates of the value of the time peer reviewers spent on reviews in 2020 amount to more than $1.5 billion for reviewers in the United States, [420] $600 million for those in China[421] and $400 million for those in the United Kingdom.[422]

In the workplace, despite technological advances in document and workflow management, more employees are finding it difficult to extract the knowledge they need from online individual or shared files or platforms; instead, many obtain it directly from colleagues.[423] Moreover, because of missing and/or poor-quality content, employees who find it difficult to obtain this information are more likely to rate the value of any information they obtain as inadequate.[424] Yet, online content and associated knowledge platforms continue to increase: the estimated value of the global knowledge-management market is expected to amount to $1.1 trillion by 2026, at a CAGR of almost 20%.[425]

THE OPPORTUNITY

The combination of technological advances in brain–computer interfaces (BCIs) and advanced machine intelligence, including quantum computing, restructures how individuals and societies collaborate and construct knowledge evolving into something that is cross-disciplinary, cross-geographical and even cross-generational. Our understanding of what constitutes knowledge and how knowledge is obtained will change in terms of both speed and breadth.

While digital realities and generative AI like ChatGPT from OpenAI[426] may enhance the efficiency of operations, programming, reporting, documentation and research, it is neuroscience and BCI that will fundamentally change how we approach education, higher education, research, careers, spiritual and cultural fulfilment and even tourism. Connected, people will be able to access and upload knowledge instantaneously and what will stand out is depth of knowledge and analysis: these will distinguish between those who are highly knowledgeable and those who are not.

BENEFITS

Increased agility and adaptability in addition to improved collaboration and innovation.

RISKS

Overemphasis on certain forms of knowledge due to unconscious bias, with the result that time and funding are diverted away from areas with greater potential. Increased access to information overload giving rise to mental health issues and poor decision making.

HALF OF THE CHILDREN

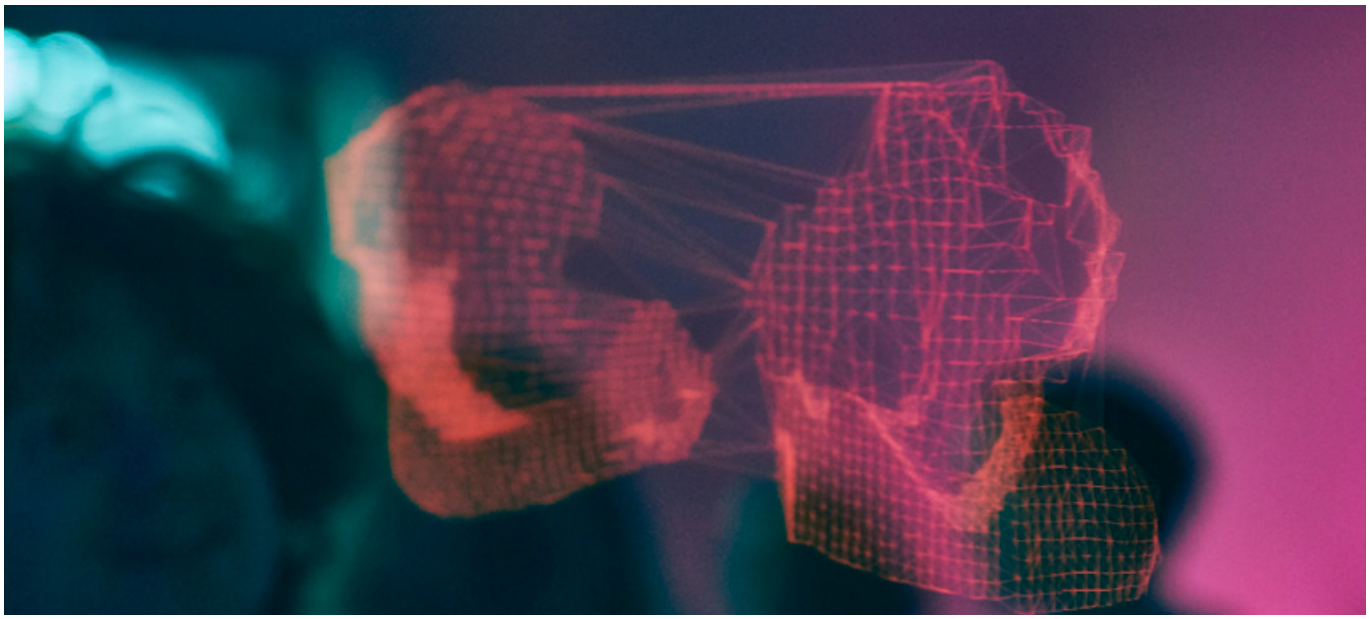
in a third of low-income countries **did not** participate in remote learning during COVID

OPPORTUNITY #21

What if no one was left behind in the transition to digital realities?

CROSSING THE DIVIDE

A global task force adopts a ‘nexus’ approach to ensuring that every person on earth is included in the transition to digital realities.



MEGATREND
Digital Realities

TRENDS
Future of Purpose & Work
Immersive Technologies & Wearables
Internet of Things (IoT)
Mobilising Innovation
Virtual Reality

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Government Services
Professional Services
Government Services
Professional Services

WHY IT MATTERS TODAY

Not everyone has access to computers or the internet. As of 2021, 57% of those living in developing countries used the internet compared to 90% in developed countries.[427] Of lower quality, a 5GB fixed-broadband connection costs 4.4% of monthly gross national income (GNI) per capita in developing countries compared to only 1.2% in developed countries.[428]

In the European Union, the current trend indicates that by 2030 only 64% of the adult population will attain at least basic digital skills (16 percentage points below the target of at least 80% of Europe's adult population). Additionally, only 13.3 million digital specialists will be employed (6.7 million below the target of 20 million).[429]

In a phenomenon known as the digital divide,[430] limited connectivity and insufficient digital skills already mean that lower-income groups may find it harder to access online learning opportunities.[431] As digital platforms evolve into digital realities, this divide may grow further, limiting people's access to both learning and work opportunities.

While the digital divide continues, the global augmented reality (AR) and virtual reality (VR) markets are expected to reach $461 billion by 2030, with a compound annual growth rate (CAGR) of 42% between 2020 and 2030.[432] The global earphone and headphone market is expected to reach $35 billion by 2028, up from $22 billion in 2022 and growing at a CAGR of 8%.[433] VR and AR have the potential to add $4 billion to the United Arab Emirates' economy by 2030, i.e. 1% of GDP, compared to a global increase of 1.8% of GDP by the same year.[434]

A 5GB fixed-broadband connection costs

4.4% of monthly gross national income (GNI) per capita in **developing countries** and only **1.2%** in **developed countries**

THE OPPORTUNITY

Digital realities have three prerequisites: access to wearables and devices, access to the internet and digital literacy. All of these are expensive and non-trivial for developing and low-income countries, and only one has been tackled through the United Nations' Sustainable Development Goals (SDGs), under Goal 9: universal access to information and communications technology.[435]

A global task force with representatives from government, non-governmental organisations, multidisciplinary research institutions and technology companies could work to develop a multifaceted framework to provide access to digital realities. Identifying the most important links across various domains, the task force could develop an integrated approach to be used at local, regional and global levels to address the digital divide. While some may choose to opt out of digital realities, the associated business and living implications will be significant and being left behind may negatively impact societies.

BENEFITS

No one is left behind when digital realities become critical to life, education and work, thanks to a proactive, integrated and multidisciplinary approach.

RISKS

Evolution of the digital divide into a digital reality divide, where a more significant proportion of global society does not have access to digital realities and hence has limited income and learning opportunities. Limited adoption, funding and support.

As of 2021,

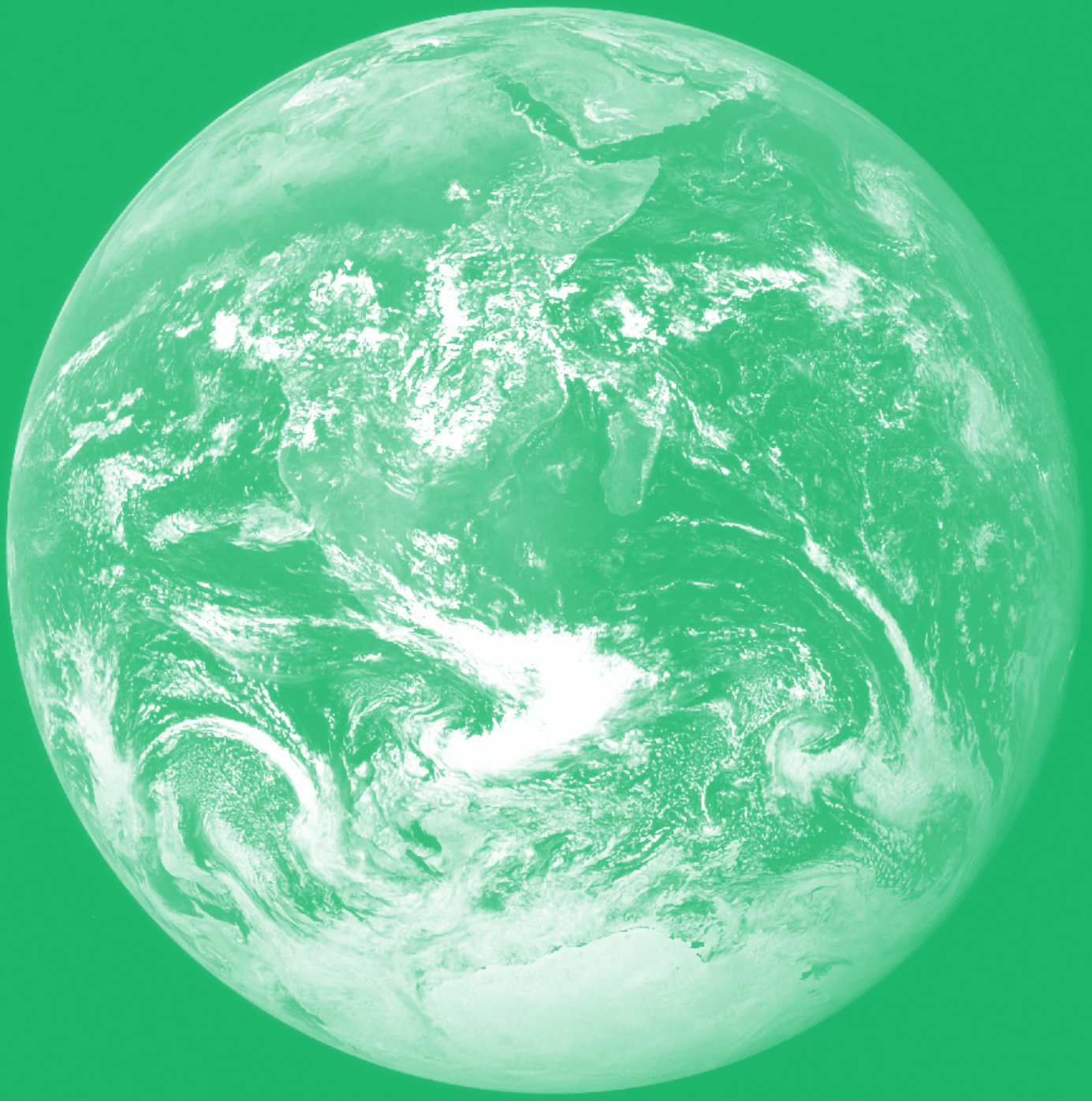
57%

of those living in developing countries
used the internet compared to

90%

in developed countries

NATURE RESTORED



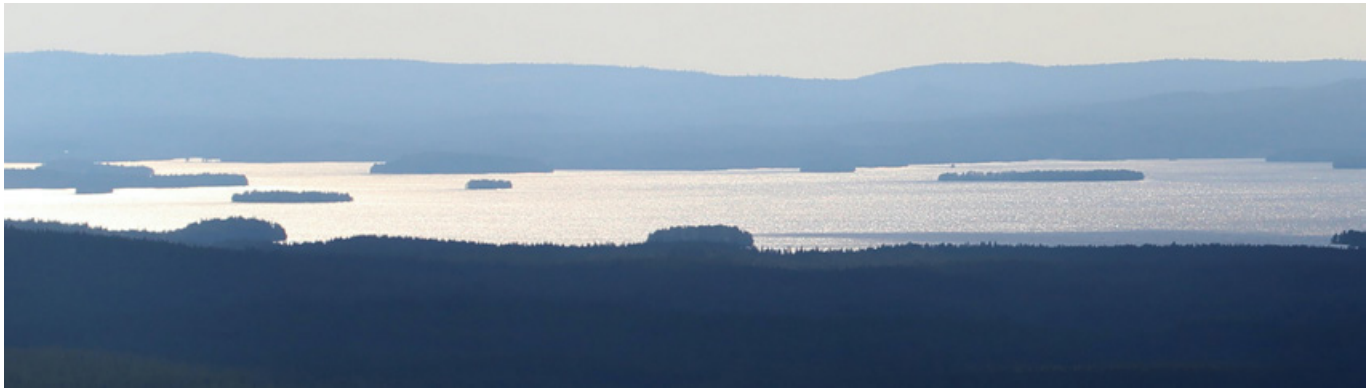
Minimise environmental risks, harness nature's capacity to restore itself or have a positive impact on crucial environmental ecosystems and habitats, creating a more stable, healthier planet for all.

OPPORTUNITY #22

What if we returned the planet to its natural state?

A WALK ON THE REWILD SIDE

Phasing out land use for food production accelerates biodiversity and ecosystem restoration – hence rewilding – while mitigating climate change risks.



MEGATREND
Saving Ecosystems

TRENDS
Deforestation & Desertification
Restoration
Bioeconomy

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Chemicals & Petrochemicals
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Infrastructure & Construction
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

As natural carbon sinks, emissions get trapped by nature through soil, the oceans and vegetation. Natural storage of these emissions slows climate change more effectively than many existing technologies.

The world's forests absorb 16 gigatons of carbon dioxide per year, which is more than three times the emissions of the United States alone.[436] However, half of this carbon dioxide leaks back into the atmosphere through deforestation and forest fires.[437] Over a third of greenhouse gas emissions can be mitigated by restoring earth's ecosystems to their natural states.[438] As natural carbon sinks, emissions get trapped by nature through soil, the oceans and vegetation more effectively than many existing technologies. [439] The top three countries with the largest natural land carbon sinks are Russia, Canada and the United States.[440]

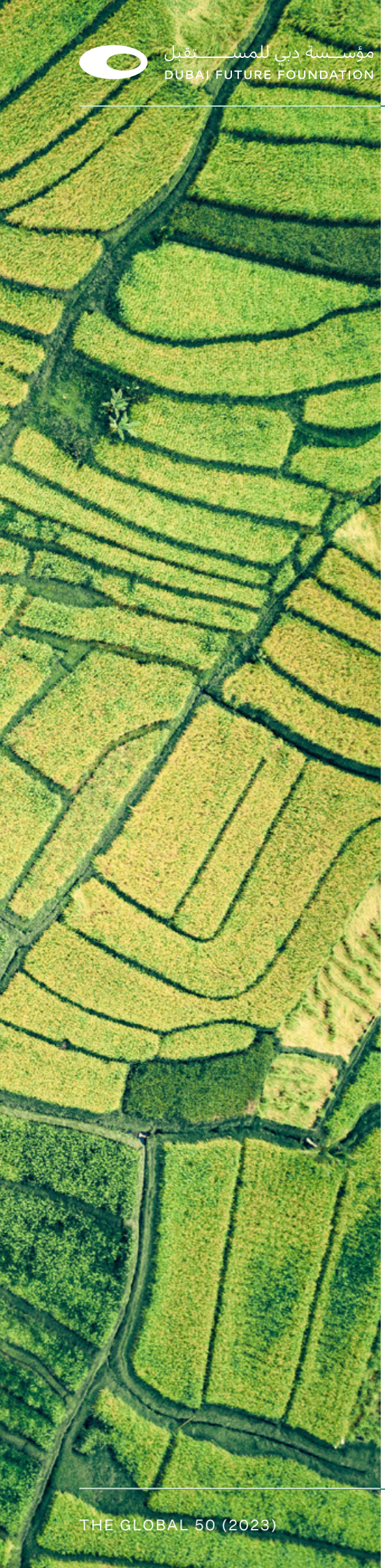
About three billion people reside in areas highly vulnerable to climate change.[441] One hectare of fully regenerated forest can absorb 10 tonnes of atmospheric carbon dioxide each year,[442] while the average person emits 4 tonnes per year.[443] Every year, approximately 1.9 billion trees are planted globally, or 60 per second.[444] The amount of land taken up by agriculture around the world is approximately 5 billion hectares, or 38% of the globe's land surface.[445] A study done in the United Kingdom found that the cost of a tree is around $7 (excluding maintenance for trees in cities), while the long-term economic benefits accumulated over 50 years can be over $9,000 per tree.[446] Using this calculation, planting 6,000 trees — as part of climate action — in strategic locations would generate benefits equal to $1 million per year over the course of 50 years.[447]

The top three countries with the

LARGEST NATURAL LAND CARBON SINKS

1 **RUSSIA**
2 **CANADA**
3 **UNITED STATES**





THE OPPORTUNITY

The natural environment is earth's own carbon sink. Rewilding large swathes of the planet could boost natural carbon capture and mitigate the impacts of climate change both locally and globally. Rewilding can restore ecosystems and offset carbon dioxide emissions. The associated shift to alternative food production methods and nutritional models would decrease the direct and indirect greenhouse gas emissions (including of methane) related to agrifood production.[448]

Aside from assisting in carbon capture, rewilding prevents deforestation and/or desertification. Rewilding can be done naturally but it can also be accelerated through the use of planting schemes using diverse indigenous plants or plants genetically engineered for faster growth, carbon dioxide absorption and resilience.[449] Improved global imaging and modelling of the interaction between climate change and biodiversity can identify where investment in rewilding will have the best outcomes.

BENEFITS

Dual benefits to nature and well-being through climate impact mitigation, improved air quality and better environments for humans and animals. Reduced economic costs of environmental degradation and climate impacts. Increased value from ecosystem services. Reversal of the trend towards habitat loss currently being experienced by some 80% of the world's land-based animal species.[450]

RISKS

Increased food costs. Displacement and loss of income and culture for rural and farming populations.

The world's forests absorb

16 GIGATONS

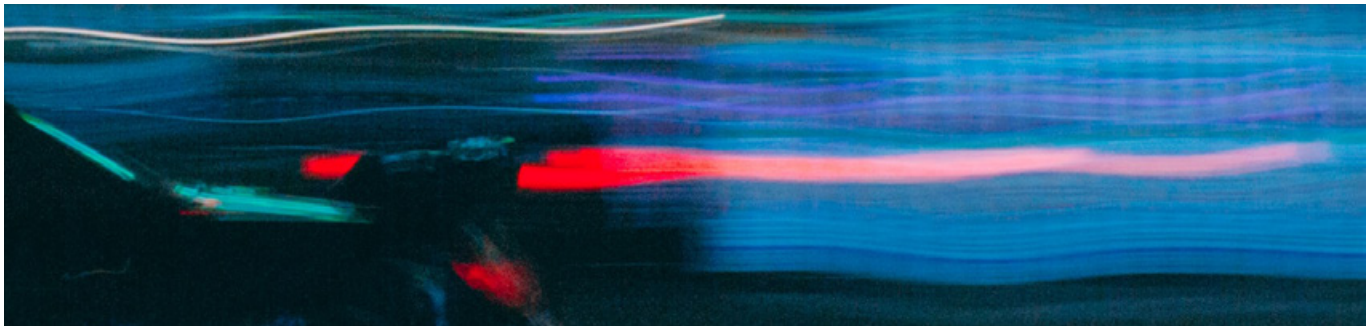
of carbon dioxide per year
However, **half of this carbon dioxide**
leaks back into the atmosphere through
deforestation and forest fires

OPPORTUNITY #23

What if the next wave of car technology innovation was in the wheels?

MULTI-PURPOSE WHEELS

A series of technological innovations in the wheels redefine the future of car transport – from maglev (magnetic levitation) solutions and drone-like technologies, to the replacement of rubber in tyres and new ways of conceptualising the function of wheels on a car.



MEGATREND
Materials Revolution

TRENDS
Advanced Mobility
Air Pollution
New Materials

SECTORS AFFECTED
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables
Financial Services & Investment
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Government Services

WHY IT MATTERS TODAY

Tyres and brake systems produce large amounts of microplastics as by-products. Up to 100,000 tonnes of microplastics from tyres end up in the ocean each year and a further 40,000 tonnes of microplastics come from wear and tear on car brakes. With the average scrapped car tyre weighing 9 kg, the amount of microplastics discharged into the ocean is equivalent to 11 million tyres each year.[451]

Research suggests that nanoparticles generated from road traffic can cause harm, and increased road traffic is a major cause of high particle concentrations in polluted urban areas.[452] Atmospheric particulate matter was recognised as the leading cause of 43,000 premature deaths in Europe by the European Environment Agency in 2015.[453]

THE OPPORTUNITY

The transport landscape is changing. Imaginative new applications of drone or maglev (magnetic levitation) technology could be the future. For example, in one scenario, there could be hybrid vehicles that are capable of running on electricity or alternative fuels but that switch over to maglev mode when the infrastructure is available. This would prevent the release of nanoparticles of dust, plastic and minerals into the atmosphere, as well as reducing noise levels. Such solutions would make the roads cleaner, improving ecosystems and human health.

