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Sustainable & Thematic Investing

2030 Thematic Roadmap: 150 Trends

Our 2030 Thematic Roadmap outlines 150 trends across 6 paradigms that we believe will dominate our discussions with investors over the next decade. Given the rise of ESG and Thematic Investing, the purpose of this report is to explore the possible trends that could fundamentally disrupt society by 2030.

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CONTENTS

EXECUTIVE SUMMARY

Our 2030 Thematic Roadmap outlines 150 trends across 6 thematic paradigms that we believe will dominate our discussions with investors over the next decade – Figure 1. We acknowledge that some trends are more speculative, while others build on risks that have already begun to crystallise. Leveraging the expertise of our sector analysts and our Research Data Science platform, we identify the trends that we believe are visible today relative to the emerging trends of tomorrow, and the trends to consider through an ESG & Sustainability lens. While these are not predictions, they provide food for thought and a starting point for debate as we consider the possible trends that could fundamentally disrupt areas of society by 2030. We mark the 2020s as the decade of decarbonisation (clean tech & renewable infrastructure), the acceleration of enabling technology (5G, AI & IoT), ongoing demographic shifts (global ageing & urbanisation), the rise of the conscious consumer (healthy living & the circular economy) and the shift towards a smart society (predictive healthcare & smart cities).

We highlight 4 key sections to this report:

1) **2030 Thematic Roadmap – 150 trends across 6 thematic paradigms (Figure 1):** In collaboration with our sector analysts, we plot the 150 trends across 6 thematic paradigms: i) Technology & Innovation, ii) Consumer, Food & Retail, iii) Industrials, Manufacturing & Transportation, iv) Health & Modern Science, v) Energy & Environment and vi) Society & Culture. We selected 'Likelihood' and 'Impact' as our respective horizontal and vertical axes and thus the basis of our mapping. That is, to what extent do we believe these 150 thematic trends are likely to impact society by 2030 given some trends may be influenced by external factors such as regulation, infrastructure, consumer adoption and pricing? (Refer to Appendix 1 for our Roadmap Methodology).

2) **'2020s – The decade of…' (Figure 2):** For each thematic paradigm, we identify the top 10 trends by impact and likelihood through to 2030. We also identify the trends that we believe are visible today relative to the emerging trends of tomorrow, and those we think are worthy of engagement through an ESG & Sustainability lens. Across our analysis, there are several overarching areas of interest that we foresee becoming more meaningful to the debate over the next decade – decarbonisation, enabling technology, demographic shifts, conscious consumerism and the smart society.

3) **Data & Investment Sciences – Corporate discussion on the 150 trends set to expand:** To better understand how the trends are being discussed by corporates, we collaborated with our Data & Investment Sciences team to search corporate transcripts for mentions of our 150 trends. Our hierarchical clustering algorithm grouped trends into *clusters* based on overlapping mentions of the different trends – Figure 9. We found that trends relating to Energy and Digital are being discussed extensively by corporates already, due to their maturity and widespread nature. Many of our emerging and key ESG & Sustainability trends are seeing limited corporate discussion today; however, we expect these to become more visible on the corporate radar in the future.

