The Winds of Change: **Technological Innovation**

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As part of "The Winds of Change" series, Sacha El Khoury, lead portfolio manager of the BMO Sustainable Opportunities European Equity Fund, addresses some of the most important sustainability megatrends that are changing the world around us, reshaping the investment landscape, and talks about how the fund is embracing the opportunities they create.

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Key risks

The value of investments and any income derived from them can go down as well as up and investors may not get back the original amount invested.

Screening out sectors or companies may result in less diversification and hence more volatility in investment values.

Unlocking opportunities in technological innovation

Technological innovation has been a colossal driving force behind modern progress. More recently through the pandemic, technology has helped the world stay connected through a series of lockdowns that have physically forced people apart. It is only expected that extraordinary conditions precipitate extraordinary changes in industries, and 2020 certainly delivered that. Lockdown has acted as a huge accelerant to pre-existing trends, particularly in the tech and digital spaces, condensing multi-year change into one short year. But with or without Covid, the general pace of change in this field is certainly accelerating and we strongly believe technology will continue to shape and mould the world we live in. As investors, not only do we want to remain on the right side of technological advances, but we want to support those technologies that are helping **connect** the world, **protect** the environment and **digitally empower** people.

What's changing?[1]

The Zettabyte Era: "Internet of Things" (IoT) devices show no sign of slowing down, with the number of devices increasing in the home and outside the home, in places like factories and hospitals. Already much of our lives are lived on wireless devices like mobile phones. In the not-so-distant future, machines, appliances, autonomous cars and even traffic lights could be connected and communicating with one another, generating enormous amounts of data.

How much data are we talking about? The current estimate for data created every day stands at 2 Zettabytes, or in terms of bytes: circa 2 quintillion bytes. There are 18 zeroes in a quintillion. That's a lot of data. The rate of data growth is also skyrocketing: 90% of the world's data has been created in only the past two years.[2]

[1] The below is in no way an exhaustive list
[2] Information Overload Research Group (2019)