Replacing rubber tyres with new materials and new wheel and brake technologies can minimise wear and tear on both vehicles and road surfaces. When used safely, lower-friction – or even frictionless solutions, augmented by advanced machine intelligence and autonomous systems – can cut energy consumption, enabling electric vehicles to travel further.

Wheels could become multifunctional. Rethinking the functionality of wheels and tyres beyond simply transportation and carrying the load of the car could lead to the development of wheels that can generate energy, filter nanoparticles and absorb emissions, among other applications.

BENEFITS

Cleaner and healthier cities. Reduction in the energy needed to run vehicles. Lower consumption of rubber (petrochemicals). Further innovation.

RISKS

Reduced friction and therefore reduced road adherence, requiring vehicles to have ultra-advanced safety systems to compensate for slippery surfaces as well as advanced road and safety management systems. Complete dependence of drivers on automated safety systems even under normal driving conditions. Increased cybersecurity risks.


TOYOTA FV2
Teilen Sie Ihre Gefühle mit dem FV2! Einfach

OPPORTUNITY #24

What if we had a responsive centennial plan for the planet?

MAKE IT 100

Beyond the Sustainable Development Goals, Planetary Development Goals are set up and agreed on a rolling 100-year time frame, creating a long-term global cooperation framework for restoring and preserving ecosystems and biodiversity.

MEGATREND
Saving Ecosystems

TRENDS
ESG & Beyond GDP
International Collaboration
Restoration

SECTORS AFFECTED
Agriculture & Food
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Insurance & Reinsurance
Metals & Mining
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

Studies have concluded that humanity has far exceeded what the planet can handle in terms of environmental pollutants and human-made materials such as plastics.[454] The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, include 17 goals, 169 targets and 231 unique indicators, 92 of which are related to the environment.[455] Looking at humanity's progress against the environmental targets as a whole, 67% are following a positive trend while 33% are showing little change or a negative trend.[456] At the current rate of investment, none of the SDGs will be achieved by 2030.[457]

Between 2001 and 2021, the earth lost just over 435 million hectares of tree cover, which was a decrease of 11% since 2000.[458] In parallel, there has been a 68% drop in mammal, bird, fish, reptile and amphibian populations since 1970.[459] There has been a 14% loss of coral since 2009 due to rising sea surface temperatures,[460] and 150 species go extinct every day – or 10% every decade.[461]

The impacts of climate inaction and non-cooperation can be measured by the likely effects of global warming on economic growth. It is estimated that, with a 1.5°C increase in the global temperate, conditions will be close to indistinguishable from what we see currently. However, warming of 2°C would result in significantly lower projected economic growth (up to a 2% annual decline) for many countries, particularly low-income countries and countries around the equator. The Middle East and North Africa are among the areas that would be most negatively affected by warming of 2°C. For example, Saudi Arabia and the United Arab Emirates could expect a decline of approximately 1.8% in their economic growth per capita annually.[462]

THE OPPORTUNITY

Set to be achieved by 2030, the SDGs are not sufficiently long term to enable natural ecosystems to recover or be restored.[463] While ambitious short-term goals are important,[464] stable long-term goals and strategies can provide the certainty and conditions needed for governments and businesses to make changes and investments at the scale required.[465]

A global supranational protection and regulatory system supported by advanced machine intelligence and modelling could set priorities for the planet. It could also define the roles and contributions needed from each country according to economic size and development needs and degree of exposure to climate change and biodiversity loss. Collating highly detailed environmental, meteorological and consumer market data would allow automated systems to calculate impacts and suggest corrections and adaptations in real time.

This system would have two primary functions. Firstly, it would survey the planet, flagging actions or plans with negative long-terms impacts. Secondly, it would empower governments, citizens and businesses to contribute to the intergenerational health of their environment and the earth's natural systems.

BENEFITS

Definition of long-term goals and coordination of efforts so as to achieve and surpass aims.
A means of organising multilateral collaboration and investment.
A set of metrics against which to measure progress.

RISKS

Disconnection between a 100-year outlook and shorter-term government policies and interests around climate change. Perception of the goals as too expensive compared to other more pressing socio-economic challenges.

There has been a **14% loss of coral** since 2009 due to rising sea surface temperatures, and

150 SPECIES GO EXTINCT EVERY DAY

– or **10%** every decade

OPPORTUNITY #25

What if the atmosphere was given the ability to self-heal?

LET THAT (CARBON) SINK IN

Using the example of the ozone layer's capacity to repair itself, advances in nanotechnology are used to build a self-repairing atmosphere that absorbs greenhouse gases, restoring balance for the benefit of the earth's climate and allowing nature to regenerate.

MEGATREND
Saving Ecosystems

TRENDS
Air Pollution
Nanotechnology
Restoration

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Infrastructure & Construction
Insurance & Reinsurance
Manufacturing
Metals & Mining
Government Services
Professional Services

WHY IT MATTERS TODAY

The atmospheric concentrations of most greenhouse gases, including carbon dioxide, methane and nitrous oxide, have increased over several centuries but most significantly since the Industrial Revolution. Between pre-industrial times (late 18th century) and 2021, carbon dioxide concentrations rose from an annual average of 280 parts per million (ppm) to 414 ppm – a 48% increase.[466] Moreover, the concentration of methane has more than doubled since pre-industrial times, reaching over 1,800 parts per billion (ppb) in 2021.[467] Concentrations of nitrous oxide reached 334 ppb in 2021.[468]

Greenhouse gases have been attributed to human activities causing a substantial part of the warming of the earth's climate.[469] Carbon dioxide has been identified as the biggest contributor to warming, followed by methane and black carbon (soot).[470] Although certain other activities have caused cooling, the net result has been a 1.1°C increase in temperature since 1880.[471]

Various carbon-capture methods and technologies have been proposed to curb emissions.[472] Other ways of reducing the amount of carbon in the atmosphere include planting forests, expanding farms, using bio-energy with carbon capture and storage and using ocean-based carbon removal methods.[473] The global carbon capture and storage market was sized at $3.22 billion in 2021 and is expected to grow at a compound annual growth rate of 5.8% from 2022 to 2030. The potential global market size for carbon capture and storage is estimated to reach $4 trillion by 2050.[474]

THE OPPORTUNITY

A combination of technologies can be used to seed the atmosphere with nanocatalysts – nano-sized catalytic materials that detect greenhouse gases and then either neutralise them or convert them into environmentally safe and useful chemicals and other derivatives, such as hydrogen gas.[475]

However, as gases that trap heat and cause other health and air quality issues, greenhouse gases are a challenge on the path towards managing climate change. As well as carbon dioxide, methane and black carbon, there are fluorinated gases and nitrous oxide. All stay within the earth's atmosphere for various periods of time ranging from a few years to a few thousand years.[476]

A global multilateral project could be developed to disperse nanocatalysts at strategic points around the globe, with trade winds and selected weather fronts affecting the dispersal in such a way as to maximise greenhouse gas neutralisation or conversion. The levels of ocean, soil and atmospheric carbon and other gases could decline rapidly (even as emissions continue), with levels falling below the most optimistic targets set by the Intergovernmental Panel on Climate Change. Ecosystems would be reinvigorated and return to their natural carbon-absorbing cycles, further slowing and eventually reversing the worst effects of climate change.

BENEFITS

Elimination of climate change and global warming. Increased growth, prosperity and well-being.

RISKS

Risk of over-reliance on geoengineering solutions rather than the prevention of emissions and greenhouse gases.

414 PPM

Between pre-industrial times and 2021, carbon dioxide concentrations rose from an annual average of

280 PPM

– a **48% increase**

OPPORTUNITY #26

What if we could recool the planet by saving the ice caps?

ICE UNCAPPED

A multi-pronged effort to restore the Arctic's sea ice, the Antarctic's ice sheet and mountain glaciers around the world leads to the cooling of the planet and oceans and prevents the further release of trapped methane into the atmosphere.

MEGATREND
Saving Ecosystems

TRENDS
Air Pollution
Geoengineering
Ice Cap Shrinkage
New Materials

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Financial Services & Investment
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Utilities
Government Services
Professional Services

By 2100, close to

150 MILLION PEOPLE

would face a devastating threat to their lives if the sea levels rises by more than

1 METRE

WHY IT MATTERS TODAY

Ice coverage in the polar regions and glaciers is a critical natural climate regulator, melting of which could significantly contribute to sea levels rising by more than a metre by 2100.[477,478] According to projections, close to 150 million people would face a devastating threat to their lives.[479] Residents of coastal areas, in particular, would face the most severe impacts, while the global economy would lose $50 trillion per year.[480]

Melting bodies of ice risk increasing methane emissions and greater concentrations of greenhouse gases in the atmosphere.[481] Melting glaciers could also lead to the extinction of species, both terrestrial and aquatic, who call glaciers their home and that fail to adapt to swiftly changing conditions.[482]

In terms of the world's cities, Guangzhou, Istanbul, Lagos, New York and Tokyo would be the most likely to face severe effects. Populations in tropical coastal regions would also be especially vulnerable,[483, 484] for example rising sea levels threaten the existence of small island states such as Kiribati, the Maldives and the Solomon Islands. These states exist in a fragile condition with heavy reliance on tourism and international trade, underdeveloped communications and infrastructure and a lack of protection against natural disasters.[485]

Besides researching and experimenting with innovative approaches to removing greenhouse gases and reducing emissions, the Centre for Climate Repair at Cambridge in the United Kingdom also focuses on refreezing as one of its core objectives. One approach currently being explored by the centre and other groups is to reflect radiation from the sun back into space through marine cloud brightening, which makes clouds thicker with smaller droplets. Another is to enhance freezing in winter by catalysing the formation of thicker ice sheets around glaciers.[486]

The Middle East and North Africa (MENA) region could be confronted with severe environmental conditions, with some coastal cities becoming inhabitable, notably Alexandria in Egypt.[487] The MENA region could be the first to run out of water, partly because of a climate-change-induced rise of temperature that is estimated to exceed 4°C by 2050, or double the global average, and exceeding the threshold for human adaptability.[488] The warmer climate could result in higher mortality, desertification and food insecurity.[489]

THE OPPORTUNITY

An effort across many fronts could increase ice formation and reverse the retreat of ice at the poles and in mountainous regions, thereby cooling the planet and its oceans and preventing the further release of trapped methane into the atmosphere. Localised geoengineering solutions could include strategies such as deploying wind power to pump colder seawater to the surface to speed freezing[490] and surface modification, which involves using materials on land to deflect heat and light.[491]

Concerted efforts to combine various techniques could restore ice coverage and thickness, allowing ice sheets and caps to regulate atmospheric and ocean temperatures and protect marine and terrestrial biodiversity and limit the risk of sea levels rising.

BENEFITS

Regulation of the climate and reduction in the economic and social costs of climate-related disruption. Protection of biodiversity in marine ecosystems and of livelihoods that depend on those ecosystems. Preserving the ice caps would also prevent the release of methane as the ice retreats.

RISKS

Unforeseeable or unintended consequences from geoengineering for local or even global natural systems.

OPPORTUNITY #27

What if we achieved zero emissions?

MISSION ACCOMPLISHED

Technological breakthroughs and unprecedented global collaboration bring greenhouse gas emissions to zero[p], restoring ecosystems and creating new ones.

MEGATREND
Saving Ecosystems

TRENDS
Air Pollution
International Collaboration
Nanotechnology
Transforming Energy

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Consumer Goods, Services & Retail
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Travel & Tourism
Utilities
Government Services
Professional Service

p Close to zero.

WHY IT MATTERS TODAY

The cost of climate change continues to rise. Besides direct costs related to climate change mitigation and adaptation, damage to habitats and food chains as biodiversity and ecosystems break down[492] gives rise to additional economic burdens in the future.[493]

Eleven million hectares of tree cover were lost in the tropics in 2021. The loss of tropical primary forests in 2021 led to 2.5 gigatons of carbon dioxide emissions, which was equivalent to India's annual fossil fuel emissions.[494] Since 1970, the world has lost 35% of its global wetland area.[495]

The atmospheric concentrations of most greenhouse gases, including carbon dioxide, methane and nitrous oxide, continue to increase beyond optimal levels.[496] As a leading cause of warming temperatures,[497] with an increase in temperature of 1.5°C, 4% of mammals would lose half their habitat, whereas if temperatures rose by 2°C, this figure would rise to 8%. Similarly, at an increase of 1.5°C, 70 to 90% of coral reefs would disappear, whereas at 2°C, the percentage would increase to 99%.[498] The Mediterranean region is projected to be particularly affected by climate change,[499] and 80 to 90 million people in the Middle East and North Africa (MENA) region are expected to suffer water stress in some form by 2025.[500]

The loss of tropical primary forests in 2021 led to

2.5 GIGATONS

of **carbon dioxide emissions**, which was **equivalent to India's fossil fuel emissions**

THE OPPORTUNITY

A multi-pronged approach to capturing greenhouse gases from the atmosphere on a global scale could drive multilateral investment and cost-sharing. New fuels, materials and biochemicals could transform energy generation, transmission and efficiency. Zero-waste manufacturing,[501] green manufacturing[502] and advances in sustainable manufacturing could reduce industrial emissions to zero. Drawing on advanced machine intelligence and data-gathering capacity, global geoengineering solutions in space could modulate how much heat can enter the atmosphere, and areas of emissions could be targeted with nanocatalysts and other emissions-absorbing technologies. These developments could be supported by solutions on the ground to restore ice sheets and caps and to rewild vast stretches of land, restoring the planet's natural capacity to deflect and absorb heat.

While biodiversity loss[503] will be a negative consequence of climate change,[504] restored and new ecosystems that thrive on warmer temperatures[505] will also need to be protected as temperature increase continues, ensuring that natural carbon sinks do not become emitters.[506] Equally, restored and new ecosystems will need to be protected in the event temperatures reverse.

BENEFITS

New and restored ecosystems and biodiversity. Better health and well-being for humans and animals.

RISKS

Unintended consequences of geoengineering solutions. Breakdowns in collaboration. Irreversible acceleration of biodiversity loss.

Since 1970, the world has lost

35%

OF ITS GLOBAL WETLAND AREA

OPPORTUNITY #28

What if we could absorb greenhouse gas emissions and particulate matter on demand anywhere in the world?

'MOBILE' SUPER SCRUBBERS

Enabled by materials science, automation and advanced machine intelligence, emissions and particulate matter are absorbed on an as-needed basis, anywhere in the world, independent of technological capabilities available on hand.

MEGATREND
Saving Ecosystems

TRENDS
Air Pollution
Nanotechnology
New Materials

SECTORS AFFECTED
Materials & Biotechnology
Chemicals & Petrochemicals
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables

WHY IT MATTERS TODAY

On average, those living in the largest urban cities in the MENA region breathe in **10 times** the **level of pollutants** in the air that the World Health Organization considers safe

THE LEVEL OF POLLUTANTS IN THE AIR THAT THE WHO CONSIDERS SAFE

Air pollution, including both particulate matter (PM) and gas emissions,[507] is responsible for 19% of all cardiovascular deaths and 21% of all stroke deaths globally.[508] It is estimated that the direct costs to health due to climate change will have risen to between $2 billion and $4 billion per year by 2030.[509]

Carbon dioxide stays in the atmosphere for thousands of years.[510] While other greenhouse gases do not stay around for as long, they become more potent and damaging than carbon dioxide over time.[511] For example, methane stays in the atmosphere for about 12 years,[512] accounts for about 25% of all greenhouse gas emissions and is more than 25 times more potent than carbon dioxide.[513] Nitrous oxide stays in the atmosphere for about 114 years; it makes up only a small share of global greenhouse gas emissions but 1 kg of nitrous oxide is 300 times more potent than 1 kg of carbon dioxide.[514]

PM is a term for small particles, measuring less than 10 µm (micrometres) across, that are found in the air and that have serious health impacts on humans, animals and aquatic life.[515] Particles measuring less than 2.5 µm, or aerosols, are a severe health hazard with long-term exposure.[516] While 90% of aerosols come from gases that are emitted by natural sources (such as volcanoes, sandstorms, plants and algae in oceans) and that react with the atmosphere to create aerosols, 10% are linked to industrial or transportation emissions.[517] Around 99% of the global population breathes air that exceeds the World Health Organization's (WHO) air quality limits,[518] and, even though PM concentrations decreased on average by 30% to 40% during the COVID-19 lockdowns in 2020 compared to levels in the same period in the years 2015 to 2019, some areas saw increases or spikes for other reasons, such as dust or secondary PM formation from other gas emissions.[519]

Even with national efforts to move away from hydrocarbon dependence in the Middle East and North Africa (MENA), climate change will have significant implications including drought, rising sea levels and extreme heat.[520] On average, those living in the largest urban cities in the MENA region breathe in 10 times the level of pollutants in the air that the World Health Organization considers safe.[521] Air pollution causes around 270,000 deaths per year and costs the region $141 billion per year, or 2% of regional GDP.[522]

THE OPPORTUNITY

Clean air will one day be a critical need if climate change persists. Materials science, automation and advanced machine intelligence could contribute to the invention of a mobile emissions and particulate matter (PM) scrubber that could absorb carbon dioxide, other greenhouse gases and PM anywhere in the world. If this idea were scaled, scrubbers could be positioned at sea as offshore platforms to absorb emissions and PM.

Mobile emissions and PM scrubbers could be standalone solutions powered by renewable sources of energy. Using advanced materials, they could efficiently absorb greenhouse gases and PM and either store them for later use or convert them into fuel[523] and other non-harmful, possibly useful chemicals.[524]

BENEFITS

Improved health with reduced air pollution in both local and wider regions. Reduced costs for lower-income countries in mitigating the effects of climate change.

RISKS

Increased dependence on technology. Difficulties using advanced machine intelligence to ensure that technologies (especially mobile or offshore ones) are autonomous yet sufficiently efficient. Misuse of platforms.


Around
99%
of the global population breathes air that **exceeds** the World Health Organization's air quality limits

OPPORTUNITY #29

What if agriculture cut its dependence on water?

WATERLESS FARMS

Advances in nanotechnology enable the delivery of micronutrients and pesticides through spray coatings that boost yields, safely protecting agriculture from pests and reducing the need for excessive watering.

MEGATREND
Saving Ecosystems

TRENDS
AgriTech
Food—Water—Energy Nexus
Nanotechnology

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Chemicals & Petrochemicals
Energy, Oil & Gas & Renewables
Health & Healthcare
Utilities

WHY IT MATTERS TODAY

Agricultural outputs will need to grow by around 70% by 2050[525] to meet the food needs of a rising population that today stands at nearly 8 billion[526] and is expected to reach 9.7 billion by 2050.[527] In parallel, the demands of industry and commerce for water will increase from 25% to 40%, most of which is driven by agriculture due to its high level of water use.[528]

While it is responsible for approximately two-thirds of global greenhouse emissions,[529] agriculture's future will also be affected by climate change due to temperature changes and shifts in precipitation and wind patterns which will lead to variations in crop yields.[530] For example, maize crop yields are projected to decline by 24%, while wheat could see growth of some 17%.[531]

Still in its early days in relation to agriculture, nanotechnology has already revolutionised drug delivery and improved treatment options for infectious[532] and non-infectious[533] diseases, including HIV[534] and COVID-19 (the Pfizer–BioNTech and Moderna vaccines both used lipid nanoparticles to carry mRNA into cells[535]). The global market for nanotechnology more generally is expected to grow at a compound annual growth rate (CAGR) of 36% between 2022 and 2030, from $1.8 billion to almost $34 billion.[536]

THE OPPORTUNITY

Agriculture accounts for nearly three-quarters of global water use.[537] Associated agrifood systems yield 11 billion tonnes of food a year, employ 4 billion people and have an important role in poverty alleviation, food security and energy efficiency.[538] More than 3 billion people live in agricultural areas with high water shortages.[539]

Applied through a spray, scalable nanotechnological solutions – including nano pesticides and nanofertilisers – can be used on both crops and soil to reduce the need for water.[540] Nanoparticles are measured in billionths of a metre and can have practical applications in climate response, engineering, space, sciences and medicine.[541, 542] Given their small size, solubility and chemical composition,[543] synthetic nanoparticles (including inorganic carbon nanotubes; iron, silica, copper, gold and silver nanoparticles; and polymers and liposomes) can act as organic carriers, enhancing the efficiency of agricultural production.[544]

Nanotechnology can significantly reduce the need for water in agriculture. It can also reduce reliance on non-renewable sources of energy, manage irrigation and enhance soil quality.[545]

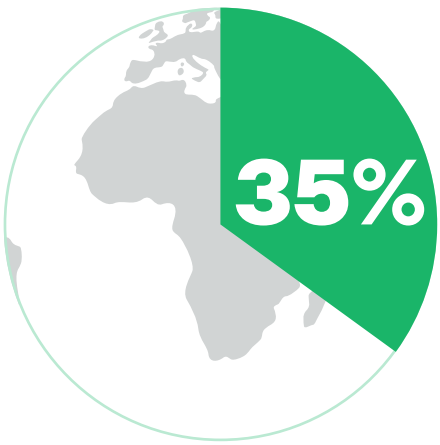
BENEFITS

Reduced need for water in agriculture. Avoidance of synthetic pesticides. Reduced waste.

RISKS

Health risks if nanotechnology (more generally) and coatings (more specifically) are not tested prior to use, particularly on food.

Over



of the world's population live in agricultural areas with **high water shortages**

SOCIETIES EMPOWERED

Empower societies by offering solutions to humanity's most complex and universal needs, optimising systems they rely on, safeguarding risks that could make societies more fragile in the face of crises and extending individual and collective potential for growth and development.