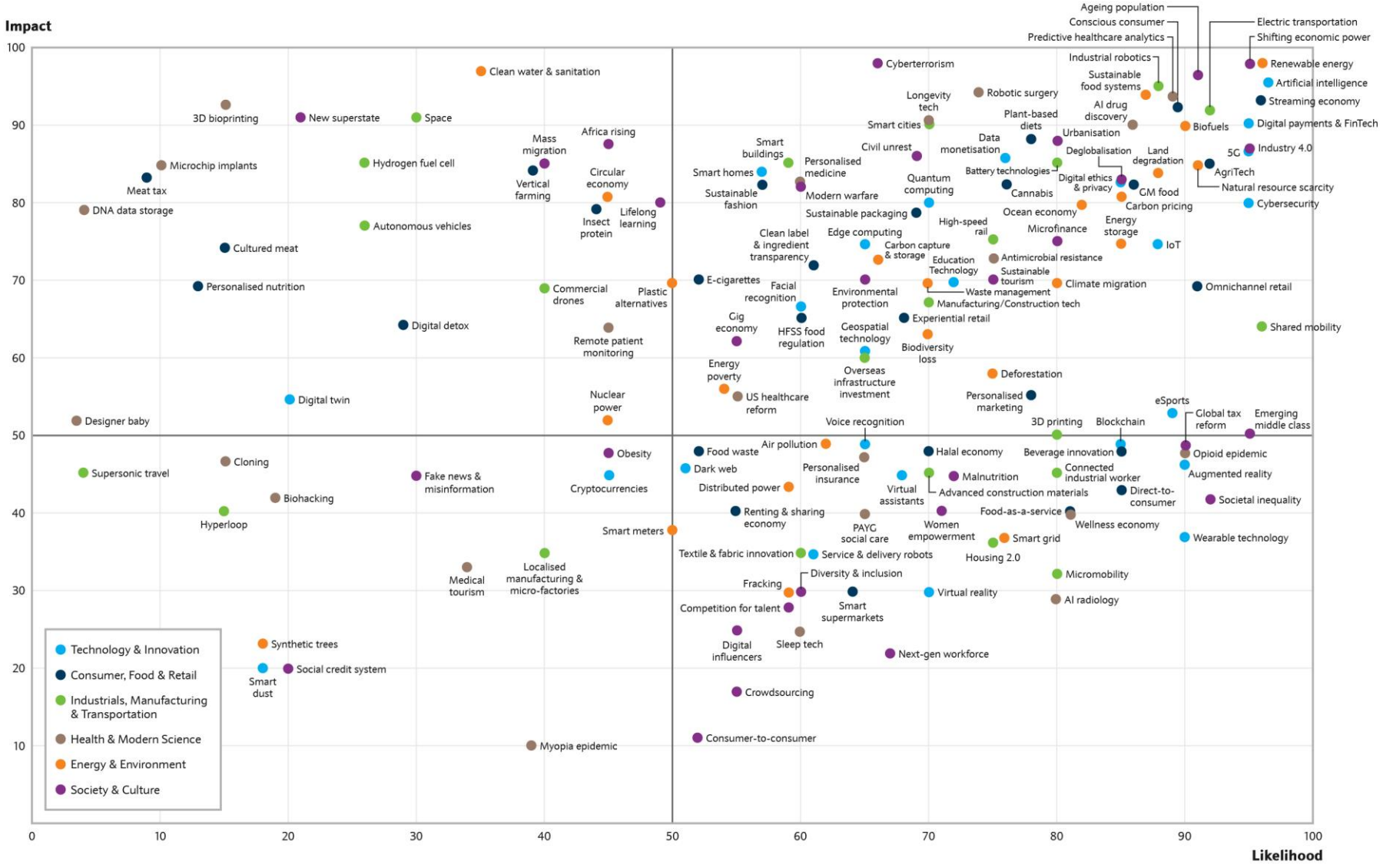
4) **Thematic Library – 2020 Catalysts:** To further support our 2030 thematic roadmap, we provide 2020 catalysts for our previously published themes including 5G, eRegulation, Generation Z, Cannabis, Smartphone Addiction, Future of Food Retail, Future of Tax, Food Waste, Education Tech, Micromobility, Plant-based Dairy, Fake Meat, Plastic Waste, Insect Protein, Drones, Global Catering, Opioids, Global Energy, Digital Payments & Fintech, Manufacturing Tech, Sustainable Tourism, Global Fashion and Utilities.

Why read this report?

Given the growing relevance of ESG and Thematic Investing, we see the 2030 Thematic Roadmap as providing our client base with a starting point for debate when investing for the next decade. Leveraging the expertise of our sector analysts and our Research Data Science platform, we analyse the 150 trends that could potentially impact investment decisions as the portfolio of the future is constructed. We acknowledge the inherent subjectivity in conducting an exercise of this nature; however, we see a key investment advantage in embracing a long-term time horizon.