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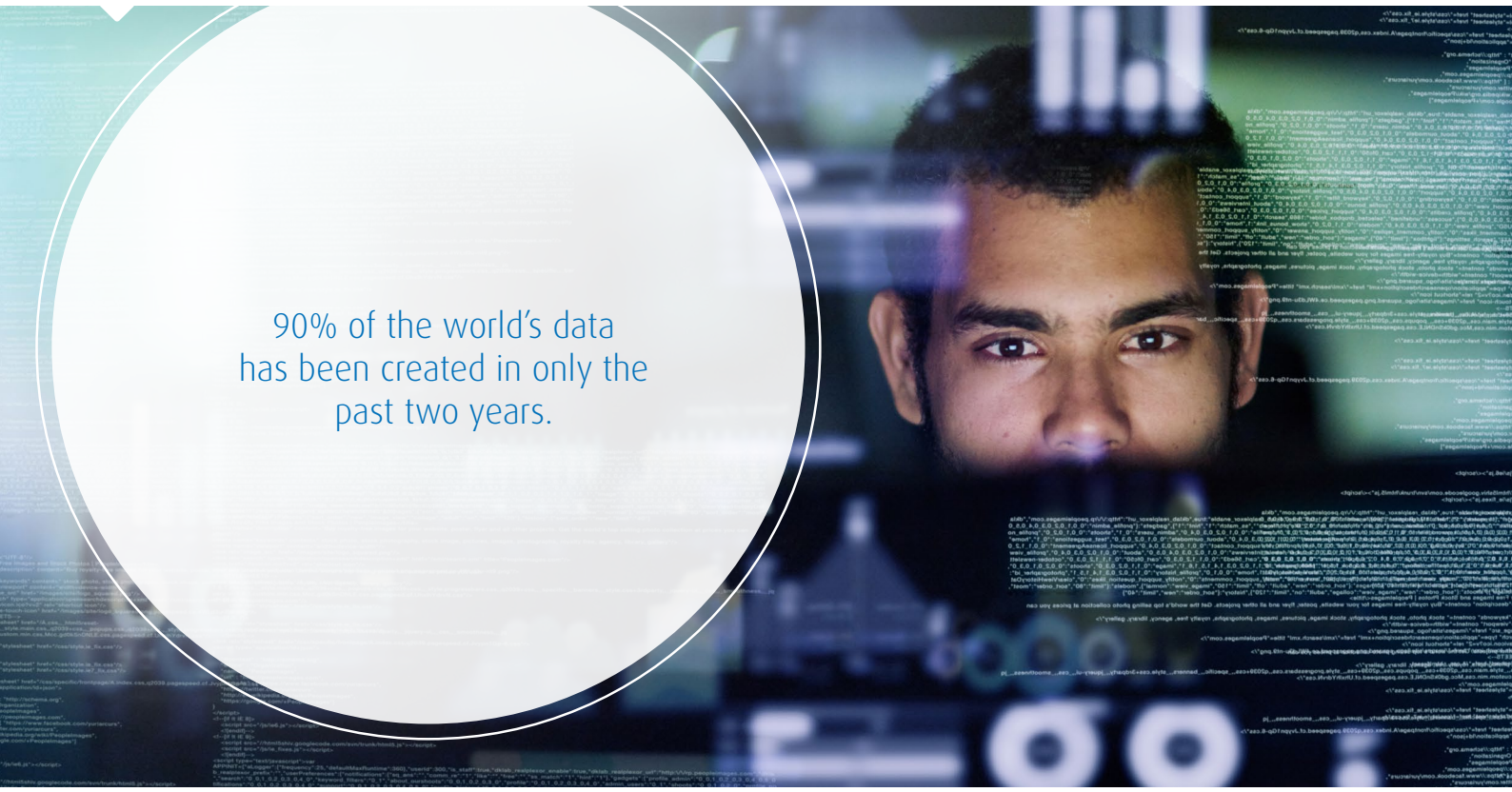
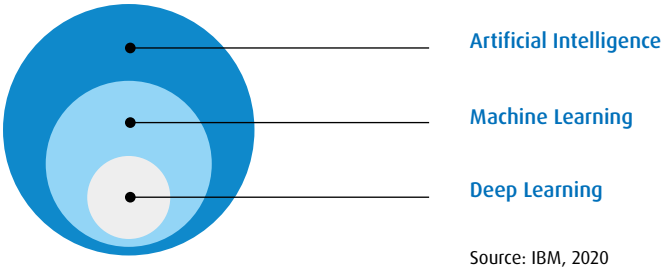


Leaps and bounds: Humans are not the only ones capable of generating data. In fact, it is estimated that machine-generated data accounts for 40% of internet data in 2020.[3] While Artificial Intelligence (AI) is software code written by humans, Deep Learning (DL) is code written by data and machines themselves, and we have only scratched the surface of DL capabilities. DL is creating the next generation of computing platforms, such as conversational computers, self-driving cars, or consumer apps like TikTok, which uses DL for video recommendations, all capable of exponentially increasing the software's capability. For instance, smart speakers like Amazon's Alexa, answered 100 billion voice commands in 2020 – 75% more than in 2019. In fact, 2020 was the breakthrough year for conversational AI. For the first time, AI systems could understand and generate language with human-like accuracy.

The robots are coming...to help: The march of robots and automation has long been mooted, whilst proceeding slowly. But as reported by the Financial Times, even as broad exports from Japan dropped last year, the export of industrial robots leapt **13%** YoY in Q2 2020. In America only pharmaceuticals saw a bigger jump in YoY imports than robotics did the first three quarters of 2020. Fears abound that automation will destroy jobs, but there is an argument to be made for the shift of labour from unskilled to skilled, from unpaid to paid – consider the introduction of the washing machine, which monetised unpaid time spent cleaning clothes as washing machine manufacturers and laundromats took hold. The gains in productivity from automation are not insignificant either and will likely provide considerable boosts to GDP growth, as well as total employment levels.

Artificial intelligence (AI) refers to any human-like intelligence exhibited by a computer, robot, or other machine through complex algorithms and data processing. AI mimics the perception, learning, problem solving, and decision-making capabilities of the human mind.