OPPORTUNITY #30

What if decentralised autonomous organisations (DAOs) became a force for positive change?

DAOs FOR SOCIAL GOOD

Advanced connectivity and digital realities enable globally minded individuals and communities around the world to collaborate and exchange knowledge, data and services and become partners in DAOs focused on specific global social issues or challenges.

MEGATREND
Borderless World— Fluid Economies

TRENDS
Advanced Connectivity
Community-based Solutions
Digital Communities
Distributed Ledger Technologies (DLT)

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Insurance & Reinsurance
Media & Entertainment
Travel & Tourism
Government Services
Professional Services

WHY IT MATTERS TODAY

There has been a rise in online communities over the past few years,[546] – a trend that accelerated during the pandemic.[547] People are finding a sense of community and discovering new ways to express their identity and their views within online groups,[548] sometimes even anonymously.[549]

Over 12 trillion hours were spent online in 2021 with close to 5 billion internet users (63% of the population) and 4.6 billion active social media users (58% of the population).[550] In 2022, Facebook had just under 3 billion users and YouTube trails behind at 2.5 billion users followed by 2 billion users on WhatsApp. [551] With greater demand for feeds that match real life and with connection central to social media use across Gen Z, Millennials, Gen X and Baby Boomer generations, a sense of community is important.[552]

Online communities are also important for business. Around three-quarters of internet users use social media to find more information on brands,[553] and community programmes that created or enhanced their use of online communities helped bring 74% more visibility to their programmes and 62% greater engagement.[554]

Online gaming is a multi-billion-dollar industry that is also based on building communities. The global market for cloud gaming was valued at $1.5 billion in 2021 and projected to grow at a compound annual growth rate of 43% by 2028, when it is expected to reach $12.6 billion.[555]

In the Middle East, Egypt was the most active country on Facebook in 2021, with 44 million users, compared to 13 million users in Saudi Arabia and 7.7 million in the United Arab Emirates.[556] On Instagram, Saudi Arabia had 15 million users, compared to 14 million in Egypt and 4.7 million in the United Arab Emirates.[557]

Both a form of organisation and a system, a DAO is an emerging approach to decentralisation that is meant to provide greater transparency, agility and efficiency.[558] Since the first known DAO formed in 2016,[559] and despite risks in cybersecurity, governance and legal liability,[560] the number of DAOs more than doubled throughout 2022; from 4,228 in early 2022[561] to 10,904 in early 2023 and close to $11 billion in total assets.[562] The largest DAO in assets ($2.6 billion) was Uniswap and the largest DAO in number of token holders (1.3 million) is Polkadot.[563] However, only 293 DAOs have one or more tokenholders, 231 DAOs have 10 or more token holders, and 167 DAOs have 1,000 or more token holders with the remainder having none.[564] PancakeSwap is the top DAO by both the number of proposals (3,900) and the number of active votes (659,300).[565]

THE OPPORTUNITY

Digital communities with international reach have the tools and access to data and information to make a concerted effort to address global challenges. With advanced computing power, organisational tasks and governance structures can be automated and run by machine intelligence, enabling the set-up of DAOs that can act as a new form of social business, going beyond profits to undertake global challenges.

With these advantages, motivated groups of like-minded individuals will be able to take and support action, drawing on their collective expertise, skills and finances. Communities will be able to use the tools offered by DAOs[566] to assess their plans and targeted outcomes, improve their effectiveness through community-led planning, and identify and engage with decision-makers and actors of influence. These communities will be able to expand their focus from legacy areas, such as the environment, to more hands-on issues such as access to education or healthcare, or even scientific research or technological innovation.

BENEFITS

New thinking and innovation from the mobilisation of pan-community action. Influence of communities on behavioural change and on raising awareness and funding. Through technology, ability of communities to deliver outcomes, not just ideas, and pioneer new forms of income generation.

RISKS

Misuse and exploitation of DAOs to intentionally or unintentionally cause harm. Global legal gaps resulting in unclear liability and accountability. Exposure of community-based systems to increased cybersecurity risks.

The number of DAOs more than **doubled** throughout 2022; from

4,228

in early 2022 to

10,904

in early 2023 and close to

$11 BILLION

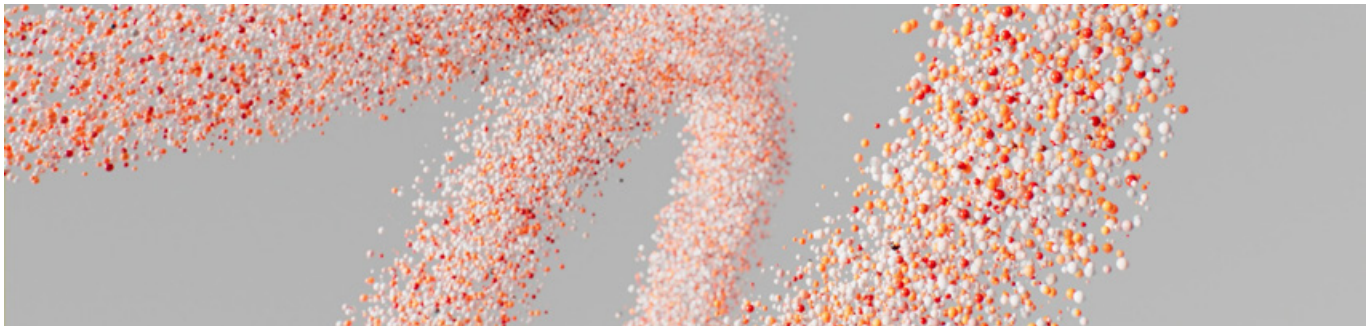
in total assets

OPPORTUNITY #31

What if the people of the world voted for action on global challenges?

WHOLE-PLANET VOTING

Global voting systems enable whole-planet decision-making around global challenges, building a sense of solidarity and empowerment among people living around the world.



MEGATREND
Future Humanity

TRENDS
Advanced Connectivity
Artificial Intelligence
Community-based Solutions
Digital Communities

SECTORS AFFECTED
Agriculture & Food
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Immersive Technologies
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

From poverty, water scarcity and health epidemics, to climate change and food shortages, there are many social challenges that directly and indirectly affect communities around the world and across borders.

COVID-19 has erased much of the progress made towards achieving the Sustainable Development Goals (SDGs). For example, four years of progress on alleviating poverty was erased as 93 million people were forced into extreme poverty in 2020.[567] Rising inequality, climate change and the impacts of COVID-19 also led to the worsening of food security, with 1 in 10 people found to be suffering from hunger in the same year. Additionally, about 22.7 million children missed basic vaccines and 147 million children missed more than half of their in-person classes and instruction.[568]

While some countries are more vulnerable to the adverse impacts of climate change than others,[569] climate change affects us all. Context-specific, the impact of climate change depends on the extent to which countries already face water shortages, shifts in biome distribution, loss of coral reefs, reduced crop production and livestock and higher rates of disease, malnutrition and migration.[570] It is estimated that by 2030, climate change will have driven up to 135 million people into poverty[571] particularly in sub-Saharan Africa and South Asia – the regions where poorer populations are concentrated.[572]

Access to water is a global issue as well as only 3% of all the water on earth is freshwater and, with growing populations, the need for freshwater has continued to increase and only 1% is accessible.[573] Some two billion people around the world do not have access to adequate water supplies and as much as two-thirds of the world's population experience water scarcity at least one month of the year.[574] Enhancing access to water for drinking and agriculture will require significant investments in infrastructure and technology even in countries with adequate water supplies.[575] For example, desalination, the process of removing salt and other particles from seawater, is an option used for increasing supplies of freshwater. New technologies – such as nano-membranes, which desalinate water more quickly – could further improve capacity and tap into new sources of freshwater.[576]

THE OPPORTUNITY

The share of individuals using the internet increased – from 54% in 2019 to 63.5% in 2021.[577] The number of social media users grew from 4.2 billion in January 2021 to 4.6 billion in January 2022, with a 10% year-on-year growth.[578] In a connected world, choices made about key global challenges in one region can have profound effects on other regions. Technology could enable real-time access to AI-powered analysis and modelling, allowing people to understand how their choices will affect others.

Votes could be held on global challenges requiring a response or strategy that went beyond the capacity or power of any one nation or region. Voters could be presented with a full view of the impacts of their choices for their country, for the world and for their personal circumstances. Depending on the topic, the options would not necessarily be binary and could consist of sets of possible responses. The results could guide national and regional action plans and investment.

A system of voting on global challenges could build a sense of solidarity and empowerment among people living around the world. It could reduce the influence of party politics and vested interest groups, as everyone would have equal access to unbiased information and clearly explained implications.

BENEFITS

Greater global collaboration and solidarity around global challenges. Reducing duplicated efforts and enabling more effective funding. Smaller countries have a stronger voice as they feel empowered from being part of a bigger group of countries.

RISKS

Greater influence for countries with larger populations if the system used the ‘one person, one vote’ principle. Social or geopolitical tensions stemming from close-run votes. Low voter turnout. Misuse of the voting platform to shift public opinion.

4 YEARS

of **progress on alleviating poverty** was erased as

93 MILLION PEOPLE

were forced into extreme poverty in 2020 due to COVID-19

OPPORTUNITY #32

What if paid social national service was standard?

SERVICE AS A STANDARD

Paid social national service is legally available for everyone, resulting in changed views of working life, community, social and environmental engagement, allowing people to contribute to their community and society before embarking on a new career or transition to the next phase of their life.

MEGATREND
Future Humanity

TRENDS
Community Enagagement & Volunteerism
Future of Purpose & Work
Longevity & Well-being

SECTORS AFFECTED
Education
Health & Healthcare
Travel & Tourism

WHY IT MATTERS TODAY

Volunteerism is a way of expressing a sense of social responsibility. The benefits of volunteering have been shown to be extensive and studies have shown that individuals experience improved mental and social health and well-being, and a sense of satisfaction.[579, 580] Volunteering can also counteract caregiver stress[581] and be central to community identity.[582] Corporate volunteers may experience better working relationships.[583]

The International Labour Organization defines volunteer work as 'any unpaid, non-compulsory activity to produce goods or provide services for others'.[584] It has been estimated based on surveys conducted in 2019–21 that globally almost 15% of the population aged 15 or over (862 million people) engage in volunteer activity each month. However, there are significant differences between the regions: while Asia and Africa are above the global average (17%), the Arab states are below it (9%). Most volunteer work is done informally.[585]

Motivations for volunteering differ, however. While studies have looked at demographic factors behind increased volunteering, more research is needed into other factors.[586] In older adults, the better the individual's physical health and psychosocial well-being, the more likely they are to volunteer.[587] Motivations for environmental volunteering similarly differ ranging from the desire to gain new skills and knowledge to a wish to improve the environment and forming connections around a common purpose.[588]

Some countries already offer a form of social service. For example, in Sweden, the Right to Leave to Conduct a Business Operation Act offers full-time employees at least six months of unpaid sabbatical leave to start their own business. Additionally, they can take time off to study or care for a family member.[589]

France has a scheme that falls somewhere between mandatory and voluntary. The government announced in 2019 that, at age 16, everyone must commit a month to learning service skills, such as first aid, and applying them in real-world settings. After this, teenagers are encouraged to volunteer for three months to a year in an area such as tutoring or aiding environmental causes.[590]

THE OPPORTUNITY

Programmes aligning personality types and skills to different areas of social service could give people a greater sense of purpose and contribute to a feeling of community spirit and solidarity. As lifespans lengthen and skills and work environments evolve, people can increasingly benefit from paid sabbaticals or obligatory periods of paid social national service. Such initiatives could allow people to step back and think – while contributing to their community and society – before embarking on a new career or the next phase of their life.

There is an abundance of social challenges to resolve around the world, from poverty and climate change to poor mental health and how best to care for the sick. Planned, systematic absences of a year or more could offer a means to smooth labour market fluctuations or to offset structural labour market changes. Those who are unemployed could find a productive way to generate some short-term income while also exploring new avenues for potential employment and stable income generation.

Linking social duty to paid schemes could make the experience more meaningful for individuals without a personal plan and those who are facing unemployment, as volunteering has been found to buffer the negative mental effects of unemployment, the pressures of family care and long-term illness.[591]

BENEFITS

Greater self-optimisation and fulfilment for individuals, contributing to improved well-being. Opportunities for individuals to grow their skills in a new area. Greater cognitive diversity within the workplace when employees return having gained new experience. Opportunities for the unemployed to explore new work possibilities, providing hope for a better future.

RISKS

Low uptake from the public or private sector or among employees or unemployed people. Poor-quality social service opportunities, meaning that they do not provide meaningful experiences or impact. Compassion fatigue among participants.


ARAB STATES are below the global average **9%**
ASIA AND AFRICA are above the global average **17%**
15%
Globally almost of the population engage in volunteer activity

OPPORTUNITY #33

What if social policies were designed and monitored at a community level and in real time?

A POLICY'S TRUE MEASURE

Advanced machine intelligence helps policy-makers design and implement effective social programmes and policies at a community level that are adjusted in real time, taking into account people's diverse characteristics and backgrounds while protecting the privacy of all.

MEGATREND
Future Humanity

TRENDS
Community-based Solutions

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Infrastructure & Construction
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

While measures of economic growth and stability are best managed by national governments, many elements of well-being and prosperity are rooted in communities and local areas. [592]

Some locations around the world are already measuring well-being at a community level including some cities in the United States and Canada.[593] The UK Research and Innovation funds partnerships with local agencies and communities that aim to explore novel policy approaches which can provide sustainable, inclusive growth in a way that is tailored to a local community.[594]

In 2019, Pew Research Center found that a median of 69% of people surveyed across 27 countries said that their country had become more diverse in the past two decades.[595] Yet, between potential labour gains and capital investments, racial and ethnic inequalities have cost the US economy some $51 trillion in lost productivity since 1990.[596]

The gender gap has been closed by 68.1% globally (63.4% in the Middle East and North Africa (MENA)), but women will have to wait several more generations to reach gender parity, estimated to be 132 years.[597] Despite progress, the MENA region loses $575 billion each year from legal and social barriers, such as gender stereotypes, lack of flexible working policies, access to financial services, discrimination and harassment laws that prevent women from accessing jobs.[598]

The largest minority group globally is people living with a disability, who together number 1.3 billion (17% of the global population).[599] Besides the moral duty for disability inclusion, the cost of exclusion of people with disabilities represents up to 7% of GDP in some countries.[600]

THE OPPORTUNITY

The theory of intersectionality has been conceptualised and applied in research relating to mental health,[601] social work,[602] education and health.[603] Its application in machine learning could allow advanced machine intelligence to help design effective social policies at a community level as an approach to improving prosperity and well-being.[604] Taking into account diverse – both in character and cultures – communities,[605] enhances analysts' understanding of communities and offers deeper explanations for the factors that influence change and people's sense of well-being.

Through the use of monitoring in real time at a community level, advanced machine intelligence could be used to identify potential areas of improvement. This would enable local communities to compare solutions and share experiences with each other. They could also test their plans in advanced simulations that reflected the structure, size, needs and culture of their locality while ensuring that individuals were equally experiencing improvements in prosperity and well-being.

At the national level, governments set benchmarks and limits for communities and allocate budgets for planned policies. Community monitoring could allow for real-time progress reports to be generated and for inefficiencies and potential risks to be flagged so that they can be corrected or mitigated through the design of bespoke programmes and initiatives. The integration of local concerns and needs directly into the policy-making process could enhance feelings of empowerment and engagement among citizens.

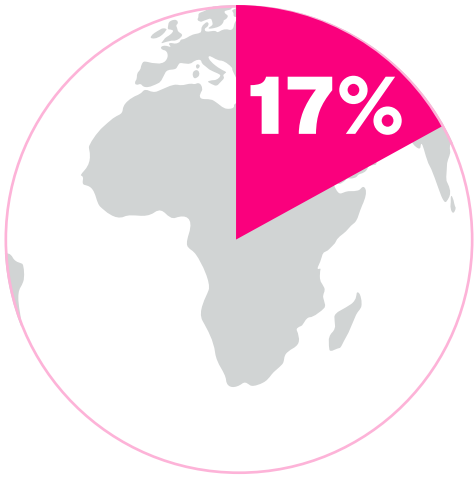
BENEFITS

Avoids the problems of 'one-size-fits-all' policymaking at one end and complex individual-level policies at the other. More effective and efficient use of funds through the use of real-time monitoring and progress reports.

RISKS

Inaccuracies in aligning community and individual-level indicators. Increased tensions if a community's level of prosperity and well-being does not match that of some of its individuals, particularly in diverse communities.

The **largest minority group** globally is people living with a **disability**



OPPORTUNITY #34

What if hybrid intelligence reduced groupthink?

CALLING OUT HERD MENTALITY

Advanced machine intelligence and new conceptual models of social psychology inform decision-making, reducing the impact of groupthink.

MEGATREND
Future Humanity

TRENDS
Artificial Intelligence
HumanXMachine

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Insurance & Reinsurance
Media & Entertainment
Real Estate
Travel & Tourism

WHY IT MATTERS TODAY

Groupthink arises when members of a cohesive group do not consider alternative perspectives because they are motivated to reach a consensus. It often leads to suboptimal or undesirable decision-making.[606] The causes of groupthink are varied and include lack of cognitive diversity, lack of impartial leadership and stress along with time constraints and lack of outside perspectives. The negative impacts of groupthink include poor decision-making, self-censorship, inefficient problem-solving, unawareness of negative outcomes and an inability to see other solutions.[607] It can also be a barrier to innovation and fresh thinking.

AI is already transforming decision-making in finance, healthcare, criminal justice and transportation.[608] In finance, for instance, Artificial Intelligence (AI) is being used to optimise processes such as credit decisions, quantitative trading and risk management models.[609] There has been a swift rise in AI's efficiency and accuracy over recent years. Credit card fraud increased by 44% in 2019–20; however, automation with AI allows credit card companies to make billions of credit and fraud risk decisions in real time, protecting customers and preventing fraud.[610]

While the negative consequences of groupthink are not often this dramatic, some of the most famous failures partially attributed to groupthink include the financial downfall of Swissair,[611] the collapse of Lehman Brothers,[612] the *Challenger* disaster[613] and the Enron scandal, all of which began at corporate board level.

THE OPPORTUNITY

Embedding psychosocial theories of groupthink into AI could enable observation of how and what decisions are made. Integrating various inputs, such as brain-computer interfaces (BCI) and Internet-of-Things (IoT)-enabled wearables, meeting rooms and Natural Language Processing (NLP) and other measures, could allow advanced machine intelligence to highlight the risks of groupthink and evaluate interventions that mitigate it.

A blend of human and machine intelligence could bring the diversity of analysis and perspectives needed to combat groupthink, particularly when there is a need to distinguish between groupthink and other in-group dynamics.[614]

BENEFITS

Improved decision-making that factors in a greater diversity of thinking and perspectives.

RISKS

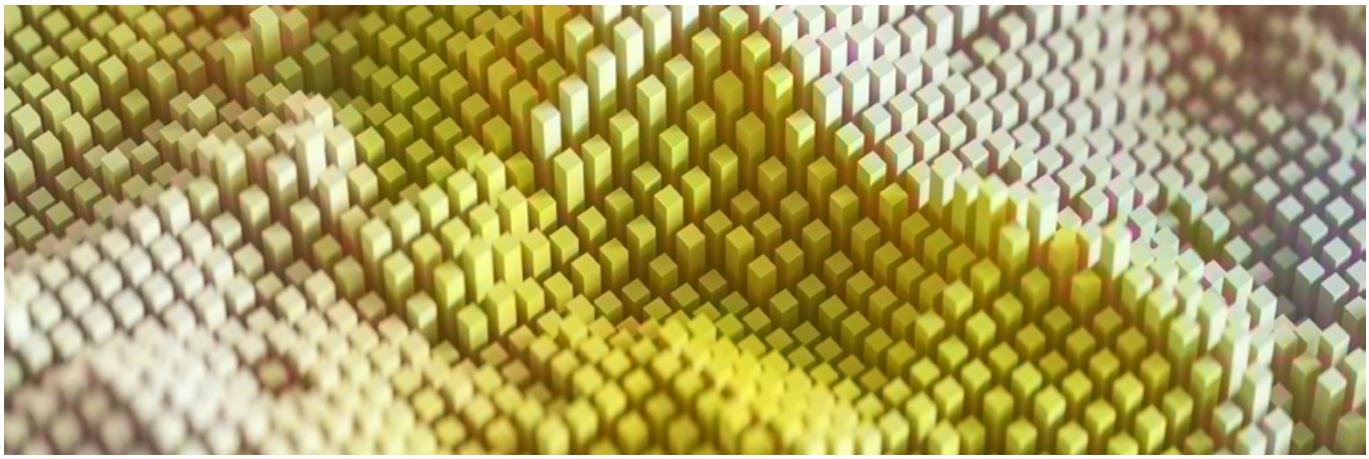
Dilution of optimal choices due to in-group dynamics mistaken for groupthink.

OPPORTUNITY #35

What if we had a convention of rights for digital realities?

A DIGITAL REALITIES CONVENTION OF RIGHTS

An international convention of digital human rights for life in a virtual world providing levels of protection for people as they live, work and socialise in digital realities.