For an enlarged version of the 2030 Thematic Roadmap, contact the Barclays Sustainable & Thematic Investing team.

FIGURE 1
2030 Thematic Roadmap



Source: Barclays Research.

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2030 THEMATIC ROADMAP

The Barclays 2030 Thematic Roadmap plots 150 trends across 6 thematic paradigms including: Technology & Innovation, Consumer, Food & Retail, Industrials, Manufacturing & Transportation, Health & Modern Science, Environment & Energy and Society & Culture. We selected 'Likelihood' and 'Impact' as our respective horizontal and vertical axes and thus the basis of our mapping. That is, to what extent do we believe these 150 thematic trends will impact society given some trends may be influenced by external factors such as regulation, infrastructure, consumer adoption and pricing (Refer to Appendix 1 for our Roadmap Methodology and Appendix 2 for our Trend Directory).

For each thematic paradigm, we identify the top 10 trends by Impact vs. Likelihood through 2030. We also identify trends we believe are visible today relative to emerging trends of tomorrow, and trends we believe are worthy of company engagement through an ESG & Sustainability lens – Figure 2.

Across our analysis of each thematic paradigm, there are several overarching areas of interest which we foresee becoming more meaningful to the debate through 2030. We mark the 2020s as the decade of decarbonisation (clean tech & renewable infrastructure), the acceleration of enabling technology (5G, AI & IoT), ongoing demographic shifts (global ageing & urbanisation), the rise of the conscious consumer (healthy living & the circular economy) and the shift towards a smart society (predictive healthcare & smart cities).

150 trends to mark the next decade…

We mark the 2020s as the decade of:

- **Decarbonisation (clean tech & renewable infrastructure):** The shift towards a low carbon energy system must accelerate to stay in line with the goals outlined in the Paris Agreement. The scaling of renewable deployment and long-term electrification will be a key priority for energy-intensive sectors, as reducing energy waste and decarbonising heating become focus areas for governments globally. Our thematic roadmap makes the case for alternative energy (Renewable energy and Biofuels) and additional infrastructure investment (Energy Storage and Waste Management). We foresee the impact climate change is having on society to become more visible (Land Degradation, Natural Resource Scarcity and Climate Migration), leading to additional market opportunities (Circular Economy and Sustainable Food Systems).

- **Acceleration of enabling technology (5G, AI & IoT):** The combination of 5G, AI and IoT will accelerate the transformation to Industry 4.0, as the way we work and live becomes increasingly data-driven. We see ongoing digital disruption (Digital Payments & Fintech), with some areas riper than others (Education Technology and eSports). At the consumer level, we will begin to see hyper-personalisation as a point of differentiation (Voice Recognition and Virtual Assistants), however on the flipside concerns regarding data governance will either create opportunities (Cybersecurity, Quantum Computing and Data Monetisation) or additional risk to business models (Digital Ethics & Privacy).

- **Ongoing demographic shifts (global ageing & urbanisation):** Our thematic roadmap identifies over 30 societal trends within the Society & Culture paradigm, however we see trends relating to demographics in particular being a key source of disruption given their relative predictability (Ageing Population and Urbanisation) compared to those with exposure to economic shifts and political fragmentation (Deglobalisation, Civil Unrest and

Shifting Economic Power). Several of the trends will benefit from an increased focus on ESG & Sustainability (Women's Empowerment, Obesity and Societal Inequality) and some trends we are positive on but may extend beyond our 2030 timeframe (Africa Rising).