Source: IBM, 2020

[3] Raj, P., and Deka, G. (2014), Handbook of Research on Cloud Infrastructures for Big Data Analytics

The pace of technology adoption is picking up – and so is the rate of disruption: The rate of innovation and technology adoption is accelerating – it took decades for the telephone to reach 50% of US households in the early 1900s, whilst the adoption of the mobile phone in the 1990s was decades faster, taking under five years to reach 50% of US households. More recently, innovations introduced are being adopted at astronomical rates. Covid has also catalysed the pace of adoption in industries like brick-and-mortar retail. According to the Office for National Statistics, E-commerce as a share of addressable retail rose in the UK from circa 7% in 2010 to circa 20% at the start of 2020, before leaping to well over 30% penetration during the next 12 months. Additional data reveals it took a decade for online grocery sales in the UK to creep from 2.5% of total grocery to 5%, before exploding to more than 10% in under a year, even with supermarkets open. Technological innovation is the mother of all disruption, and a major driver of change. The pace of change will only accelerate going forward as the rate of adoption increases.

How are we embracing the change?

Industrial revolution: Technology has revolutionised the industrial world – from automation to Industry 4.0, the holy grail of manufacturing technologies and the basis for "smart" factories. Imagine a factory floor where problems are dealt with before they even happen, minimising downtime; where energy efficiency is optimised, minimising environmental and economic costs; where traceability is the norm, minimising wastage and reinforcing integrity of production. **Dassault Systèmes** is one of the leading software providers that enable Industry 4.0 and are ushering industrial clients and others through that transition.

Making sense of data: The proliferation of data points is problematic to say the least. Data in and of itself is useless without a framework to make sense of it. Enabling better, faster decisions by providing tools that quickly find targeted and actionable information is one of the ways **RELX** makes sense of the enormous amounts of data it wields on behalf of its clients. **RELX** will serve customers across

Processing power is a big factor in explaining the rapid pace of technological advances: in the mid 80s, a super computer cost $32 million. Today, a smartphone with the same processing power will cost you just a few hundred dollars.

What is Big Data? It is the confluence of Internet data, business data, and sensor data that together requires a new generation of technical architectures and analytics to process.

the pharmaceutical industry for instance, where its tools enable faster approval times for drugs, or in the financial industry where their solutions help tackle fraud, identity theft, cybercrime and bribery, and help lenders lend more responsibly.

Empowering, digitally: **Wolters Kluwer** is another software company which develops expert solutions that endeavour to achieve the same thing – provide customers with the right information, packaged in the right way, at the right time, and at the point of maximum impact. Nowhere is that clearer than in their healthcare end-market, where their expert solution UpToDate puts the latest science and evidence into the hands of doctors to get the best outcomes. They leverage physician-authored clinical data points and synthesize all of that data into trusted evidence-based recommendations that are proven to improve patient care, quality and outcomes.

The above-mentioned data crunchers and solution providers are fully entrenched in their customers' processes and their solutions deliver enormous value-add at a relatively low cost. In that sense they are very hard to displace and customers are sticky, giving them a very stable and recurring revenue base from which to grow.

The Enablers: Big Data, the Internet of Things, autonomous driving, AI, 5G mobile networks – they are a lot more than title-grabbing catch phrases. They are our technological future, and this future is only possible because of semiconductors or microchips. Storing data and processing data are all possible because of these tiny, barely visible electronic components that have become the building blocks of our modern society. **Infineon** is a world leader in semiconductor solutions and is particularly exposed to the automotive end-market (40%) where the energy transition is well underway with the growth of Electric Vehicles (EVs), which require multiples of microchips per car relative to legacy ICE (Internal Combustion Engine). But these complex microchips wouldn't even be possible without the machines that build them, particularly those provided by **ASML**. This Dutch company's unique lithographic systems are used to make the machines used by semiconductor manufacturers worldwide. They have a monopoly in the next generation tool, EUV (Extreme Ultraviolet Lithography), which is crucial to deliver next-gen microchips. Semiconductors are the backbone of a smart and connected world, and none of that would be possible without ASML's technology.