MEGATREND
Digital Realities

TRENDS
International Collaboration

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Immersive Technologies
Media & Entertainment

WHY IT MATTERS TODAY

The number of people online continues to grow. Today, two-thirds of the global population – just over 5 billion people – have access to the internet[615] and there were 4.6 billion social media users worldwide in 2021[616] compared to 3.5 billion in 2019.[617]

Video games are witnessing similar growth, with global revenues rising 32% between 2019 and 2021. Revenues are expected to rise at a compound annual growth rate (CAGR) of 8.4% through 2026, creating a $321 billion industry.[618]

In terms of geographies, China and the United States accounted for around half of the global gaming and esports revenues in 2021. However, Turkey – followed by Pakistan (21.9% CAGR) and India (18.3% CAGR) – is likely to be the fastest-growing video games market between 2021 and 2026 with a 24% CAGR.[619]

In addition, augmented reality (AR) and virtual reality (AR) are both paving the way towards digital realities. The AR and VR market was valued at $15 billion in 2020 and is projected to reach $454 billion by 2030 with a CAGR of 40.7%.[620] VR and AR have the potential to add $4 billion to the United Arab Emirates' economy by 2030.[621]

It is no surprise that increasing engagement online and advancing AR and VR technologies are leading to increasing cybersecurity risks.[622] With hazards ranging from privacy and data breaches to ransomware, around one in three people fell victim to cybercrime in 2021, and many more will have encountered content that is legal but potentially harmful or unreliable.[623] Data breaches will cost over $5 trillion annually by 2024.[624]

While the Council of Europe and the United Nations respectively published a 'Guide to Human Rights for Internet Users'[625] and a 'Charter of Human Rights and Principles for the Internet'[626] in 2014, these documents have not evolved to include the risks that individuals will face in more immersive digital realities, which will be made more complex through advanced machine intelligence. Moreover, while the Council of Europe's guide is binding for all 47 of the council's members, the United Nations' charter is not legally binding.

THE OPPORTUNITY

Life online brings new possibilities and challenges. Most of modern individuals' financial, work and social activities are already dependent on digital platforms and the rules and regulations that govern them. But, to date, beyond the protection of data, many of those rules have simply been carried over from the physical world and have not been adapted to new forms of community, behaviours or social and economic norms. A convention of human digital rights could be designed for future digital realities.

An internationally agreed convention of human digital rights could specify what is acceptable behaviour and provide levels of protection for people as they live, work and socialise in digital realities. It could preserve people's right to determine and protect their own digital identity and dignity and could also offer a base that different platforms and communities could use to develop frameworks to protect people's rights in virtual worlds. Digital reality spaces and communities adhering to the convention would be more transparent, trusted and attractive, and would be able to grow their user populations and give them a commercial advantage.

BENEFITS

Greater protection and a common international basis for evaluating digital spaces.

RISKS

Inflexibility of the convention, making it a source of division among communities and digital realities. Slow evolution of legal systems, meaning they fall out of sync with the convention, making enforcement challenging.

Just over

5 BILLION PEOPLE

have access to the internet

Data breaches will cost over

$5 TRILLION

annually by 2024

OPPORTUNITY #36

What if we secured our digital identities using quantum encryption?

QUANTUM AVATAR

Quantum encryption protects the integrity of avatars in digital realities, creating an environment of trust that uplifts creativity, commerce and security.

MEGATREND
Technological Vulnerabilities

TRENDS
Cybersecurity
Digital Art & Design
Metaverse
Virtual Reality

SECTORS AFFECTED
Cyber & Information Security
Data Science, AI & Machine Learning
Immersive Technologies

WHY IT MATTERS TODAY

As the digital reality universe grows, so does the use of avatars to navigate them. Every interaction an avatar has in a virtual environment leaves a trail of data points. Estimates suggest that a 20-minute virtual reality session with a headset can generate up to 2 million data points about an individual's body language, which can reveal both mental and physical health conditions.[627] Linking such data to financial, communication and contact data gathered in digital realities mean avatars could become prime targets for cyberattacks. The more active avatars are, the more they are at risk of data fraud and misrepresentation and even full avatar identity theft (known as cybersquatting).[628]

Today, avatars are second nature in gaming, which today boasts nearly 3 billion players worldwide.[629] Video games revenues rose 32% between 2019 and 2021 and are estimated to rise at a compound annual growth rate (CAGR) of just over 8% through to 2026, creating a $321 billion industry.[630]

In addition, avatars are core to augmented reality (AR) and virtual reality (VR). The AR and VR market was valued at $15 billion in 2020 and is projected to reach $454 billion by 2030 with a CAGR of 40.7%.[631] AR and VR have the potential to add $4 billion to the United Arab Emirates' economy by 2030.[632]

There are nearly

3 BILLION

gamers worldwide

THE OPPORTUNITY

An avatar is a virtual self-representation.[633] Protecting it from harm and from harming others will be key in the future, particularly in digital realities, where the lack of the possibility of physical harm may reduce people's perceptions of the importance of harms suffered and caused. Additionally, in such spaces, avatars can themselves be separate legal personalities who can be controlled by Artificial Intelligence (AI) as opposed to a human.[634]

Quantum encryption could allow people to protect their avatars (i.e. their identity and data) from malicious attacks and accidental breaches. Ensuring complete avatar security would create a high-trust environment that enabled the growth and success of new social and business models in digital reality spaces. Agreements, purchases and expressions of opinion or creativity could each be verified, reducing costs and the risk of misrepresentation or falsification.

Together with a legal review – and possibly new laws and regulations relating to avatars covering fraud, identity theft, defamation and other crimes – quantum-secured avatars could provide greater confidence to individuals and society in digital realities.[635]

BENEFITS

Safer, lower-cost transactions and improved social interactions, contributing to the growth and stability of digital realities.

RISKS

Unnoticed quantum encryption breaches, enabling avatar doubles to infiltrate sensitive situations for criminal or espionage purposes. Slow evolution of legal systems, meaning they fall out of sync with the quantum approach to encryption, making enforcement challenging.

Estimates suggest that
a **20-minute virtual reality session**
with a headset can generate up to

2 MILLION

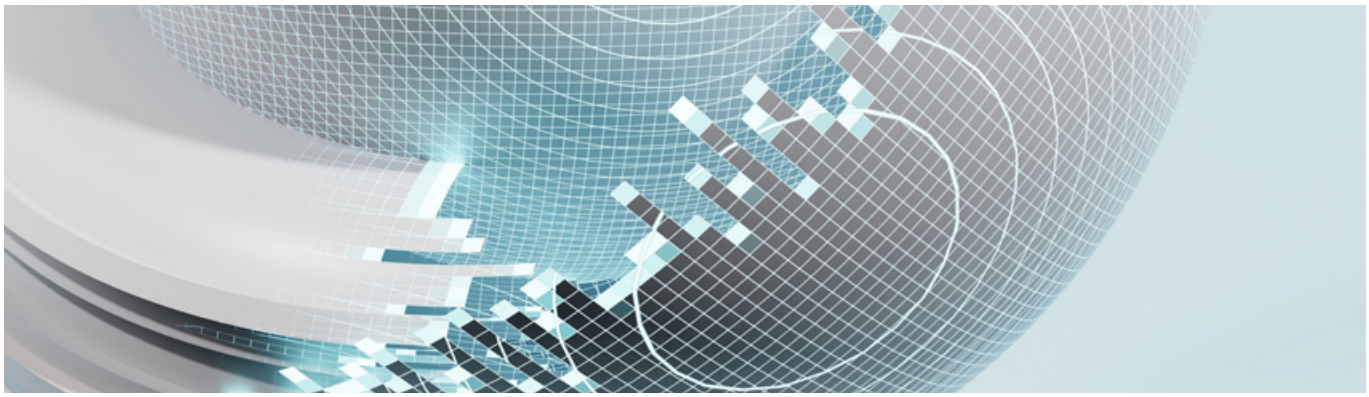
data points about an individual's body language

OPPORTUNITY #37

What if we designed a liveability index for digital realities?

ONLINE KERB APPEAL

As more businesses, sources of entertainment and social interactions move to immersive, virtual environments, establishing a comparable measure for liveability in digital realities quantifies the challenges faced by individuals and their avatars.



MEGATREND
Digital Realities

TRENDS
Immersive Technologies & Wearables
Virtual Reality

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Immersive Technologies
Insurance & Reinsurance
Media & Entertainment

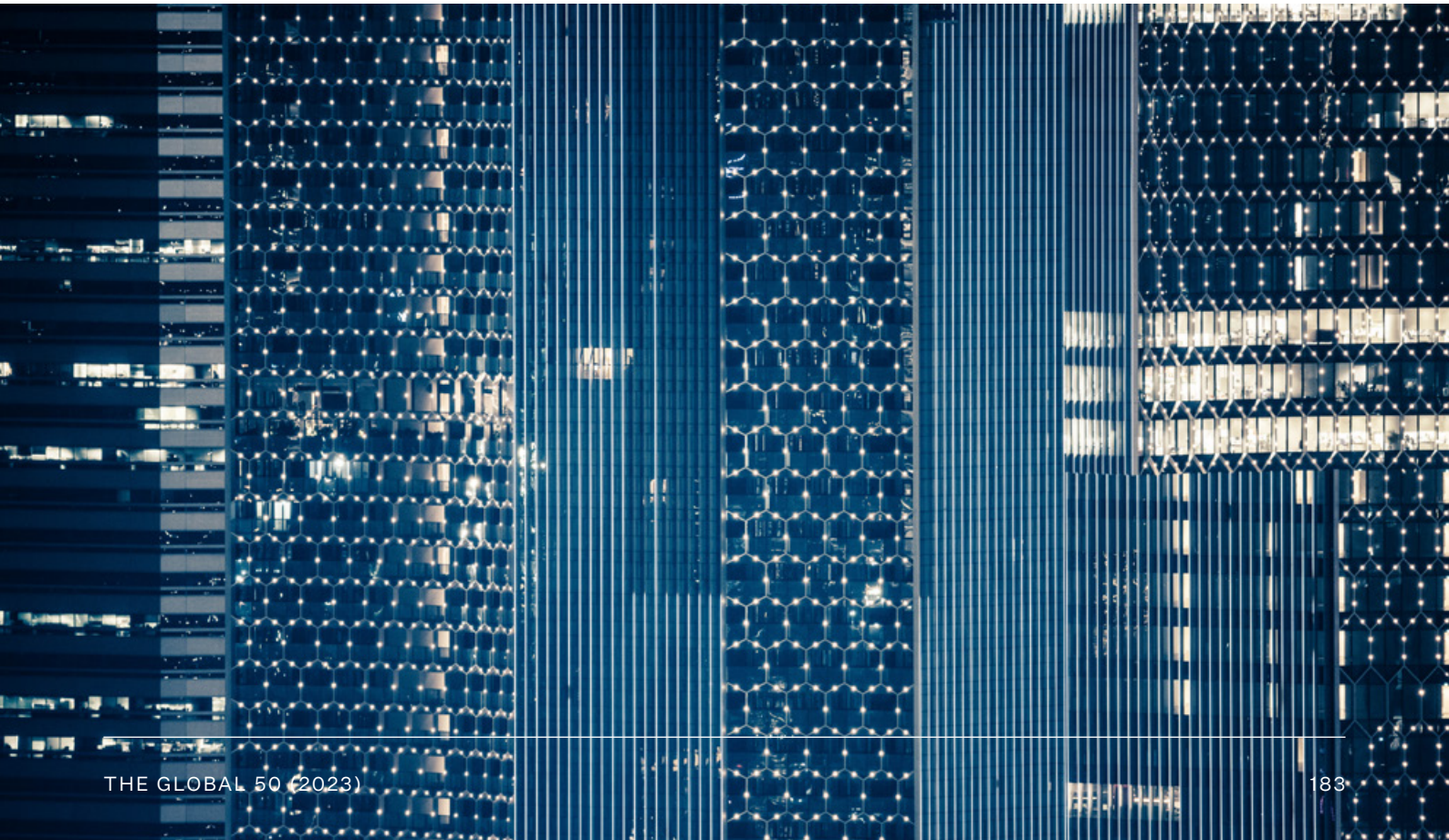
WHY IT MATTERS TODAY

There are at least 128 social media sites in the world today.[636] Almost 60% (4.7 billion) of the global population used social media and, as of October 2022, Facebook had 2.9 billion, YouTube 2.5 billion and Instagram 1.3 billion users registered.[637]

While the boundaries of the metaverse continue to be explored, it combines – among other aspects – augmented reality (AR) and virtual reality (VR) platforms,[638] blockchain, cryptocurrencies, advertising and gaming.[639] The global metaverse market was valued at just under $23 billion in 2021[640] and could reach $5 trillion by 2030.[641]

With the global mobile games market picking up pace, there were 4.6 billion downloads from the App Store and Google Play in June 2022 – an increase of 2.2% since June 2021.[642] As of May 2022, the traditional gaming platforms, such as PlayStation and Nintendo Switch, hosted a total of 93,880 video games.[643] Adding in the mobile app stores, including the App Store and Google Play, there were 831,523 games globally.[644]

Led by Saudi Arabia and the United Arab Emirates, the Middle East and North African gaming market is projected to increase by 19% in the period 2019 to 2025 to more than $5 billion.[645]



THE OPPORTUNITY

While complex, developing a digital reality liveability index could enable platform operators and policy-makers to build and improve services and functions that contribute to the success of digital realities and enable more prosperity and well-being. The index could help companies to better target their investments and services to attract new customers and retain existing ones. It could also help individuals to choose where to spend their time, decide where to move their assets or understand how to find digital realities offering them better potential to develop a business idea or income stream. A liveability index ranking would make the differences between digital realities more transparent, contributing to trust and driving innovation and improvement.

As the digital economy, and associated digital goods and services, grows with revenue streams linked to virtual platforms, it is important to be able to measure, track and compare where and how value is being created and the associated well-being and economic health of communities inhabiting virtual spaces.

BENEFITS

Improved trust and safety for both companies and individuals operating and living in digital realities, thanks to an increase in the availability of information. Reduced attractiveness of poorly governed and unsafe digital realities among investors.

RISKS

Possibility of platforms gaming the system (as is the case for all rankings). Disproportionate investment in higher-ranked platforms at the cost of smaller, nascent ones. Lack of clear boundaries around what a digital reality is, resulting in confusion and loss of credibility for the index.

The **global metaverse market** could reach

$5 TRILLION

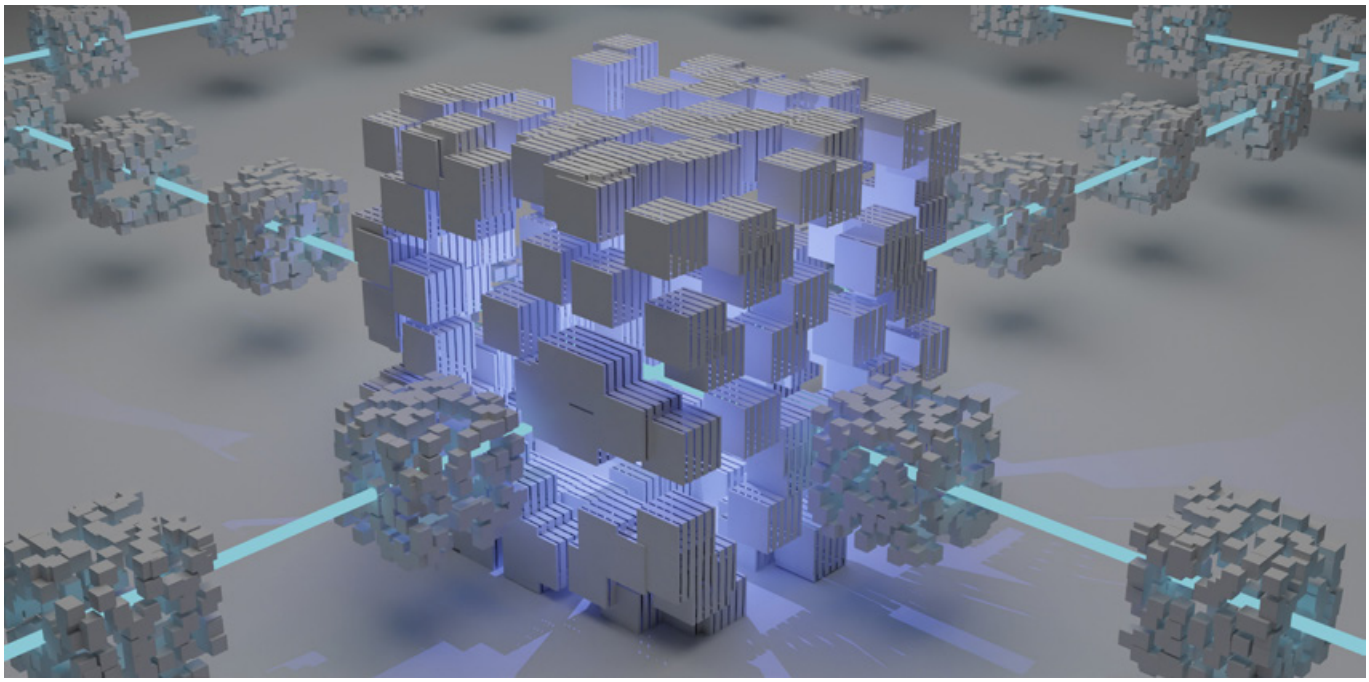
by 2030

OPPORTUNITY #38

What if we tokenised our most sensitive data?

NOT A TOKEN GESTURE

Individuals tokenise sensitive personal data to protect its integrity and retain control over who has access – with a possible commercial upside.



MEGATREND
Technological Vulnerabilities

TRENDS
Artificial Intelligence
Data Protection & Privacy
Tokenisation

SECTORS AFFECTED
Materials & Biotechnology
Communication Technologies & Systems
Cyber & Information Security
Data Science, AI & Machine Learning
Insurance & Reinsurance

WHY IT MATTERS TODAY

With annual increases of 15% between 2022 and 2025, the costs associated with cybercrime are expected to reach $10.5 trillion worldwide by 2025 – a 300% increase from 2015 levels. [646] By 2030, it is estimated that the economic benefits associated with a secure digital identity will range between 3% and 13% of GDP.[647]

While 137 out of 194 countries globally (almost 71%) have put in place legislation to protect privacy and personal data, the levels of adoption in Africa and Asia dip to 61% and 57%, respectively.[648] At the same time, the average cost of a data breach in 2022 was $4.35 million and, having gone up 42% since 2020, a data breach in healthcare had an average cost of $10 million.[649] Stolen or compromised credentials were the most common data breach and, at 327 days, the longest to identify. [650] Almost half of these breaches occurred in the cloud, and organisations with a hybrid cloud model had lower average data breach costs ($3.80 million) compared to organisations with a public ($5 million) or private ($4.2 million) cloud model.[651]

Besides the economic cost, cybercrime affects people too. A survey found that, out of those who had been victims of fraud, 70% felt anxious, stressed, displeased or frustrated when they were warned about potential fraud.[652] It has been estimated that the cost to a fraud victim's well-being can be valued at around $3,000 or higher, compared to a financial cost of around $700.[653]

The potential target market size when it comes to data protection is up to $100 billion and only 30% to 35% of that market is currently served.[654]

71%

of countries globally have put in place legislation to protect privacy and personal data

THE OPPORTUNITY

Tokenisation transforms financial markets[655] and offers individuals the possibility of sharing their sensitive data by converting the data into charitable value – for the greater good – or monetary benefit, if sought.

In this way, the data can be put to use and its original sensitive elements which make the data traceable to an individual or family, for example that used in training predictive models for novel cancer treatments – are stored outside the database. Tokenisation offers advantages over encryption as tokenised data cannot be decoded and tokenisation is irreversible. When individuals are confident that sensitive data cannot be traced back to them or accidentally revealed, they will be more willing to share and, in doing so, contribute to medical and scientific innovation and enhance community-based policymaking .

BENEFITS

More transparent data-sharing systems will engender more trust, particularly in the sharing of personally sensitive areas such as health and education. More distributed gains across business and society by delivering greater value to individuals that are generating and sharing data.

RISKS

Sophisticated mass breach of tokens. Dependency on network stability and associated technologies. Widening economic gaps brought about by margins in the value of personal tokens.

The costs associated with **cybercrime** are expected to reach

$10.5 TRILLION

worldwide by 2025 – a

300%

increase from 2015 levels

OPPORTUNITY #39

What if this is the end of secondary education as we know it?

SECONDARY NO MORE

Dissolve grade levels and equip youth in secondary education with the confidence, resilience and strong mental health to explore potential futures and make informed decisions through entirely personalised, adaptive and cognitively diverse environments.

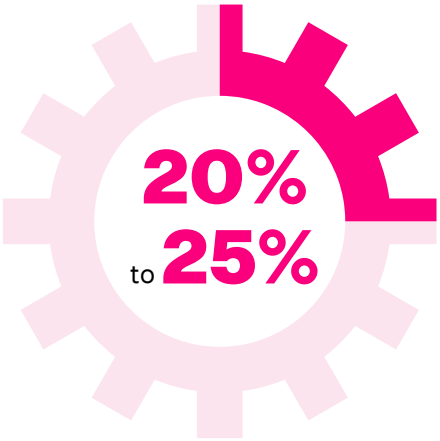
MEGATREND
Future Humanity

TRENDS
Future of Purpose & Work
HumanXMachine
Mental Health
NeuroscienceTransforming Education

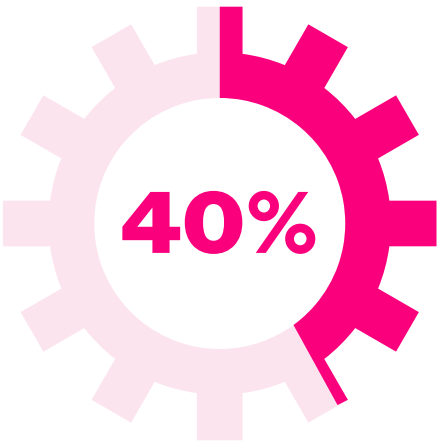
SECTORS AFFECTED
Communication Technologies & Systems
Data Science, AI & Machine Learning
Education
Health & Healthcare
Immersive Technologies

WHY IT MATTERS TODAY

By 2030, automation will put around



of jobs **at risk** in Asian and Nordic countries and around



in some Eastern European countries.