- **Rise of the conscious consumer (healthy living & the circular economy):** Consumption habits will evolve as the modern consumer considers the impact of their purchasing decisions on the environment and/or society. A growing expectation for ethical, environmental and sustainable products/services leaves many trends well positioned across our thematic roadmap (Sustainable Packaging, Plant-based Diets, GM Food and AgriTech). New products will emerge (Beverage Innovation, Sustainable Fashion and Cannabis) and ongoing demand for convenience (Streaming Economy) will further support the need for new industry standards (Clean Label & Ingredient Transparency and Digital Detox).
- **Shift towards a smart society (predictive healthcare & smart cities):** We view the smart society as one that harnesses digital technology to maximise the performance and wellbeing of society. The healthcare sector remains significantly underinvested today, though our thematic roadmap points towards a future where prevention and early diagnosis is imperative (Predictive Healthcare Analytics, Remote Patient Monitoring and Longevity Tech). The increased availability of data suggests we should also see patient empowerment (Wellness Economy, Personalised Medicine and Personalised Insurance). Beyond healthcare, infrastructure projects also screen well (Smart Cities and Industrial Robotics).

FIGURE 2

2030 Thematic Roadmap: Analysing the 6 thematic paradigms

	Technology & Innovation	Consumer, Food & Retail	Industrials, Manufacturing & Transportation	Health & Modern Science	Energy & Environment	Society & Culture
Top 10 trends by Impact vs. Likelihood	IoT 5G eSports Artificial intelligence Cybersecurity Education technology Digital payments & FinTech Data monetisation Quantum computing Digital ethics & privacy	Sustainable packaging Plant-based diets Omnichannel retail Conscious consumer AgriTech Sustainable fashion Streaming economy GM food Cannabis Beverage innovation	Smart cities Industrial robotics High-speed rail Electric transportation Shared mobility Smart buildings Battery technologies Manu/Construction tech Overseas infrastructure investment 3D printing	Longevity tech AI drug discovery Antimicrobial resistance US healthcare reform Robotic surgery Personalised medicine Predictive healthcare analytics Personalised insurance Opioid epidemic Wellness economy	Carbon pricing Renewable energy Biofuels Climate migration Land degradation Natural resource scarcity Sustainable food systems Energy storage Ocean economy Waste management	Ageing population Industry 4.0 Cyberterrorism Deglobalisation Urbanisation Sustainable tourism Microfinance Shifting economic power Emerging middle class Civil unrest
Biggest trends of today	5G Artificial intelligence Digital payments & FinTech	Streaming economy Plant-based diets Conscious consumer AgriTech Beverage innovation	Smart cities Industrial robotics Electric transportation	Robotic surgery AI drug discovery Opioid epidemic	Renewable energy Carbon pricing Biofuels	Ageing population Shifting economic power Industry 4.0 Urbanisation
Emerging trends of tomorrow	eSports Data monetisation Cybersecurity Education technology Service & delivery robots Facial recognition	Sustainable fashion Halal economy Insect protein	3D printing Manufacturing/ Construction Tech Housing 2.0 Space	Predictive healthcare analytics Wellness economy Personalised medicine Longevity tech	Ocean economy Waste management Air pollution Circular economy	Gig economy Next-gen workforce Africa rising Sustainable tourism Cyberterrorism
Key ESG & sustainability trends	Digital ethics & privacy Service & delivery robots	Clean label & ingredient transparency Digital detox Food waste Sustainable packaging	Textile & Fabric Innovation Industrial robotics	US Healthcare reform Antimicrobial resistance Cloning	Clean water & sanitation Climate migration Energy poverty Sustainable food systems Deforestation	Women's empowerment Obesity Malnutrition Societal inequality Environmental protection

Source: Barclays Research

1) Technology & Innovation

We selected 25 trends within Technology & Innovation, with our top ten including IoT, 5G, eSports, Artificial Intelligence, Cybersecurity, Education Technology, Digital Payments & FinTech, Data Monetisation, Quantum Computing and Digital Ethics & Privacy. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 3. From an ESG/Sustainability perspective, we highlight Digital Ethics & Privacy as well as Service & Delivery Robots as we see greater corporate responsibility for consumer data and shifts in traditional labour roles.