Semiconductors include data processors – CPUs or logic chips – and Memory chips (DRAM and NAND) which are used to store data in memory

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A final note...on the hidden costs of technology

The gains in productivity and efficiency from technology are clear to see – but what about the costs associated with the massive boom in tech? With the exponential growth in data collection and use, data centres are at the heart of this matter: the servers, storage equipment, backups and power cooling infrastructure in data centres require electricity, and lots of it. Globally, data centres accounted for approximately 1% of the global total electricity consumption in 2018[4] – this is more than the national energy consumption of some countries – and they emitted as much CO_2 as the commercial airline industry.[5]

Those are scary numbers, but let's put that into perspective – a new study of data centres globally found that while their computing output jumped 6x from 2010 to 2018, their energy consumption only rose 6%.[6] Data generation and usage will grow going forward, but the relationship with energy consumption is not linear, because of a number of important factors:

- **Efficiency is the name of the game**: Processor efficiency has improved, reducing idle power, and increasing storage drive density and slowing server growth.
- **Hyperscale my data**: The shift to cloud computing relies on hyperscale data centres: the largest and most efficient type of data centres run by the likes of Amazon Web Services (AWS), Google, Facebook and others. They usually boast the most cutting-edge technology that helps reduce energy costs. The shift from on-premise to large scale data centres has in fact been shown to reduce the workload carbon footprint by 88% for the median surveyed US enterprise data centre.
- **Tech to the rescue**: AI plays a crucial role in reducing the energy used for cooling – Google's DeepMind AI for example has driven the energy used for cooling at one of Google's data centres down by 40% in 2016, using only historical data collected from sensors within the data centre.
- **Location, location, location**: Setting up data centres in cold regions helps reduce energy usage by removing the need for cooling equipment altogether. Microsoft is said to be experimenting with innovative technologies such as installing data centres on the seabed.
- **Renewables**: Electricity accounts for circa 70% of data centres' total operating costs.[7] As renewables start becoming cost competitive versus fossil fuel options, tech firms are committing to boosting their renewables exposure. Facebook, Google, Microsoft and Amazon were amongst the top 10 largest buyers of renewable energy in the US in 2019.[8]

As ever, rather than seeing them as a threat, data centres arguably present an opportunity to accelerate the sustainable energy transition, because they sit at the nexus of energy efficiency, renewable energy and burgeoning data economy enabled by digitalisation.

On average, hyperscale data centres only require 16% of the power as compared to on-premises infrastructure for the same amount of computations (AWS, 2020).