Adolescence is a unique time in people's lives. Particularly during this phase of intense emotional, physical and social change and challenges, mental health issues can reduce adolescents' well-being, with the effects potentially lasting a lifetime.[656] These issues can be hard to overcome and can put individuals' future prosperity and well-being at risk, so protecting adolescents and safeguarding their mental health is important. In figures that are likely to be underreported, one in seven adolescents (aged 10 to 19 years) could be experiencing mental health issues.[657] Nearly 5% of individuals aged between 15 and 19 have an anxiety disorder that affects them on a daily basis, and many of them deal with their disorder through risk-taking behaviours, which may lead to addiction or suicide.[658]

While access to education has improved globally since 2000, it still presents challenges. Half of the 244 million children who are out of school are aged between 15 and 17, with sub-Saharan Africa having the highest out-of-school rates (48%).[659]

Even when there is access to education, the question of improving educational outcomes and catering to different abilities and learning preferences has always been of focus.[660] Enabled by technology as per teachers' needs[661] and sought learning outcomes,[662] personalised learning provides students with foundational knowledge, opportunities for real-world application, improved capabilities and clarity for plans and skills for the future.[663]

AI, robotics and automation are expected to contribute up to $15 trillion to global GDP by 2030, but it is also anticipated that automation will put around 20% to 25% of jobs at risk in Asian and Nordic countries and around 40% in some Eastern European countries.[664]

In the Middle East and North Africa (MENA), unemployment is a particular concern for young people aged 18 to 24.[665] In 2021, there was 14% unemployment in the MENA region not including the countries of the Gulf Cooperation Council (GCC). Waged and salaried workers made up 66% of the workforce while 34% were self-employed. Including the GCC, the MENA region witnessed a 5% unemployment rate in 2021. Waged and salaried workers made up 95% of the workforce and 5% were self-employed.[666]

THE OPPORTUNITY

With primary school education focused on the basics of reading, writing, mathematics, communications and the critical thinking skills needed to acquire knowledge, secondary school becomes entirely personalised. Focused on the application of acquired cognitive skills, access to deeper knowledge and analysis, and on the discovery and development of talent and interests within a structured and healthy environment focused on positive social–emotional health, secondary schooling is adaptive in breadth, depth and speed to the aspirations and potential in young people.

Authoritative, supportive and structured school environments would deliver better educational outcomes, particularly in terms of adolescents' well-being and their social and emotional health. Student—student and student–teacher relationships would be built on respect, supporting and preparing students both academically and in terms of emotional resilience.[667]

Thanks to advances in both psychological and neurological sciences and their application, grade levels are abolished and intellectual diversity could become a priority, improving individual engagement, collective cooperation and better knowledge capture, learning, concentration and recall.[668]

No longer labelled as 'just students', post-14s would make informed decisions and explore potential future careers. Through ongoing opportunities for practical experience and learning, they would be empowered to prepare for adulthood in the most effective way, paving a path towards their prosperity and well-being in the future.

BENEFITS

Well-adjusted adolescents with better life outcomes in terms of employment, income, social skills and mental health.

RISKS

Inability of schools and teachers to support adolescents and structure school life and assessments in line with the re-engineered pedagogy. New challenges for higher educational institutions responding to new ways of assessment and student preparation for higher education.

TRANSFORMATIONAL

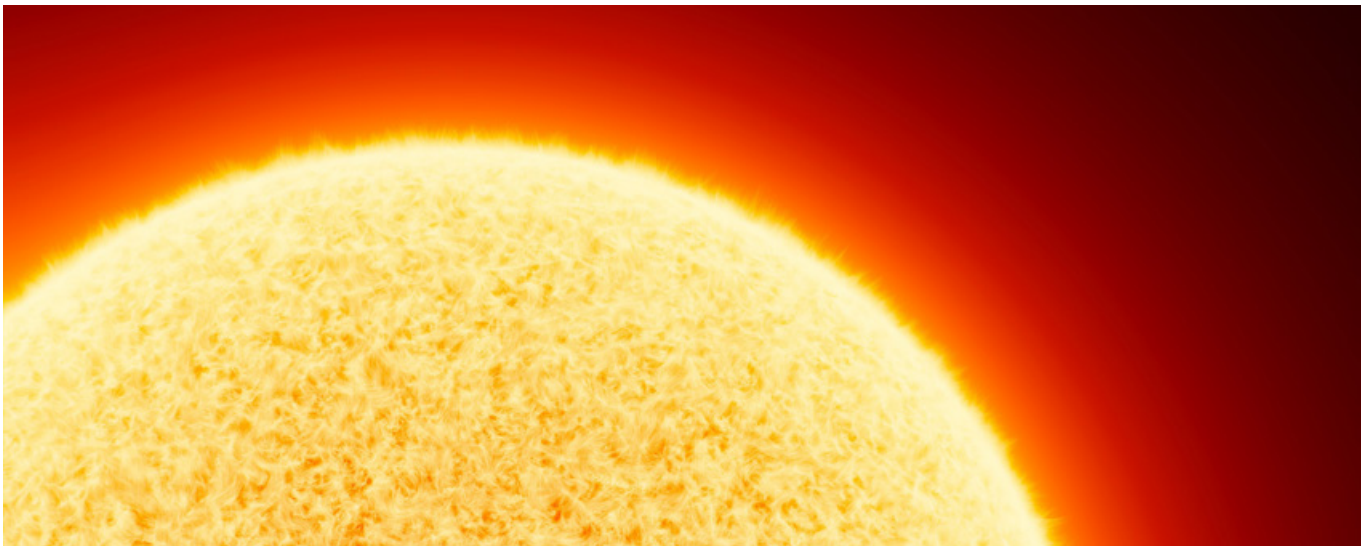
The power to radically change ways of life by replacing the models that countries, communities and individuals live by. These new models enable individuals and communities to innovate and improve and aid the transformation of humanity to new digital and non-digital realities.

OPPORTUNITY #40

What if solar farms were moved to space?

INFINITE 'SOLAR' ENERGY

Floating solar panel farms are installed in space and are operated by advanced machine intelligence to ensure optimal positioning, allowing unlimited renewable energy to be generated and transmitted to earth.



MEGATREND
Energy Boundaries

TRENDS
Future of Space
Transforming Energy

SECTORS AFFECTED
Materials & Biotechnology
Automotive, Aerospace & Aviation
Communication Technologies & Systems
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Utilities

WHY IT MATTERS TODAY

Every hour, more solar energy reaches earth than the total annual energy used by global populations,[669] around 160,000 TWh of energy.[670] Yet, about 770 million people live without access to electricity, most of them residing in Africa or Asia.[671] The world's population is expected to reach 9.7 billion by 2050, and energy consumption is anticipated to increase by at least 50% over the same period.[672]

In 1975 solar panels started out at the price of $105 (2015 price equivalent) per Watt, but by 2013 they had fallen to less than a dollar.[673] China's heavy investment in solar photovoltaics was one of the key drivers of this reduction, and by the end of 2021 China's share across all manufacturing stages for solar panels exceeded 80%[674] and the value of China's solar photovoltaic related exports was over $30 billion.[675]

Of more benefit, solar energy is also cost-effective as consumers in the United States, for example, can save up to 50% of electricity costs in some countries compared to the traditional grid.[676] Solar energy also enables the transition to renewable energy thereby reducing carbon dioxide emissions from the energy sector. In 2021, carbon dioxide emissions from energy combustion and industrial processes were responsible for 89% of the energy sector's greenhouse gas emissions worldwide. Energy-related carbon dioxide emissions grew by 6% in 2021.[677] In Egypt, three-quarters of carbon dioxide emissions are derived from the energy sector, with power plants accounting for 45% of these emissions.[678]

About

770 MILLION PEOPLE

live **without access to electricity**,
most of them residing in Africa or Asia

THE OPPORTUNITY

Far greater quantities of solar energy can be generated and transmitted from space than on earth, and with no downtime,[679] space-based solar panels have the capacity to generate 40 times more energy than solar panels on earth.[680] Emissions-free, solar space farms could accelerate efforts to reduce the production of greenhouse gases and become the cleanest alternative to increasing energy needs.

Many countries are looking to tap into the potential of space-based power stations. For example, the UK government is considering an investment of nearly $20 billion[q] to build a solar power station in space.[681] In Europe, installing a continent-wide space-based solar power programme could bring in benefits worth over $190 billion.[r,682]

With reusable space rockets, the cost of launching solar panels into space could continue to decrease,[683] and as scientists continue to uncover ways that solar energy can be stored for long periods,[684] the capture and storage of solar energy could be optimised through materials science, robotics and advanced machine intelligence.

Energy could be beamed to earth via technologies such as microwave laser satellites or laser solar satellites,[685] and uninterrupted flows of solar energy could fulfil the increasing industrial and domestic demand around the world, supporting economic growth and development and facilitating access to new technology and systems that improve health, education and well-being.

BENEFITS

Constant flow of clean energy beamed around the world. Ability to meet energy demands and provide off-grid access in remote areas.

RISKS

Difficulty of managing extra-terrestrial energy facilities and protecting them from accidental (e.g. from asteroids or space debris) or deliberate damage causing power outages on earth.

q Based on GBP/USD exchange rates as at 20 January 2023.
r Based on EU/USD exchange rates as at 20 January 2023.

Energy consumption is anticipated to increase by at least

50%

by 2050

OPPORTUNITY #41

What if digital realities rewrote liability laws in the real world?

LAW AND ORDER FOR WEB 3.0

New models of liability emerge from our online lives and reshape liability laws and regulations in the real world.

MEGATREND
Digital Realities

TRENDS
Cybersecurity
Legal Transformation
Metaverse

SECTORS AFFECTED
Cyber & Information Security
Data Science, AI & Machine Learning
Financial Services & Investment
Immersive Technologies
Insurance & Reinsurance

WHY IT MATTERS TODAY

A legal liability arises when a party has certain responsibilities towards another party in a given area and this should be no different for digital realities, avatars, all parties involved in the associated online flows of goods and services and the value they generate. Cybercriminals seek to exploit human or security vulnerabilities to steal data, passwords and, more directly, money. From hacking and phishing to ransomware and Denial of Service (DoS),[686] cyberattacks can be emotionally and financially devastating with victims displaying mental health symptoms of anxiety, depression and paranoia.[687]

Just over $3.2 billion of cryptocurrency was stolen from various exchanges, platforms and private entities.[688] As FTX – one of the world's largest cryptocurrency exchanges – filed for bankruptcy on 11 November 2022, transfers and deposits were being made into what was perceived as anonymous decentralised finance (DeFi) wallets.[689]

Like non-fungible tokens (NFTs), decentralised finance (DeFi) wallets and platforms — part of digital realities — also face attacks that arise from vulnerabilities in underlying protocols or smart contracts. An analysis found that over half of the value stolen from DeFi protocols happened by exploiting vulnerabilities in code in 2021.[690] Besides security breaches, other reasons for theft include flash loan attacks.[691] This type of attack occurs through the use of funds obtained through a flash loan – a service provided by many DeFi platform exchanges – to manipulate the price of cryptocurrency tokens across platforms. The attacker then sells all their tokens at once at a profit.[692]

On average globally, the cost of a data breach was $4.35 million in 2022, although in the United States the figure was $9.4 million.[693] The share of breaches caused by ransomware grew by 41% in 2021, and this type of breach took 49 days longer than average — 277 days in 2022 — to identify and contain.[694]

Microsoft processes 24 trillion signals every 24 hours and its security solutions (e.g. those built into Windows) blocked billions of attacks on its customers in 2021.[695] Tracking more than 35 unique ransomware families and 250 unique threat actors across the globe plus those who participate in the rising ransomware-as-a-service (RaaS) gig economy,[696] more companies are taking a zero trust approach to security to reduce both the number and scale of cyberattacks.[697]

THE OPPORTUNITY

Avatars bartering or exchanging virtual goods and services in fully digital worlds are a long way from what most legal and judicial systems are designed to manage.[698] As more users and businesses move to or start up in digital realities, there will inevitably be a need for systems to define and protect rights and clearly outline liabilities.

Existing laws and regulations could be reviewed and a new global framework for legal liability could be defined and built into future legislation. Crossing multiple jurisdictions and liabilities, this effort could bring together a partnership of governments, legal researchers and practitioners, software programmers, investors and regulatory bodies, paving a new way of thinking about and transacting in digital realities.

Real-world legal systems may not be easily transferable to digital realities. Moreover, given the transnational nature of digital realities and the novel forms of services, goods, currencies and entities found within them, the challenge – as acknowledged in Europe[699] – is non-trivial. When it comes to fraud, identity theft, defamation and crime,[700] it is currently unclear how legal liability would apply, who it would apply to, what laws and regulations would be applicable, and which court(s) of law would be used to enforce actions and penalties.

BENEFITS

Liability protection and enforcement in digital realities. Gains in efficiency, time and cost-savings by reducing the need for specialised legal research and case development.

RISKS

Tensions between nation-states' legacy systems (designed for physical entities) and emerging digital realities, causing gaps and conflicting approaches that leave many in legal limbo with contradictory outcomes.

Over

$3.2 BILLION

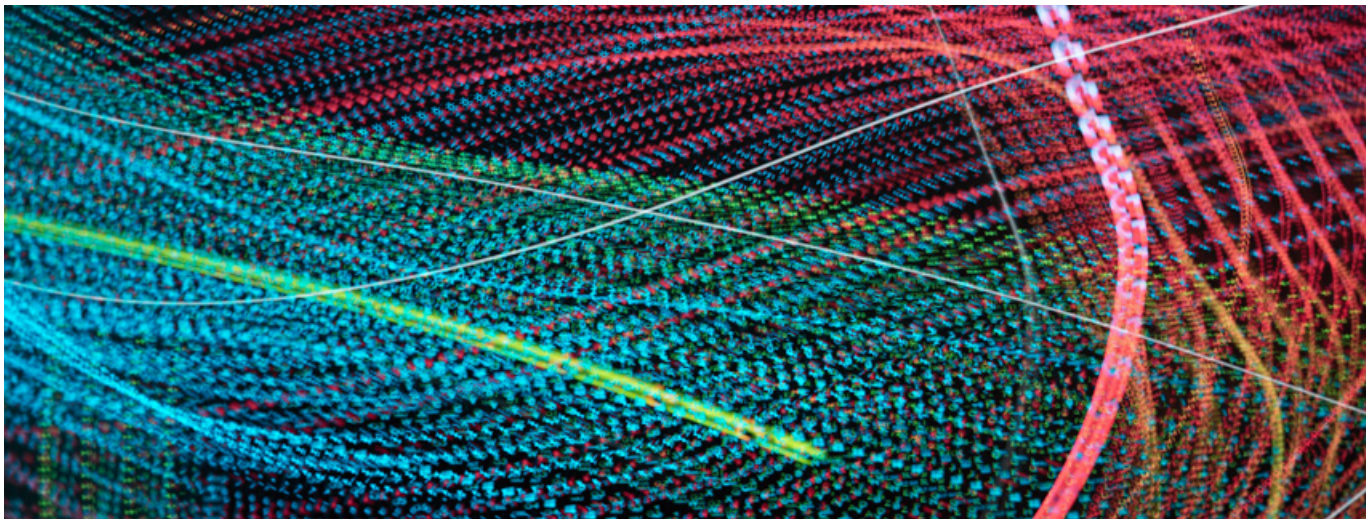
of cryptocurrency was stolen from various exchanges, platforms and private entities

OPPORTUNITY #42

What if accounting reinvented itself?

ACCOUNTING FOR INNOVATION

Enabled by a range of technological advances, new means of valuation, measurement and reporting make historical accounting approaches redundant, opening up new opportunities for innovation in problem-solving and fraud detection.



MEGATREND
Devaluation of Raw Data

TRENDS
Artificial Intelligence
Edge Computing
Future of Purpose & Work
Internet of Things (IoT)

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Financial Services & Investment
Immersive Technologies
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Real Estate

WHY IT MATTERS TODAY

Impacting accounting practices, the operating costs relating to compliance grew by over 60% for retail and corporate banks between 2014 and 2022.[701] These costs are associated with increasing regulatory changes driven by developments in crypto assets, operational resilience, sanctions, digitisation and environmental, social and governance (ESG) matters. In 2021 for example, and impacting 190 countries around the globe, an average of 246 regulatory alerts were sent daily, equating to 64,152 alerts annually.[702]

At the same time, the COVID-19 pandemic led to a surge in reliance on digital payments. In low- and middle-income countries (excluding China), over 40% of adults made payments using a card, phone or the internet for the first time.[703] In the United Arab Emirates, two-thirds of residents increased their use of digital payment methods in 2021 (higher than the global average of 61%).[704]

More generally, digital trade is the trade in goods and services that are digitally ordered and/or digitally delivered.[705] In 2021, digitally deliverable services reached almost 64% of global services exports.[706] The e-commerce market is projected to increase from $3.3 trillion in 2022 to $5.4 trillion in 2026.[707] In 2022, digital payments had a total transaction value of $8.5 trillion and 25% of global small and medium businesses have adopted financial application programming technologies and distributed accounting technologies.[708]

The **operating costs relating to compliance** grew by over

60%

for **retail and corporate banks** between 2014 and 2022

The global smart sensor market – which enables smart parcel tracking – is also evolving and is expected to grow at a compound annual growth rate (CAGR) of 13.7%, from $32 billion in 2021 to $77 billion in 2028.[709] The RFID tag market was worth $10 million in 2021 and is expected to reach nearly $18 million in 2028.[710]

The Middle East and North Africa (MENA) region's smart sensor market is expected to double from nearly $2 billion in 2021 to $4 billion by 2028, an increase at a CAGR of nearly 11%.[711] It is estimated that the United Arab Emirates' share of the smart sensor market will grow at a CAGR of 16% in the period 2021–26, reaching a valuation of $842 million.[712]

THE OPPORTUNITY

Through advanced machine intelligence, distributed ledger technologies (DLT), the Internet of Things (IoT) and advanced analytics, the accounting profession can be re-engineered into one that is focused on innovation through problem-solving, fraud detection and evolving the capture of assets and flows. Blockchain technology will help to guarantee authenticity when accounting data is shared, also assuring its security.[714] Fully automated, collection and analysis is customised. Algorithms could continuously generate total value and accounting / cash flows, analysing financial and non-financial data, automatically checking for compliance and formatting reports according to national and international standards.

The ability to improve the capture and use of accounting information with a high degree of automation and customisation means that it will be possible to embed new forms of value into accounting processes in both the public and the private sectors. Examples of areas where these new forms of value will emerge include environmental, social and governance (ESG)[715] metrics; sustainability, ecosystem and carbon accounting systems for governments (such as the United Nations' System of Environmental–Economic Accounting, or SEEA);[716] and measures of inclusive wealth more generally. Regulatory bodies, funders and philanthropists will more quickly be able to identify the efficiency and effectiveness of underlying organisations.

These technologies could massively reduce business costs and enable companies to better manage their liquidity and finances. Enabling businesses, governments and supervisory agencies – for example, financial regulators and environmental agencies – to access real-time information and analysis would increase the overall efficiency of the financial system and mitigate the risks that come from lagging, poor-quality or incorrect accounting and financial reporting.

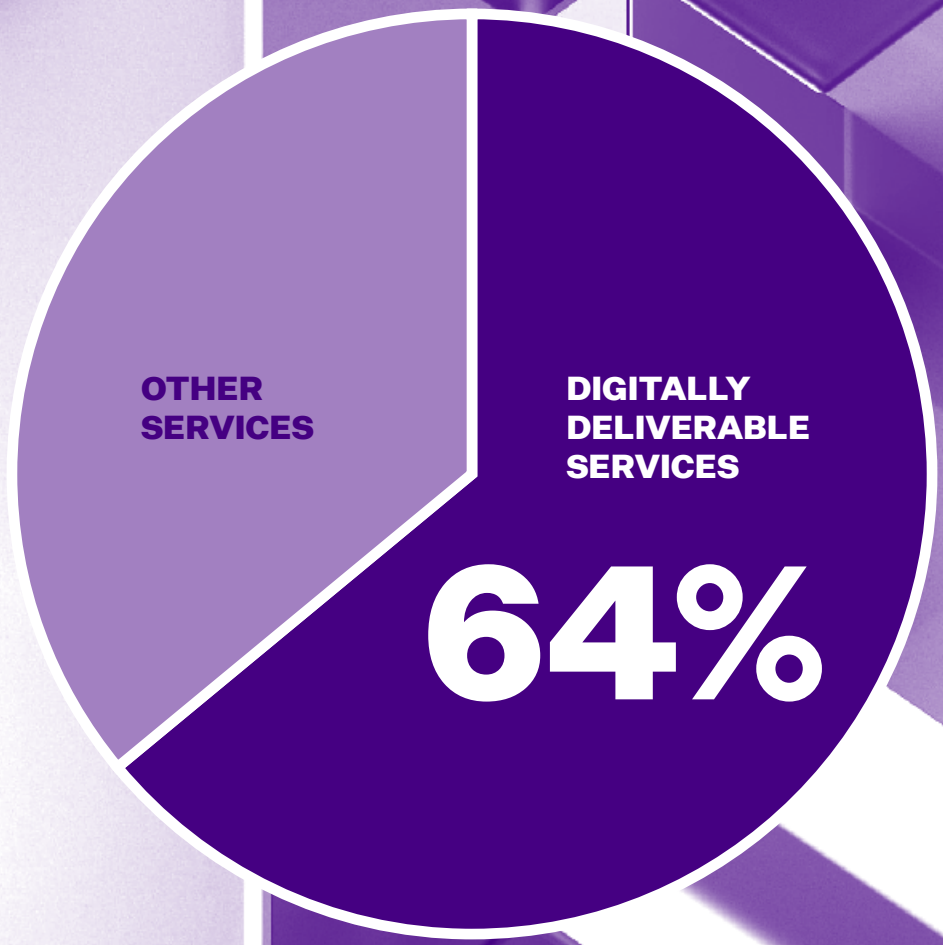
BENEFITS

Improved transparency, efficiency and resource allocation. Efficiency in detecting fraud and embedding new regulations and flows into accounting and reconciliation processes.