25 trends for 2030

We define '**Technology & Innovation**' as disruptive and emerging technology that fulfils unaddressed needs and/or solves global problems. This includes the underlying technologies themselves (e.g. Artificial Intelligence, IoT, Blockchain, Augmented Reality, 5G, Virtual Reality, Quantum and Edge Computing), as well as adjacent products and services (e.g. Smart Homes and Wearable Technology). Beyond social media, the next wave of disruption within commerce is likely to be driven by voice technology and the desire to provide personalised product recommendations (e.g. Voice Recognition and Virtual Assistants).

While it is encouraging to see digitalisation becoming a permanent fixture of modern life, on the flip side concerns regarding data governance and privacy are increasing as consumers consider how companies are making use of their personal data (e.g. Digital Ethics & Privacy, Cybersecurity and Data Monetisation). Authentication of the consumer will remain a priority (e.g. Facial Recognition) for a variety of services (e.g. Digital Payments & FinTech).

New market opportunities are emerging (e.g. eSports, Education Technology, Digital Twins and Geospatial Technology), while, despite significant hype and significant levels of investment, others (e.g. Cryptocurrencies and Smart Dust) appear likely to have limited impact based on the known variables today.

FIGURE 3
Technology & Innovation – 25 trends

Technology & Innovation

25 trends for 2030:

Tech enablers
5G
Artificial intelligence
IoT
Blockchain
Edge computing
Quantum computing

Industry disruption
Education technology
Cybersecurity
Geospatial technology
Digital payments & FinTech
eSports
Digital ethics & privacy
Service & delivery robots

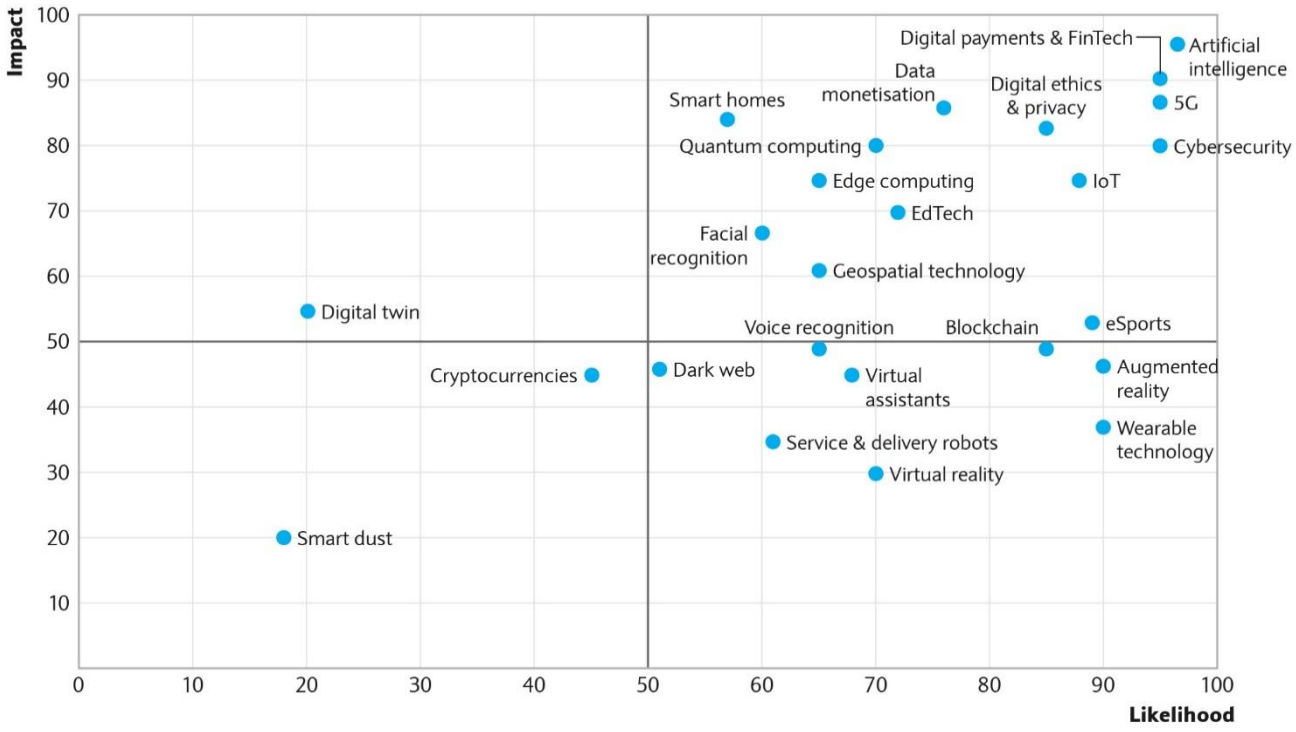
Innovative use-cases
Facial recognition
Digital twin
Smart homes
Data monetisation
Augmented reality
Virtual assistants
Wearable technology
Virtual reality
Dark web
Smart dust
Cryptocurrencies
Voice recognition