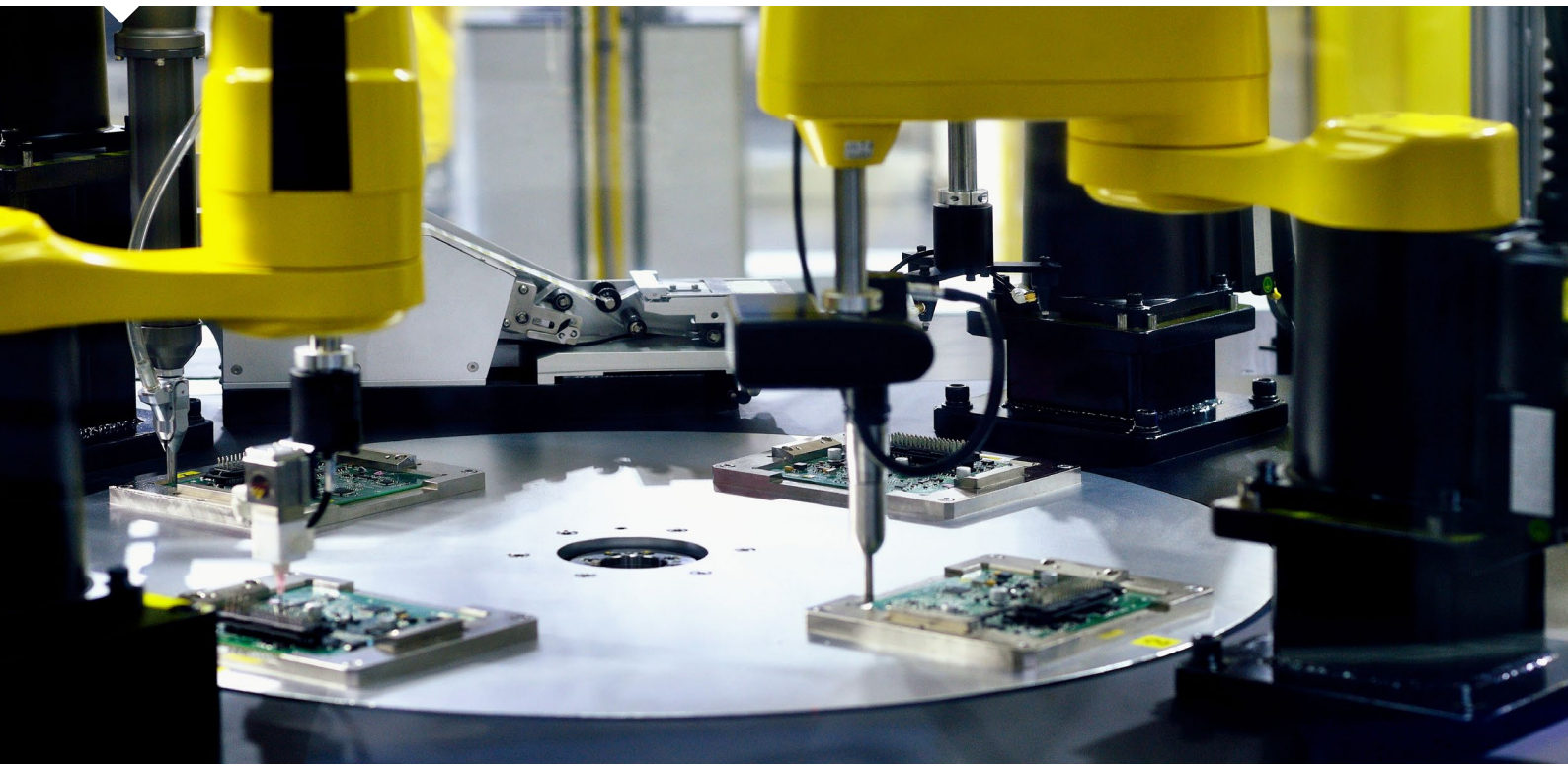
A final final note...on the hidden societal costs of AI

Industrial revolutions have led to labour displacement, and robot automation will not be different. However, the move from unskilled to skilled labour is much easier to wrap one's head around than labour displacement due to AI automation, which puts skilled jobs at risk. For more on this broad and fascinating topic, I invite you to read one of our own Responsible Investment team's analysts – David Sneyd – ESG Viewpoint on Artificial Intelligence, Automation and the Future of work.

ESG Viewpoint on Artificial Intelligence, Automation and the Future of work

Download now

[4] Masanet, E., Shehabi, N., Lei, N., Smith, S., Koomey, J. (2020), Recalibrating global data center energy-use estimates, DOI: 10.1126/science.aba3758, Science 367 (6481), 984-986
[5] Data Economy (2017), Data Centers 'Going Green' To Reduce A Carbon Footprint Larger Than The Airline Industry
[6] Masanet, E., Shehabi, N., Lei, N., Smith, S., Koomey, J. (2020), Recalibrating global data center energy-use estimates, DOI: 10.1126/science.aba3758, Science 367 (6481), 984-986
[7] SSG (2017), Power in the Data Center and its Cost Across the U.S.
[8] The Renewable Energy Buyers Alliance, 2019



The Sustainable Opportunities European Equity Strategy has a large exposure to technological innovation, via its exposure to the Connect & Protect theme and the Digital Empowerment theme, both themes together accounting for 26.3% of the fund (percentages as at 28 Feb 2021).

Health & Wellbeing	30.0
Digital Empowerment	19.0
Sustainable Finance	18.8
Sustainable Cities*	14.4
Resource Efficiency	10.1
Connect & Protect	7.3

*Includes Energy Transition and Sustainable Mobility themes

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