RISKS

Vulnerability of systems to cyberattacks due to heavy reliance on automated analysis. Issues from barriers to adoption, such as resistance to change and the high price of technology.[713]

GLOBAL SERVICE EXPORTS IN 2021



OPPORTUNITY #43

What if deliveries went underground?

HATCHES, TUBES AND ROBOT DISPATCHES

An AI-powered pneumatic tube system for city-wide delivery on demand that offers a completely integrated on-demand delivery model reviving an old approach with the technological advances needed.

MEGATREND
Devaluation of Raw Data

TRENDS
Artificial Intelligence
HumanXMachine
New Materials
Quantum Technology

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Infrastructure & Construction
Logistics, Shipping & Freight
Manufacturing

WHY IT MATTERS TODAY

Delivery services have grown exponentially as consumers continue to switch from physical to online retail. E-commerce will account for just over 20% of global retail sales by the end of 2022, up from 10% in 2017.[717]

Valued at $3.3 trillion in 2022, e-commerce sales are expected to grow to $5.4 trillion by 2026.[718] In 2021 Amazon shipped an estimated 7.7 billion packages globally.[719] In the United States, 21.5 billion parcels were shipped in 2021 at a rate of 683 parcels per second and 166 parcels per household.[720] In the United Kingdom, 5.4 billion parcels were shipped in 2021 at a rate of 171 parcels per second and 192 parcels per household.[721] In India, 2.7 billion parcels were shipped in 2021 at a rate of 85 per second and 11 parcels per household.[722]

As cities grow, couriers compete for road space with commuters and essential transport (e.g. emergency services). On-demand delivery comes at significant hidden environmental and economic costs not least from vehicle emissions and increased wear and tear on infrastructure.[723] With the aim of finding ways to reduce delivery related emissions, a study in central Tokyo, Japan, estimated that switching to electric vehicles would account for a 20% drop in carbon dioxide emissions in urban areas. A further 14% could be gained through the use of hydrogen-fuel-cell electric vehicles, another 8% from delivery robots and 7% from autonomous ground vehicle (AGV) lockers. The rest of the approaches examined by the study were minimally impactful from an emissions perspective; these included micro-hubs, parking retrofits, delivery parking zones, drones and tricks, parcel boxes and goods trams.[724]

Survey figures show that, while 26% of US retailers offered same-day delivery by the end of 2021 compared to 46% in Canada and 34% in the EU and the UK, 1% of retailers in all four countries do not have plans for same-day delivery by 2025 with the remainder — 73% of US retailers, 54% of Canadian retailers and 66% in the EU and the UK — plan to offer it by 2025.[725] Demand for express delivery will result in there being 36% more delivery vehicles in inner cities by 2030.[726]

Valued at

$3.3 TRILLION

in 2022

e-commerce sales are expected to grow to

$5.4 TRILLION

by 2026

THE OPPORTUNITY

The idea of a city-wide pneumatic tube system is not new – no longer operational because of high operational costs, the New York postal service was connected in 1897 through pipes that delivered letters and parcels around the city.[727]

New materials, new building techniques and automated, AI-powered distribution centres could offer completely integrated on-demand delivery models giving traction in reviving the former approach. Pneumatic tunnels (also called vacuum tunnels) embedded into the urban infrastructure to connect buildings and distribution nodes could offer 'beyond-the-doorstep' delivery solutions to hospitals and other critical services. With development costs integrated into zoning and real estate plans, the tunnel system could be run on a pay-per-use basis.

Integrating small robotic distribution centres around cities would mean that packages could be electronically tagged for delivery to an address and loaded into a sealed pipe for instant dispatch. Buildings would be equipped with hatches where goods could be sent and received. Perfect traceability of goods from dispatch to delivery would be guaranteed, as the system would automatically track tagged goods via distributed ledger technology databases.

BENEFITS

Reduced traffic. Environmental benefits. Reduced costs caused by delays, damage and losses. Faster, more secure deliveries.

RISKS

Long wait times to connect older buildings due to the high costs of retrofitting pipe systems. Risk of pipe damage creating delivery bottlenecks and/or damaging goods. High costs or high difficulty of adequately maintaining the pneumatic system. Risk of unauthorised use of pipes for transport of illegal goods or cyber-attacks.

E-commerce was expected to account for just over

20% OF GLOBAL RETAIL SALES

by the end of 2022, **up from 10% in 2017**

OPPORTUNITY #44

What if we could make new materials in seconds?

FRESH THREADS

Advanced machine intelligence enables novel algorithmic models and techniques for predicting how new materials will function, accelerating the discovery of new materials.

MEGATREND
Materials Revolution

TRENDS
Artificial Intelligence
HumanXMachine
New Materials
Quantum Technology

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Utilities

WHY IT MATTERS TODAY

Algorithms can push the boundaries of what can be achieved in materials science, by accelerating progress and unlocking materials previously unachievable by humans alone. Materials science and innovation are key to disruptive innovation. 3M and Hitachi are two companies that are frontrunners in materials innovation, each investing approximately $1.9 billion per year in research and development (5.9%[728] and 3.4%[729] of their revenues, respectively).

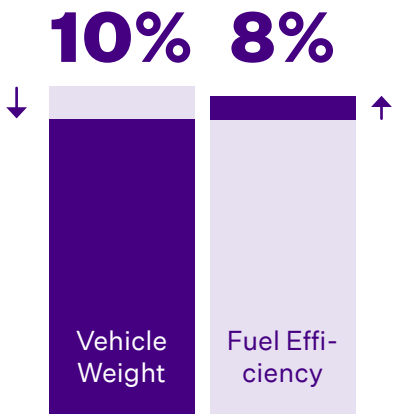
Materials science and innovation is also not new. Since 1859, scientists have been trying to achieve a single-layer material using chemical and mechanical methods involving expensive and specialised equipment, but it was not until 2004 that graphene was first isolated from graphite. Almost invisible, graphene is 200 times stronger than steel and is the most conductive material discovered to date, yet it is stable and non-reactive,[730] promising to transform sectors.

Materials science and innovation are also critical to decarbonisation[731] and transportation.[732]

For example, a 10% reduction in vehicle weight through the use of lightweight materials can result in up to an 8% improvement in fuel efficiency.[733] Using lightweight materials in only one quarter of US cars and trucks could save more than 22.7 billion litres of fuel annually by 2030[734] – that is, approximately 3.7% of the fuel these vehicles consumed in 2021.[735] Similarly, a 20% reduction in aircraft weight through the use of lightweight materials has resulted in up to 12% efficiency.[736]

The lightweight materials market is estimated to reach $279 billion by 2030, having grown from just over $172 billion in 2021 at a compound annual growth rate (CAGR) of 5.5%.[737]

Materials innovation also shapes the future of robotics,[738] smart materials and nanomaterials.[739] The market for robotics is expected to reach $214 billion by 2030, growing at a CAGR of almost 23%.[740] The smart materials market was valued at $5 billion in 2021 and is expected to reach $8 billion by the end of 2027, growing at a CAGR of 6.9%.[741] The global nanomaterials market was estimated to be worth nearly $10 billion in 2021.[742]



A **10% REDUCTION**
in vehicle weight through the **use of lightweight materials** can result in up to an
8% IMPROVEMENT
in fuel efficiency

THE OPPORTUNITY

Currently even the most powerful Artificial Intelligence (AI) models used for materials science sacrifice accuracy for speed, which can prove problematic when materials are being designed to function in specific situations, such as in microelectronics.[743] Today, complex simulations – for example, of the properties of new metal alloys – can take days or even weeks to run, and it can take decades to develop new materials.[744] Further vast improvements are needed in advanced machine intelligence relating to materials.[745]

Improving accuracy and speed across property prediction, function and complex interactions could revolutionise fields such as medicine, energy, construction and aviation.[746] High-speed processors could run millions of simulations in milliseconds, enabling ultra-rapid design and testing of novel materials in multiple configurations.[747]

Novel algorithmic models and techniques for predicting how new materials will function could be used to improve materials discovery. These advances could make it possible to design, prototype and test new materials and properties (or optimise existing materials and properties) in highly complex environments – for example, in the engineering of biomaterials for organ repair or in carbon dioxide capture.

Such exponential increases in the speed and accuracy of materials modelling would result in reduced development costs, accelerated lab-to-market times and improved return on investment. Ultra-rapid advances in materials would drive breakthroughs in energy storage and transmission, transport, sustainable production and consumption and healthcare and well-being.

BENEFITS

Faster, more cost-effective development of new materials. Reduced environmental impact and more versatile materials. Ability to identify and address the potential risks of novel materials before widespread use.

RISKS

Delays to the regulatory reforms that would be needed to aid innovation and discovery of new materials. Use of advances to do harm.

20% REDUCTION IN AIRCRAFT WEIGHT

through the use of lightweight materials,
has resulted in up to

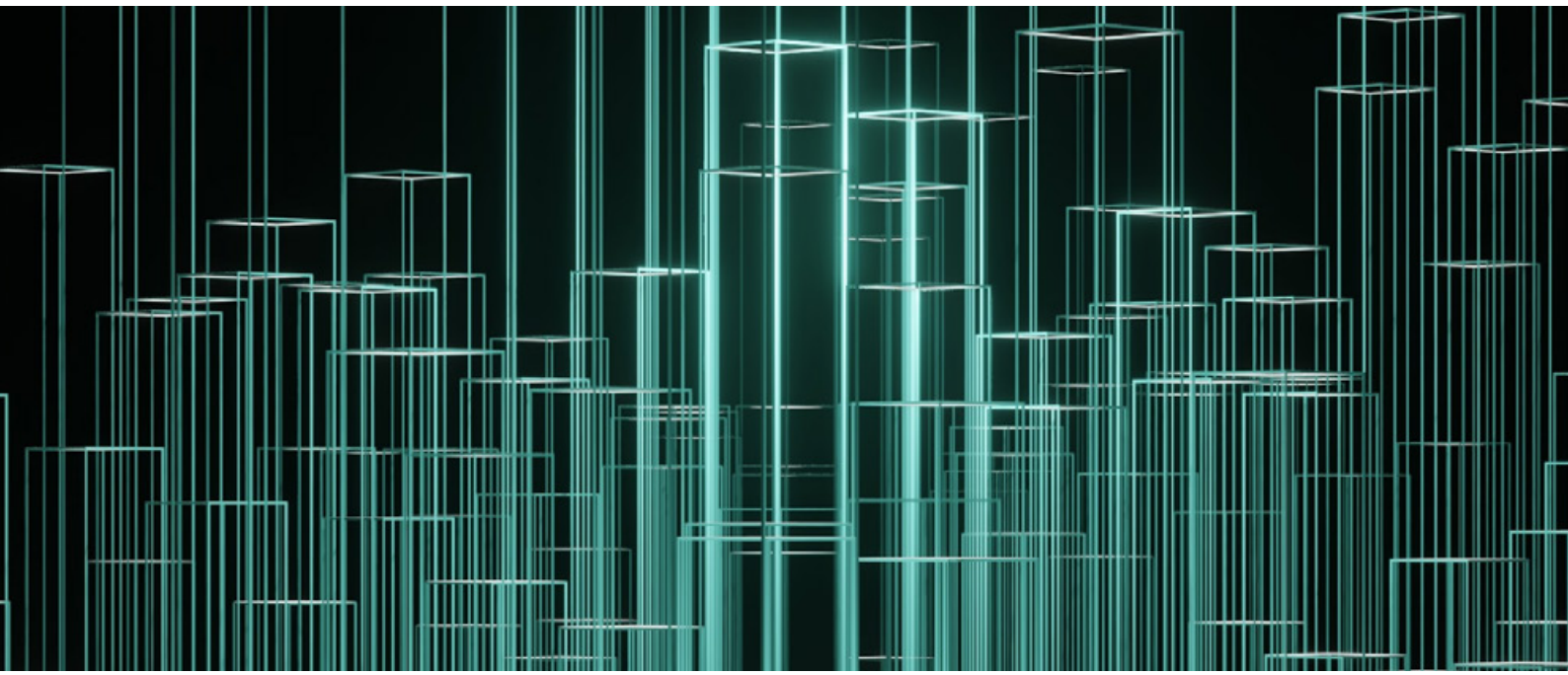
12% EFFICIENCY

OPPORTUNITY #45

What if the Fortune Global 500 was purely virtual?

GOING ALL-DIGITAL

Operating entirely in digital realities, virtual companies generate more revenue than physical ones.



MEGATREND
Digital Realities

TRENDS
Digital Economy
Future of Purpose & Work
Metaverse

SECTORS AFFECTED
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Financial Services & Investment
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Media & Entertainment
Real Estate

WHY IT MATTERS TODAY

Digitally native brands (DNBs), also called native virtual companies (NVCs),[748] have become market disruptors. On average, they grow at triple the rate of the overall e-commerce market, and those with the fastest growth have gone from $50 million in revenues to $1 billion in four to eight years.[749]

Impacting on those who set up, operate and consume products and services from DNBs, there is an upward trend both in terms of access to and the time spent using the internet.[750]

Globally, over 12.5 trillion hours were spent online in 2021.[751] More than two-thirds of the global population use a mobile phone, with the number of unique users having reached just over 5 billion by the end of 2021,[752] and 63% of the world's population now has access to the internet,[753] spending an average of 2 hours 27 minutes per day on social media.[754] However, trends differ widely by country, as residents in emerging markets spend the most time on social media, possibly because of a higher proportion of young people (those in the 16- to 24-year-old segment).[755]

The global gig economy both enables and is enabled by DNBs. Even though the employment status of gig workers is being reviewed in Europe, the United Kingdom[756] and the United States,[757] gig workers are expected to make up nearly 10% of all freelancers by 2023, with the number of workers reaching 78 million and wage disbursements growing to nearly $300 billion.[758] Transportation and delivery platforms comprised 83% of all platform revenues in 2021 and India supplied 25% of online web-based labour.[759] While the United States has one of the biggest gig economies in the world, with a 44% share of the global volume of the gig economy,[760] other countries are also experiencing growth in their own gig economies, including Brazil, France, India and the United Kingdom.[761] The gig economy is also disrupting start-ups and employment in the Middle East and North Africa (MENA),[762] with no less than 14 million gig workers in Egypt.[763] By 2023, the revenues from the global gig economy are expected to be valued at $455 billion.[764]

THE OPPORTUNITY

As the number and economic impact of DNBs expand with the rise in digital reality populations, they offer entrepreneurs the potential to develop and scale new business ideas and models rapidly, driving competition, customer choice and growth similarly to how multinational corporations once did in their early days.[765] Large, established DNBs could become standard-setters for markets, as they continue to grow and outstrip real-world companies and become engines of growth forming the largest companies globally in revenues without any physical presence.

The global economy is increasingly driven by digital goods and services. Many companies and business models already function entirely in digital spaces, with client, supplier and employee interactions taking place at a distance. In such cases, physical headquarters exist for legal and fiscal purposes only. The emergence of digital realities offers an entirely new space for companies to establish a presence and build markets, raising interesting legal, fiscal and cultural questions. Regulations will need to be reviewed to enable the growth of DNBs while also protecting investors and consumers alike.

DNBs are also responding to the demands of populations in digital realities. Their roles range from real estate and token management to guiding people through the maze of principles and rules governing different digital reality spaces. These brands offer products and services that enhance life in digital realities, in areas including entertainment, education, finance and identity.

BENEFITS

An open business environment that enables company agility to improve consumer choice and offer opportunities and flexibility in employment. Creation of space for greater entrepreneurship. Accelerated growth due to the ability to transcend borders.

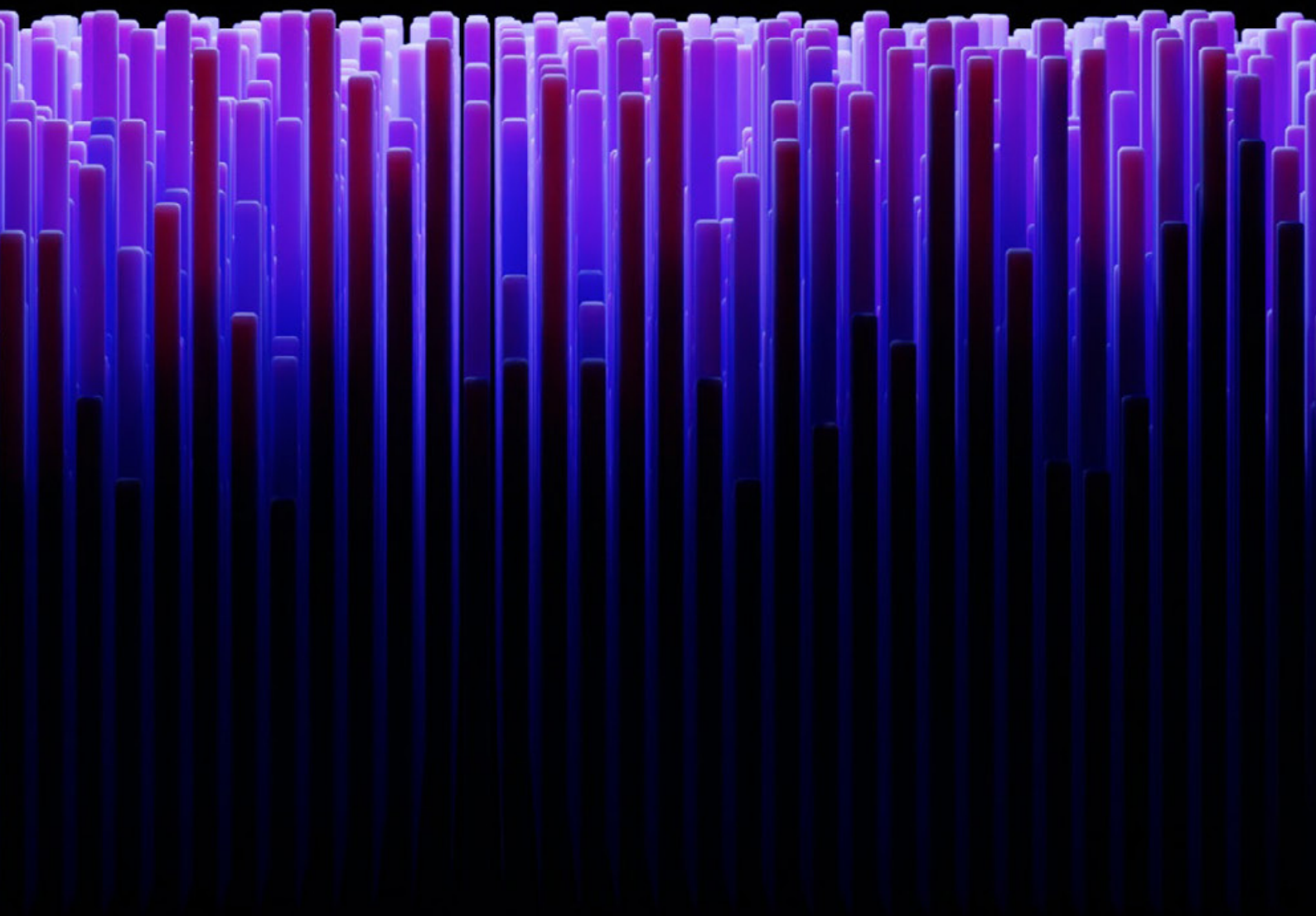
RISKS

Fraudulent behaviour in less regulated spaces reducing trust in such companies. Increase in cybersecurity risks. Return to the multinational corporation model if brands evolve back to having a physical presence.

The gig workers are expected to make up nearly

10% OF ALL FREELANCERS

by 2023



OPPORTUNITY #46

What if future potential was reported alongside GDP?

GROSS DOMESTIC FUTURE (GDF)

The stock of various national assets complement GDP as a measure of a country's future potential growth, or gross domestic future (GDF). These assets include natural resources, human capital, intellectual capital, physical capital and capacities for innovation and technological development.

MEGATREND
Future Humanity

TRENDS
Artificial Intelligence
ESG & Beyond GDP
Real-time Analytics

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

The Human Development Index, maintained by the United Nations Development Programme, incorporates the conventional approach to measuring economic progress, education and health, which are important variables in determining the development of a society.[766] However, new measures intended to capture broader aspects – both qualitative and quantitative – are becoming increasingly prominent. Examples include the Global Competitiveness Index (141 countries in 2020),[767] the Legatum Prosperity Index (167 countries in 2021)[768] and the Global Innovation Index (132 countries in 2021).[769] Businesses are also looking to better assess and incorporate social and environmental aspects in their reporting, as evidenced by the rise in environmental, social and governance (ESG) benchmarking.[770]

Countries such as New Zealand have introduced a 'well-being budget'. Such metrics go beyond GDP to encompass broad outcomes including health and safety, in order to assess the success of related policies.[771] The New Zealand government also conducts assessments of its citizens asking them to evaluate their current life satisfaction and expected level of life satisfaction in five years' time, and to provide objective information such as their employment status.[772]

The United Arab Emirates (UAE) undertakes a host of initiatives and research efforts to assess the well-being and happiness of its citizens.[773] The UAE University has set up the Emirates Center for Happiness Research to offer evidence-based methods to implement initiatives that will help to enhance happiness and future well-being.[774]

Global GDP has increased tremendously over the past 50 years, growing from around $3 trillion in 1970 to $96 trillion in 2021.[775] Estimates suggest that if countries and businesses prioritised nature, they could generate $10 trillion in annual business value, creating 395 million jobs by 2030.[776]

THE OPPORTUNITY

Gross domestic product (GDP) captures the monetary value of the final goods and services (bought by end consumers) produced in a country in a year. It includes most outputs generated within the borders of a country and determines the size of its economy accordingly.[777] However, although it is often seen as a measure of welfare and future economic success,[778] it fails to capture both of these elements comprehensively. This is because current economic flows do not reflect the future potential of an economy, which can be further developed.

Measuring assets critical to future growth and development differentiates a country's potential from its past performance and offers new perspectives for investment and long-term planning. New measures can inspire greater action to develop, protect or restore assets recognised as economically valuable. The new system will be supported by advances in ways to monitor, measure and collate non-financial and non-conventional data in real time, such as data on biodiversity, skills and talent, cultural and Indigenous sites and heritage.

Forested and less agriculturally intensive countries can benefit from the global demand for natural carbon sinks. Youthful countries that are focusing on the use of technology in education and employment can see their demographic and economic capital boom as ageing accelerates in many regions. Indigenous cultures and traditions can become more valuable over time as sources of skills, information and know-how that can be leveraged for education and scientific research, and to draw tourism. Countries that are preserving or successfully restoring biodiversity can leverage their environmental and genetic capital to achieve improved well-being but also to encourage innovation in the areas of medicine and materials.

BENEFITS

Better measurement of assets, allowing nations to sustainably develop and use what they have for future growth, prosperity and well-being.

RISKS

Lower rankings for smaller countries (in terms of land mass and/or population size) and more trade-led economies, leading to reduced access to benefits that depend on assessment of monetary value of final goods
and services.

Estimates suggest that if countries and businesses **prioritised nature**, they could generate

$10 TRILLION

in annual business value, creating

395 MILLION JOBS

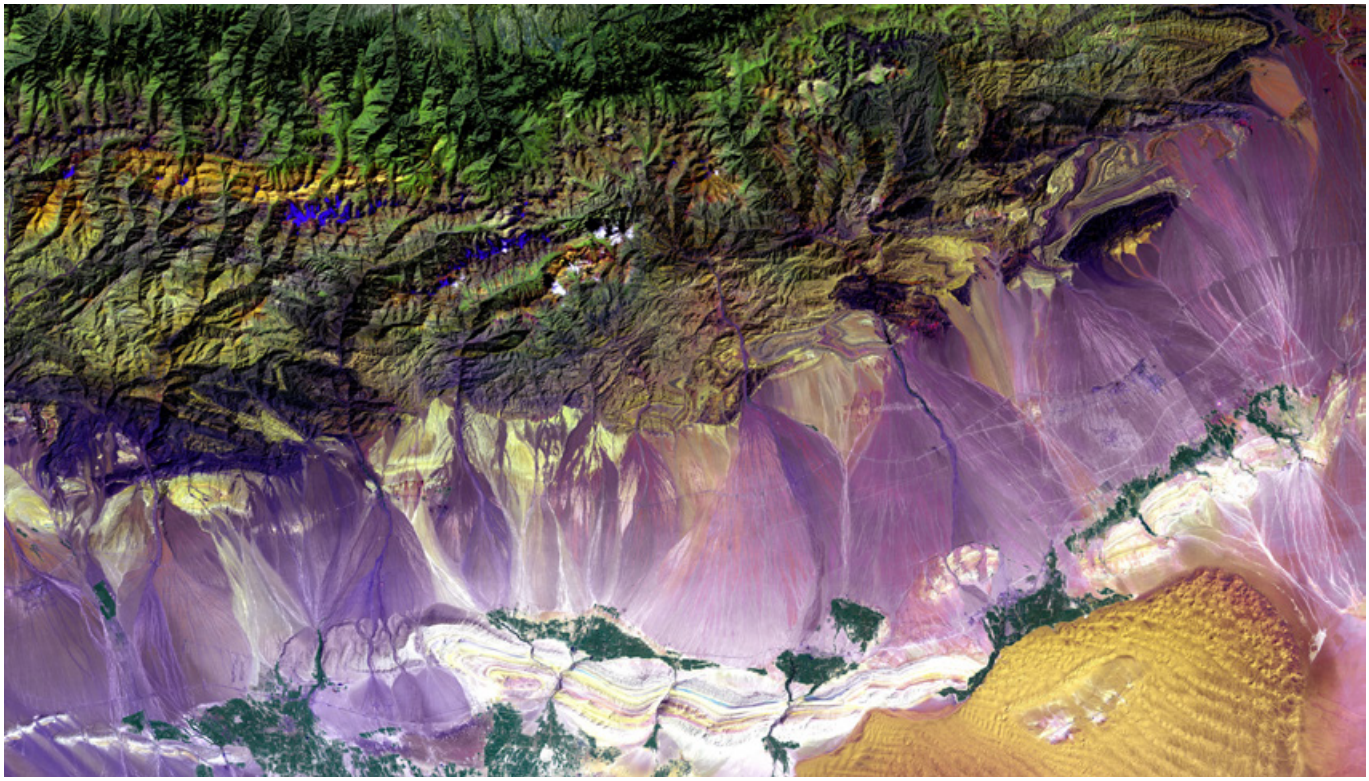
by 2030

OPPORTUNITY #47

What if we could X-ray the whole planet?

EARTH X-PLORATION

Cosmic ray imaging technology makes it possible to ‘X-ray’ the entire world, revealing new sources of water, energy, minerals and other resources while helping to identify geological and structural problems.



MEGATREND
Saving Ecosystems

TRENDS
Food—Water—Energy Nexus
Future of Raw Materials
Transforming Energy

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Energy, Oil & Gas & Renewables
Infrastructure & Construction
Insurance & Reinsurance
Manufacturing
Metals & Mining

WHY IT MATTERS TODAY

As the world transitions towards clean energy, by 2040, demand for minerals – from **chromium, copper and cobalt to Lithium, Nickel and Aluminum** — could have increased up to

4x

Beneath the surface, the earth's mantle is made up of three sub-layers, which together are 2,900 kilometres thick and make up 84% of the planet's volume.[779] While the exact internal structure of the earth is not known, geologists have hypothesised that some of the mantle rock beneath the lower mantle holds water.[780] If just 1% of the weight of the mantle rock was water, that would equate to almost three times the amount of water in the oceans.[781]

Conventional ways of looking for resources (such as oil and gas) are often costly and time-consuming, involving seismic studies and drilling dry wells.[782] The cost of a failed exploration can be anywhere from $5 million to $20 million or more per exploration site.[783] In Newfoundland, Canada, the exploration and drilling of offshore oil wells cost nearly $91 million per well between 1998 and 2019.[784]

The shift towards renewable energy is likely to drive up demand for exploration for minerals and metals.[785] By 2040, demand for minerals — from chromium, copper and cobalt to lithium, nickel and aluminum — to could have increased up to four times, from around 7 million tonnes to 28 million tonnes, as the world transitions towards clean energy.[786]

Funded by the National Science Foundation in 1958, project Mohole aimed to reach the 'Moho', the crust–mantle boundary most easily reached by drilling through the sea floor.[787] The mantle itself may potentially be a natural source for many minerals[788] and, despite its failure to achieve its intended purpose of reaching the Moho by 1966, Project Mohole opened up new exploratory and positioning techniques and drilled over 180 metres into the sea floor beneath 3.5 kilometres of water – the deepest anybody had drilled at that time.[789]

Other programmes have emerged since then. The Japan Agency for Marine–Earth Science and Technology (JAMSTEC) set up a floating laboratory for a deep sea drill to reach the earth's mantle at a point where tectonic plates meet. Even though this was not achieved, the project was able to drill nearly 3.3 kilometres into the seafloor, at a cost of approximately $55 million.[790]

Russian scientists took 20 years to drill a hole just over 12 kilometres deep in the sea floor, but drilling was abandoned in 1992 when temperatures of 180°C were reached and drill bits damaged.[791] Interestingly, and as a potential source of clean energy, Quaise, a spin-off of the Massachusetts Institute of Technology (MIT) born out of nuclear fusion research, has raised $63 million to dig further into the earth's crust to access this geothermal power.[792]

THE OPPORTUNITY

No one has drilled beyond the earth's mantle.[793] While satellite imagery is revealing more information about what lies on the earth's surface and just beneath, exploring deeper is expensive and time-consuming.[794] Advanced cosmic ray imaging technology and instrumentation can reveal what lies far beneath our feet.[795]

Cosmic 'X-ray' technology can reveal untapped sources of critical minerals, reduce the time and cost required to identify new sources of geothermal energy, improve groundwater surveying and provide enhanced geological data for urban and project development.

Advances are steadily being made using X-ray computed tomography (XCT)[796] as well as 2D and 3D X-ray and neutron-based imaging techniques[797] to obtain the most accurate imagery and identify even the most minute elements present in the geological core of the earth. A combination of these and cosmic ray imaging technologies can be used to reveal new aspects of our planet, identify and better manage new and existing resources.

BENEFITS

Economically valuable information about natural resources below the earth's surface. Improved understanding and management of resources. More effective spending on infrastructure development and safety, contributing to economic growth and well-being.

RISKS

Winner-takes-all approach to using the technology to find new resources. Failure of cosmic ray imaging technologies to take off like other radiography techniques (despite increased funding) and to deliver on their promise. Resource depletion that undermines efforts to protect and preserve the planet.

The **Earth's mantle** is made up of **three sub-layers**, which together are

2,900 KILOMETRES

thick and make up

84%

of the planet's volume

OPPORTUNITY #48

What if energy was stored in space?

SPACE AS STORAGE

Space becomes a site for mass energy storage, with supercapacitors transmitting energy to meet all human needs both on earth and in space.

MEGATREND
Energy Boundaries

TRENDS
Future of Space
Transforming Energy

SECTORS AFFECTED
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Automotive, Aerospace & Aviation
Communication Technologies & Systems
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Utilities

WHY IT MATTERS TODAY

Global energy consumption is expected to increase by 50% by 2050, with renewable energy use projected to grow at the same rate[798] as there is a strong trend towards renewable energy as countries seek to reduce their reliance on fossil fuels and cut their emissions while better preserving natural ecosystems.[799]

However, there are certain problems with the production and use of energy from sources such as solar radiation, wind and other natural sources. Energy derived from solar panels or wind needs to be charged in preparation for consumption, and energy needs to be stored properly for long-term availability[800] particularly when there is not enough sunlight or there are unfavourable wind conditions. This is especially the case during long, dark winters, when energy is in high demand.[801]

In space, the need for long-term energy storage is also growing. As of 2021, the space launch market was worth $6.6 billion with a compound annual growth rate (CAGR) of nearly 15%,with market growth primarily driven by rising demand for small satellites.[802] The United States is planning to build a lunar base through its $93 billion Artemis programme.[803] A similar joint venture was announced by Russia and China in 2021. They aim to set up an uncrewed lunar base around 2030.[804] In 2023 at least six countries – India, Japan, Russia, South Korea, United Arab Emirates and the United States – intend to send missions to the moon.[805] And with more people increasingly becoming interested in space tourism and not just to experience space conditions but also to experience living in space,[806] greater capabilities are required for long-term energy storage.

In 2023 at least six countries

INDIA
JAPAN
RUSSIA
SOUTH KOREA
UAE
UNITED STATES

intend to send missions to the moon

THE OPPORTUNITY

The ability to store energy in space would not just expand what can be done in space but also revolutionise access to energy on earth. Finding robust and efficient methods of long-term energy storage will be important. Storage of energy in space can provide a solution and help to future-proof the planet against a possible energy crisis.

The most notable feature of supercapacitors, when they are used as energy storage devices, is their ability to bridge the gap in energy between conventional capacitors, batteries and fuel cells. They also have high power density and a long life span.[807] The global supercapacitor market was valued at $5 billion in 2021. Expanding at a CAGR of just over 23%, it is expected to reach a valuation of $25 billion by 2030.[808]

With sufficient advances – in areas such as materials science, advanced machine intelligence, nanotechnology and robots – massive energy-storage units with powerful, lightweight supercapacitors can store vast reserves of energy generated in space (via solar or other technologies), benefitting from space's unique conditions (cold and zero gravity). This energy can then be beamed to earth on demand or used for space stations, exploration and bases as a reliable source of power.

BENEFITS

Expanded access to energy on earth, supporting further space activity and contributing to growth.

RISKS

Human-caused or accidental damage (e.g. from space debris) to space energy-generation facilities and supercapacitors. Maintenance costs (due to damage) that make facilities too expensive to maintain.

The global supercapacitor market was valued at

$5 BILLION

in 2021 and is expected to reach

$25 BILLION

by 2030

OPPORTUNITY #49

What if businesses considered the future beyond ESG?

ESG-F: INTO THE FUTURE

Beyond environment, social and governance (ESG), businesses report on how their approaches to ESG are fit for long-term impact, preventing gaps from arising and anticipating the concerns of stakeholders in the future.

MEGATREND
Future Humanity

TRENDS
ESG & Beyond GDP

SECTORS AFFECTED
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Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

In 2004, the International Finance Corporation together with the World Bank Group and 20 global banks, asset managers and investment banks coined the term 'environmental, social and governance' (ESG) in response to a widening gap between the financial industry and changing expectations in these areas.[809] ESG was viewed as a means of raising shareholder value and global competitiveness and of supporting sustainable development and investment, and the integration of ESG and reporting was key for the financial industry.[810]

Since then, interest in and implementation of ESG have spread to other industries, with more investors and customers seeking transparency from companies about the activities they carry out under ESG.[811] Globally, ESG assets amounted to $41 trillion in 2022 and are expected to exceed $50 trillion by 2025.[812] Europe's ESG market and associated prudential requirements are among the most mature in the world.[813] Reflecting this, in the lead-up to 2018, Europe's year-on-year growth in ESG assets accounted for half of the world's total.[814] Both investors and organisations in Europe see ESG as central to their investment decisions and how they communicate their legitimacy to their stakeholders.[815]

However, the United States is catching up, particularly as the global focus on ESG increases and the focus on corporate social responsibility (CSR) decreases.[816] The United States witnessed more than 40% growth in ESG assets between 2020 and 2022, and the value of its market exceeded $20 trillion in 2022.[817] More than 90% of companies listed on the S&P 500 and more than 70% of the Russell 1000 report on ESG.[818] Although ESG reporting is not mandated by law or through financial regulation in all countries around the world, this is changing. The US Securities and Exchange Commission and the European Commission have announced increased disclosure and reporting requirements,[819] and these will have an impact on ESG reporting around the world.

While countries in the Middle East and North Africa (MENA) have already progressed on governance-related standards, they are still in the early stages of transitioning to reporting on environmental and social standards.[820] More significantly, Bahrain, Oman, Saudi Arabia and the United Arab Emirates, have made considerable net zero commitments for 2050 and 2060.[821] And companies in this region are more likely to be prepared to embed social goals – particularly family businesses.[822] Families own 75% of the businesses in the MENA region[823] and many of them will already have a clear set of societal values embedded in their day-to-day operations.[824]

THE OPPORTUNITY

There are three general approaches to ESG action and reporting: preventing harm; delivering value outside core activities, which is closer to corporate social responsibility (CSR); and full integration into strategy and operations.[825]

As stakeholders and investors call for more transparency on ESG reporting[826] – particularly in response to increasing concerns about 'greenwashing'[827] – companies can strengthen their disclosures by showing how their approaches to ESG are fit for the future. Between standards, frameworks, ratings and rankings, and various approaches to ESG reporting,[828] companies can not only report on how they are responding to ESG needs today but also on how they are prepared for ESG needs tomorrow and how sustainable their actions will be in the long run beyond preparedness and operational risk management.

By embedding the future into ESG reporting, along with their purpose, their culture and values, their operations and their growth plans,[829] companies will truly be deemed as future ready.

BENEFITS

Evidence that companies are committed to ESG in both the short term and the long term. Greater focus within companies' strategies. Greater competitive advantage, particularly with the younger generations.

RISKS

Difficulty making global comparisons due to inconsistent approaches to ESG. Continued 'greenwashing' (false or exaggerated disclosures).

BAHRAIN OMAN SAUDI ARABIA AND UAE

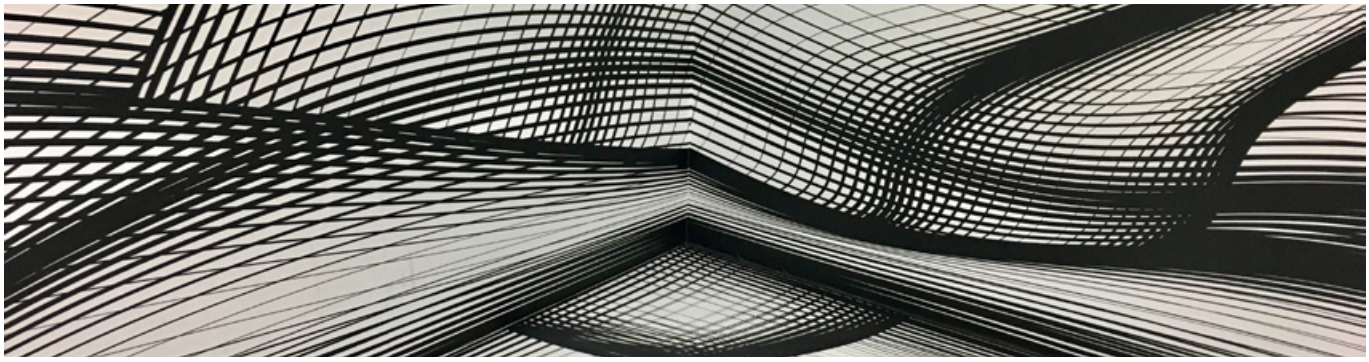
have made considerable net zero commitments for 2050 and 2060

OPPORTUNITY #50

What if teleportation was a reality?

TELE-POSSIBLE

Leaps in quantum physics revolutionise communication, encryption and computation, transforming digital realities into true realities and one day enabling teleportation of people and things.



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Future Humanity

TRENDS
Advanced Connectivity
Quantum Technology

SECTORS AFFECTED
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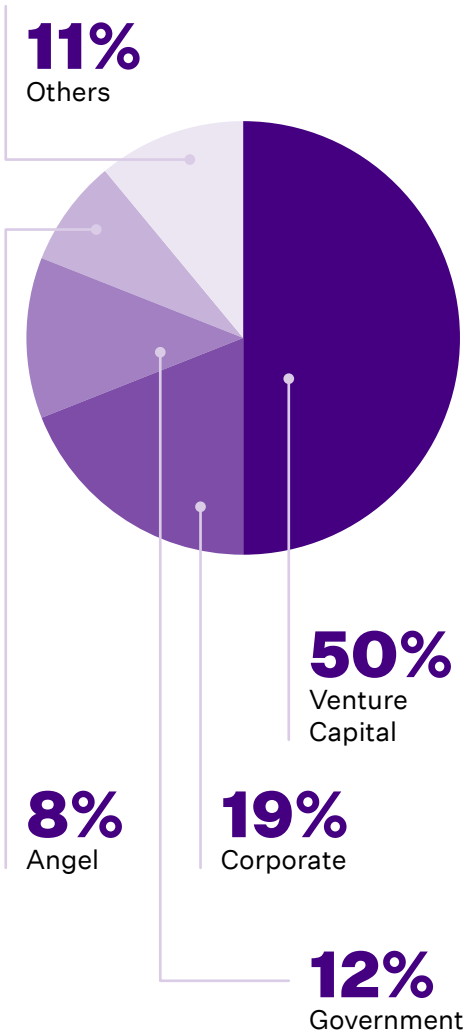
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Cyber & Information Security
Data Science, AI & Machine Learning
Education
Energy, Oil & Gas & Renewables
Financial Services & Investment
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Insurance & Reinsurance
Logistics, Shipping & Freight
Manufacturing
Media & Entertainment
Metals & Mining
Real Estate
Travel & Tourism
Utilities
Government Services
Professional Services

WHY IT MATTERS TODAY

In 2022, the Nobel Prize in Physics was awarded to Alain Aspect, John F. Clauser and Anton Zeilinger.[830] Their research in quantum mechanics helped to prove that photons, and potentially other small particles, could maintain a connection with each other even when apart.[831]

The quantum technology sector is rapidly expanding: funding for start-ups in 2021 exceeded $1.4 billion (double the funding raised in 2020), with the largest share going to quantum computing.[832] Nearly half of all funding comes from venture capital (50%), followed by corporate (19%), government (12%), angel (8%) and other forms of investment.[833]

Funding for Start-Ups in Quantum Technology in 2021



Between quantum sensors, quantum communications and quantum computing, quantum technology is a growing market that is still generally dominated by North America.[834] However, while nearly 40% of the players, over 60% of all start-up funding and 10 out of the 12 biggest hardware players are based in North America, China is leading the commercial implementation of quantum communications and Japan is the frontrunner in industry adoption of quantum technologies.[835] Widely uncertain, in 2040, the market size for quantum computing is estimated to be $9–93 billion, followed by quantum sensors at $1–7 billion and quantum communications at $1–6 billion.[836]

For example, China has committed $15 billion of public funding over five years (2020 to 2025) to quantum technology, and in 2021, France announced $2.2 billion plan of which $1.2 billion is of public funding along with the European Union which announced in 2018 a ten-year, $1 billion programme for quantum technologies.[837] While the United Arab Emirates does not have a national strategy for quantum technology, it is listed with Australia, Denmark, Finland, Ireland, Italy, New Zealand, Norway, Portugal, Spain, Sweden and Switzerland as countries that have significant government-supported initiatives.[838]

A new supercomputer called Frontier (built by Hewlett Packard Enterprise in the United States) can perform over a billion, billion operations per second, making it the first exascale supercomputer in the world.[839] Using such supercomputers, quantum computing can contribute to new discoveries about diseases such as cancer.[840] This will be enhanced by the next generation of processors, which will move beyond single-chip processing and increase in scale from 100 qubits — quantum-based units of information — today to 4,158 qubits by 2025.[841] IBM offers a cloud-based quantum computing service which enables the creation of powerful algorithms that can speed up applications by a factor of 120.[842]

THE OPPORTUNITY

Research in quantum physics has the potential to radically disrupt communications, encryption, computing and optics. Experiments have already shown that it is theoretically possible to teleport particles and photons while retaining their characteristics.[843] And, while this is not exactly teleportation, NASA has used hologram technology to project a doctor onto the International Space Station, which is seen as one way to expose more people to space.[844]

Holoportation and potentially teleportation will open up multiple new possibilities in communications, digital realities, medicine, space and atomically precise engineering. In communications, holoportation and teleportation will offer an ultra-secure way to transfer and exchange large quantities of data and send secure encrypted messages. They can be used in immersive environments to transmit views of people (and perhaps eventually people themselves) in real time, eliminating digitally generated avatars.[845]

The movement of people and goods and our ability to participate in social and economic activities have been core to human identity and purpose. Evolving teleportation to atoms and one day people would mean that teleportation can direct materials to precise locations without changing their properties.[846] This would have an impact on space exploration, medicine and even our understanding of what being human means, and hence what our purpose is on earth.

Teleportation of people and things would lead to a repurposing of all means of transportation, the associated infrastructure, utilities and how we deliver services. It would also transform what we expect from education, medicine, fitness, leisure activities, employment, shopping, travel, tourism and social gatherings, both at the individual level and at the community level. Our concept of space and time would fundamentally change.[847]

Teleportation of people and things would change life as we know it.

BENEFITS

Secure, instant and controllable transmission of people and materials enabling realistic and secure experiences, communications and medicine.

RISKS

Unintended consequences such as sub-atomic damage to particles. Risk of winner-takes-all use of teleportation technology. Physical extinction as a result of being everywhere, anywhere, at any time.

CHINA

has committed

$15 BILLION

of public funding over five years
(2020–2025) to **quantum technology**

METHODOLOGY

REVIEW OF PUBLISHED TRENDS AND FUTURES

- List of reputable, global or influential institutions that publish trends or future reports with a balance across international government organisations, academia, government and private sources.
- Gather reports published between September 2021 and September 2022.
- Analyse the content and extract key messages.

THIS YEAR A detailed review of 56 reports published by 50 reputable organisations from a total of 160 initial reports uncovered key trends, megatrends and uncertainties across geographies.

EXPERT INTERVIEWS

- Identify a main list of experts to approach for interviews ensuring that there is coverage across geographies, area of expertise and sectors.
- Select experts who did not participate in interviews the previous year.
- Conduct virtual roundtable interviews under Chatham House rules, with the focus on growth, prosperity and well-being, seeking answers to the questions: **'Irrespective of where the world is today, what might the future 50 years from now look like? What is your vision for the future? What is your wish?'**

THIS YEAR Of the 30 experts, 9 provided global input, 5 from the Middle East and North Africa (MENA) and 16 from other countries and region in interviews conducted between 26 July 2022 and 6 September 2022.

VIEW ON THE FUTURE AND THE PROCESS OF FORMULATING NEW IDEAS

- Use the metareview and analysis of interviews to validate uncertainties, assumptions and megatrends, i.e. to reflect against our point of view on the future.
- Brainstorm and draft opportunities and questions of the future using combination and what-if analysis to finalise a list of opportunities.
- Select 50 opportunities to feature in this year's report and deduced categories.

THIS YEAR An initial brainstorm generated a total of 237 opportunities.

This research was undertaken by Dubai Future Research, the research arm of the Dubai Future Foundation. The Dubai Future Foundation produces insights and foresight reports using evidence-based analysis and imagination that enable stakeholders to anticipate and better navigate the future. Our publications can be found at www.dubaifuture.ae/insights/.

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GLOSSARY

A

Advanced machine intelligence

A future form of artificial intelligence, advanced machine intelligence (in the context of The Global 50) is a product of algorithms, data and processing power – including quantum computing – that enables computers to learn from data and to analyse and model vast datasets at speed in order to carry out advanced problem-solving and complex tasks. Advanced machine intelligence is referred to in the opportunities.

Agrifood systems NEW

Agrifood systems encompass all activities in the agricultural sector: specifically, all processes involved in the production, storage, transportation, distribution and disposal of agricultural products, as well as inputs and outputs, consumers and suppliers and associated management and underlying policies.

Agritech

Agritech covers a range of technologies contributing to increased agricultural yields and efficiency. It spans genetic modification, chemical and biochemical pesticides, herbicides and fertilisers and technologies for water and effluent management, harvesting, animal husbandry and storage.

Augmented reality (AR) NEW

Augmented reality includes both wearable technology and the outputs of superimposing virtual reality or digital media, smells, sounds and other sensory perceptions onto the real world.

Autonomous ground vehicle (AGV) NEW

Autonomous ground vehicles are robotic vehicles that can perform various tasks without human input. A combination of pre-programmed points, computer vision and sensors guide their movement. More advanced AGVs use AI to make decisions and navigate through, and in, various locations.

Autonomous ground vehicle (AGV) Lockers NEW

AGVs fitted with lockers that can travel to neighbourhoods, make door-to-door deliveries (where available) and notify customers to collect their parcels.

Avatar NEW

An avatar is a two-dimensional or three-dimensional image that is digitally designed by a human or computer. The image is intended to embody a person's character and may be a partial or full representation – exaggerated or not – of how they look. Alternatively, it may be a generated digital identity developed through the person's choice of character, icon or persona.

B

Biomaterials

Biomaterials are matter, surfaces or constructs that interact with biological systems. They can be natural or synthetic, incorporating metal, polymer or ceramic components. Biomaterials are designed to have specific characteristics for use in, for example, medicine and healthcare, textiles, building materials or packaging.

Biomimicry

Biomimicry is the imitation of natural biological forms, properties or processes in engineering and design approaches to develop better products and processes.

Biotechnology

Biotechnology uses and engineers living organisms and biological matter (genetically or at the molecular level) to develop processes and products for healthcare, pharmaceuticals, materials, fuels and agriculture and food systems.

Brain–computer interface (BCI)

Brain–computer or brain–machine interfaces are communication pathways that use wires connected to the brain or an external device to 'read' the brain's neural signals (electron activity) or send signals to the brain using electric currents.

C

Carbon capture and storage (CCS)

Carbon capture and storage is the process of capturing and storing atmospheric carbon dioxide (CO_2). CO_2 can be stored through geological capture – by converting the CO_2 gas into liquid under pressure and pumping it into porous rock or former oil-extraction sites. Alternatively, biological carbon capture is the natural absorption of CO_2 by vegetation, soil and the oceans.

Carbon sink NEW

A carbon sink is anything found in nature that captures and stores carbon dioxide from the atmosphere. Examples include soil, plants and oceans.

Compound annual growth rate (CAGR)

The compound annual growth rate is the average annual growth rate over a specific period of time that is greater than one year.

Cryptocurrency

A cryptocurrency is a digital currency that relies on encryption for transactions and to produce new units (or coins). Cryptocurrencies are verified and traced using distributed ledger technology (DLT).

D

Decentralised autonomous organisation (DAO)

A decentralised autonomous organisation is an organisation that is governed by code and not a CEO or board of directors. Governance tokens are held by various stakeholders who have an interest in a particular project or the organisation and who subsequently vote on decisions.

Decentralised autonomous organisation (DAO) proposals

Ideas presented to a DAO community for consideration and votes.

Decentralised finance (DeFi) NEW

Decentralised finance is a type of financial service that avoids all centralised financial service institutions and intermediary approaches to saving, transferring, loan disbursal and other financial services. Enabled by secure distributed ledger technology (DLT) and digital wallets, DeFi empowers individuals, enabling them to carry out peer-to-peer financial digital exchanges. It is claimed that DeFi avoids all of the red tape associated with financial services today.

Decibel (dB) NEW

The decibel is the standard unit for measuring how loud a sound is.

Denial of service (DoS)

Denial of service is a type of cyberattack that restricts access to a system or many systems that provide services to users.

Digital native brand (DNB) NEW

Digital native brands are brands that are born and operate entirely online. They do not establish a physical presence and their employees work remotely, yet many such companies are able to generate revenues similar to those of the Global or the Fortune 500 or greater. Their only physical presence may be for shipping and distribution in the case of physical goods. Also called native virtual company (NVC).

Distributed ledger technology (DLT) NEW

A distributed ledger is a database of information that is simultaneously duplicated across a network of computers in different locations. Blockchain, an example of a DLT, promises to deliver flexibility, security and efficiency in recording and retrieving information. In contrast to a centralised ledger, it is a flexible system for recording information. A distributed ledger is a decentralised database that processes, validates and records transactions that have been agreed upon by all parties involved. Validated transactions are timestamped with a unique encrypted signature. All participants on the distributed ledger can view all records.

Driver

Drivers include phenomena, events, policies, strategies or scientific and technological advances that create the conditions for a trend to manifest itself and/or accelerate its impact. They can be deliberate or spontaneous and create shifts in demand, behaviour and policies.

E

Ecosystem

An ecosystem consists of all living matter and organisms in a space, their physical environment and the interactions between them.

Exascale (computing) NEW

Exascale computing is a new type of supercomputing that surpasses the capability of supercomputers. While supercomputer performance is reported in FLOPS – floating-point operations per second – exascale computing performance is reported in exaFLOPS, with an exaFLOPS being equivalent to 10^{18} FLOPS.

F

Faraday cage NEW

The Faraday cage, or shield, was invented by Michael Faraday in the 19th century. Faraday discovered that a thin shield of materials could obstruct electromagnetic fields and protect anything or anyone inside an enclosure – hence the word ‘cage’ – covered with these materials from electromagnetic radiation.

Fascia NEW

All of the organs, blood vessels, bones, nerves and muscles in the human body are covered by the fascia. It is a thin web of connective tissue that holds everything together. However, with ageing, lack of movement, excessive repeated movement or trauma, it tightens up and hardens around what it covers, causing pain.

Flash loans NEW

Flash loans are available to users of decentralised finance (DeFi). Users can obtain unsecured loans from lenders without intermediaries. They are 'flash' loans because they are enabled by distributed ledger technology (DLT), which enables them to be returned within the same transaction, allowing for arbitrage (i.e. buying and selling to take advantage of price differences) across other platforms.

G

Gene editing

Gene editing involves making highly precise changes to a DNA sequence using enzymes that have been engineered to target a specific sequence for removal and replacement.

Gene therapy

Gene therapy involves modifying an individual's genes to cure or treat a disease. Therapies include replacing a disease-causing gene with a healthy copy, deactivating a disease-causing gene or introducing a new or modified gene to treat a disease. Gene therapies are in the research stage for cancer, genetic diseases and infectious diseases.

Geoengineering

Geoengineering covers a set of technologies designed to manipulate the environment to mitigate or partially prevent climate change effects. Geoengineering approaches include solar radiation management, cloud seeding and carbon dioxide removal.

Geothermal power NEW

Geothermal power is a type of renewable energy generated from heat stored in rocks and fluid deep underneath the earth's crust, where temperatures reach thousands of degrees Celsius.

Gig economy

In the gig economy, economic activity is based on flexible and temporary employment and contracts, either as people's primary income or as supplementary income.

Greenhouse gases (GHGs) NEW

Greenhouse gases are gases that trap heat emitted in the earth's atmosphere, causing the earth's temperature to rise either immediately or over many years. This process is known as the greenhouse effect. The accumulation of GHGs is the main cause of climate change. Gases are emitted from industrial processes, agriculture and some modes of transportation. However, they can also be emitted from natural sources such as volcanoes and as a result of deforestation and melting ice sheets.

Greenwashing NEW

Greenwashing is the name given to the practice of intentionally making exaggerated environmental disclosures, engaging in environmental initiatives and/or issuing environmental commitments that are not implemented in practice or do not deliver the intended impact. It can mislead investors, consumers and the general public about commitments to environmental goals.

Gross national income (GNI)

Gross national income consists of gross domestic product (GDP) plus net overseas receipts from employees' compensation in addition to property income and net taxes after production subsidies.

Gigawatt (GW)

A gigawatt is a unit of energy, equal to 1 billion watts.

Gigawatt hour (GWh)

A gigawatt hour is a unit of energy representing one billion watt hours and equivalent to one million kilowatt hours (KWh).

H

Human genome NEW

The human genome consists of three billion base pairs of the human DNA (deoxyribonucleic acid). Thousands of genes have been decoded so far.

Hyperloop

A hyperloop is an ultra-high-speed transport technology that uses a sealed, low-pressure tunnel or system of tunnels. Electromagnetic levitation allows autonomous pods to be propelled through the hyperloop with almost no friction.

I

Internet of Things (IoT) NEW

The Internet of Things (IoT) is a concept referring to the many devices and sensors that are connected to the internet. In this way, captured data can be collected, shared and analysed for various purposes, such as health monitoring, improvement and delivery; managing smart cities; monitoring and improving manufacturing; and administering transportation.

Interoperability

Interoperability is the capacity of different systems, devices, applications and products to process and exchange data without delay, disruption, errors or inconvenience to the end user.

M

Machines

Machines (in the context of The Global 50) are computers or robots with intelligent processing capacity. See also advanced machine intelligence.

Microplastics NEW

Microplastics are minuscule plastic particles (under 5 mm in size) that emerge from various sources and processes, including friction of wheels on roads, clothing manufacturing, plastic goods and industrial waste. Microplastics end up in the atmosphere or in the oceans and seas and are a health concern to both humans and animals who ingest them either on land or in water.

Muon NEW

Muons are formed when highly electrically charged particles – cosmic rays – arrive from outer space and go through the earth's atmosphere. Muons are similar to electrons but over 200 times heavier, making them capable of going through dense solids, including all levels of earth itself.

N

Nanocatalysts NEW

Nanocatalysts are nanoparticles that increase the rate of a chemical reaction without themselves being transformed by the reaction.

Nanometres NEW

A nanometre is a standard unit of size: 1 metre is equivalent to 1 billion nanometres.

Nanoparticles NEW

A nanoparticle is a particle that is under 100 nanometres in size.

Nanoscale NEW

Nanoscale is a scale used to measure lengths under 100 nanometres.

Nanotechnology NEW

Nanotechnology is research, science and technology conducted at nanoscale.

Native virtual company (NVC) NEW

See digital native brand (DNB).

Net positive NEW

The term 'net positive' refers to the state in which the amount of greenhouse gases (GHGs) removed from the atmosphere is greater than the amount of GHGs emitted into the atmosphere. It can also refer to the general position of achieving more positive than negative impact on the environment, society and beyond.

Net zero NEW

The term 'net zero' refers to the state in which the amount of greenhouse gases (GHGs) emitted into the atmosphere is equal to and balanced by the amount of GHGs removed from the atmosphere. It can also refer to the general position of balancing positive and negative impacts on the environment, society and beyond.

Non-fungible token (NFT) NEW

Non-fungible tokens represent real or digital assets that are secured by smart contracts and reside on a blockchain with unique codes and metadata that distinguish them from each other. NFTs can be exchanged with cryptocurrencies. Assets include animations, images, text, tweets, in-game items, tickets and others.

P

Particulate matter (PM) NEW

Particulate matter consists of small particles found in the air. It may give rise to health concerns and may come from natural or synthetic sources. It includes dust, dirt, soot and smoke, and it may also be in liquid form. PM is sometimes reported as either $PM_{2.5}$ or PM_{10}, referring to the size of the particulate in micrometres (μm).

Post-traumatic stress disorder (PTSD) NEW

Post-traumatic stress disorder is a serious mental health condition. It occurs as a result of a traumatic event or experience that people consciously or subconsciously recall and that affects their decisions in daily life.

Proteome NEW

The proteome is the set of proteins in an organism. Proteins are key to the functioning of cells.

Q

Quantum computing

Quantum computing is based on the principles of quantum physics and exploits the ability of subatomic particles to exist in two states simultaneously (e.g. 1 and 0). This exponentially increases how much data can be encoded (as qubits) and thus enhances potential computational power.

R

Radio-frequency identification (RFID) tag NEW

Radio-frequency identification tags are barcodes embedded in or placed on goods in order to identify them, track them and communicate information through radio frequency for analysis.

Ransomware NEW

Ransomware is malicious software that is designed to carry out cyberattacks to restrict victims' access to their system or information in return for payment.

Ransomware-as-a-service (RaaS) NEW

Ransomware-as-a-service is a business model and service – including software, infrastructure and processes – offered by and to cybercriminals to enable them to carry out ransomware attacks on others.

S

Signal

Events, hypes, new technologies, products and services, local and regional data and disruptions that have the potential to grow to become drivers or trends.

Smart contracts NEW

Smart contracts are written in code and stored on a blockchain to safeguard against theft and to protect the ownership of underlying real or digital assets.

Space debris NEW

Space debris encompasses both natural (e.g. meteoroids) and artificial waste that is in orbit around the earth.

Supercomputer NEW

A supercomputer is a computer that performs at a significantly faster rate than general computers, as measured in floating-point operations per second (FLOPS).

Synthetic biology

Synthetic biology involves the redesign or re-engineering of organisms and molecules to give them new properties – for example, synthetic enzymes capable of digesting plastic.

T

Teleportation NEW

Teleportation is a theoretical possibility involving the transportation of information and matter based on the theory of quantum mechanics and entanglement.

Telesurgery NEW

Telesurgery is surgery where the patient and the surgeon are in different physical locations.

Terawatt hour (TWh) (NEW)

A terawatt hour is a standard unit of energy equivalent to 1,000 gigawatt hours (GWh).

Trend

A sustained socio-economic, environmental or technological change that has a measurably rising influence, such as physical or financial impact.

V

Virtual reality (VR) NEW

Virtual realities are computer-generated environments in which users can immerse themselves using wearable headsets or other accessories. In this way, they can interact with others and simulate real-life experiences and reactions in fictitious environments.

W

Web 3.0 NEW

Web 3.0, or Web3, is the third generation of the internet. It is characterised by greater reliance on AI for enhanced searchability and interaction.

Y

Youthwashing NEW

Similar to the term greenwashing, youthwashing (in the context of The Global 50) means intentionally making exaggerated disclosures related to young people, engaging in youth-based initiatives and issuing commitments about young people that are not implemented in practice or do not deliver the intended impact.

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ABOUT THE DUBAI FUTURE FOUNDATION

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Dubai Future Foundation aims to realise the vision of His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, for the future of Dubai and consolidate its global status as a leading city of the future. In partnership with its partners from government entities, international companies, start-ups and entrepreneurs in the UAE and around the world, Dubai Future Foundation drives joint efforts to collectively imagine, design and execute the future of Dubai.

Under the supervision and with the support of His Highness Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, Crown Prince of Dubai, Chairman of the Executive Council of Dubai and Chairman of the Board of Trustees of Dubai Future Foundation, DFF works on a three-pronged strategy: to imagine, design and execute the future. It does this through the development and launch of national and global programmes and initiatives, preparing plans and strategies for the future, issuing foresight reports and supporting innovative and qualitative projects. These contribute to positioning Dubai as a global capital for the development and adoption of the latest innovative solutions and practices to serve humanity.

Dubai Future Foundation focuses on identifying the most prominent challenges facing cities, communities and sectors in the future and transforming them into promising growth opportunities by collecting and analysing data, studying global trends and keeping pace with and preparing for rapid changes. It is also looking at future sectors, their integration and the reshaping of current industries.

Dubai Future Foundation oversees many pioneering projects and initiatives, such as the Museum of the Future, Area 2071, The Centre for the Fourth Industrial Revolution UAE, Dubai Future Accelerators, One Million Arab Coders, Dubai Future District, Dubai Future Solutions, Dubai Future Forum, Dubai Metaverse Assembly. Its many knowledge initiatives and future design centres contribute to building specialised local talents for future requirements and empowering them with the necessary skills to contribute to the sustainable development of Dubai.

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