Top 10 by Impact/Likelihood:
IoT
5G
eSports
Artificial intelligence
Cybersecurity
Education technology
Digital payments & FinTech
Data monetisation
Quantum computing
Digital ethics & privacy

Biggest trends of today:
5G
Artificial intelligence
Digital payments & FinTech

Emerging trends of tomorrow:
eSports
Data monetisation
Cybersecurity
Education technology
Service & delivery robots
Facial recognition

Key ESG & sustainability trends:
Digital ethics & privacy
Service & delivery robots



Source: Barclays Research

2) Consumer, Food & Retail

We selected 27 trends within Consumer, Food & Retail – with our top ten including Sustainable Packaging, Plant-Based Diets, Omnichannel Retail, Conscious Consumer, AgriTech, Sustainable Fashion, Streaming Economy, GM Food, Cannabis and Beverage Innovation. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 4. From an ESG/Sustainability perspective, we highlight Clean Label & Ingredient Transparency, Digital Detox, Food Waste and Sustainable Packaging.

27 trends for 2030

We define **'Consumer, Food & Retail'** as new products and services within the consumer space (e.g. Streaming Economy, Experiential Retail, Smart Supermarkets and Renting & Sharing Economy, Halal Economy), as well as manufacturing processes and systems that facilitate the development of sustainable food value chains (e.g. Vertical Farming, Sustainable Packaging and AgriTech).

The consumption of meat remains a topical issue, leading to acceptance of alternative protein (e.g. Plant-Based Diets, Cultured Meat and Insect Protein) and regulatory discussion (e.g. Meat Tax). Personalisation remains a key priority for companies and the consumer (e.g. Personalised Marketing and Personalised Nutrition), as does convenience (e.g. Omnichannel Retail, Food-as-a-Service and Direct-to-Consumer).

A change in consumer sentiment (e.g. Conscious Consumer) has also led to a shift in how goods and services are valued (e.g. Food Waste, Digital Detox, GM Food, Sustainable Fashion). Industries have started to adapt (e.g. Cannabis, e-Cigarettes and Beverage Innovation) and thus new industry standards are emerging (e.g. Clean Label & Ingredient Transparency and HFSS Food Regulation).

FIGURE 4
Consumer, Food & Retail – 27 trends

Consumer, Food & Retail

27 trends for 2030:

Sustainable consumption
Sustainable packaging
Plant-based diets
Food waste
Conscious consumer
Sustainable fashion
Renting & sharing economy
AgriTech
Meat tax
Vertical farming
Insect protein
GM food
Cultured meat

Personalisation & convenience
Personalised marketing
Omnichannel retail
Experiential retail
Streaming economy
Personalised nutrition
Food-as-a-service
Smart supermarkets
Direct-to-consumer
Halal economy

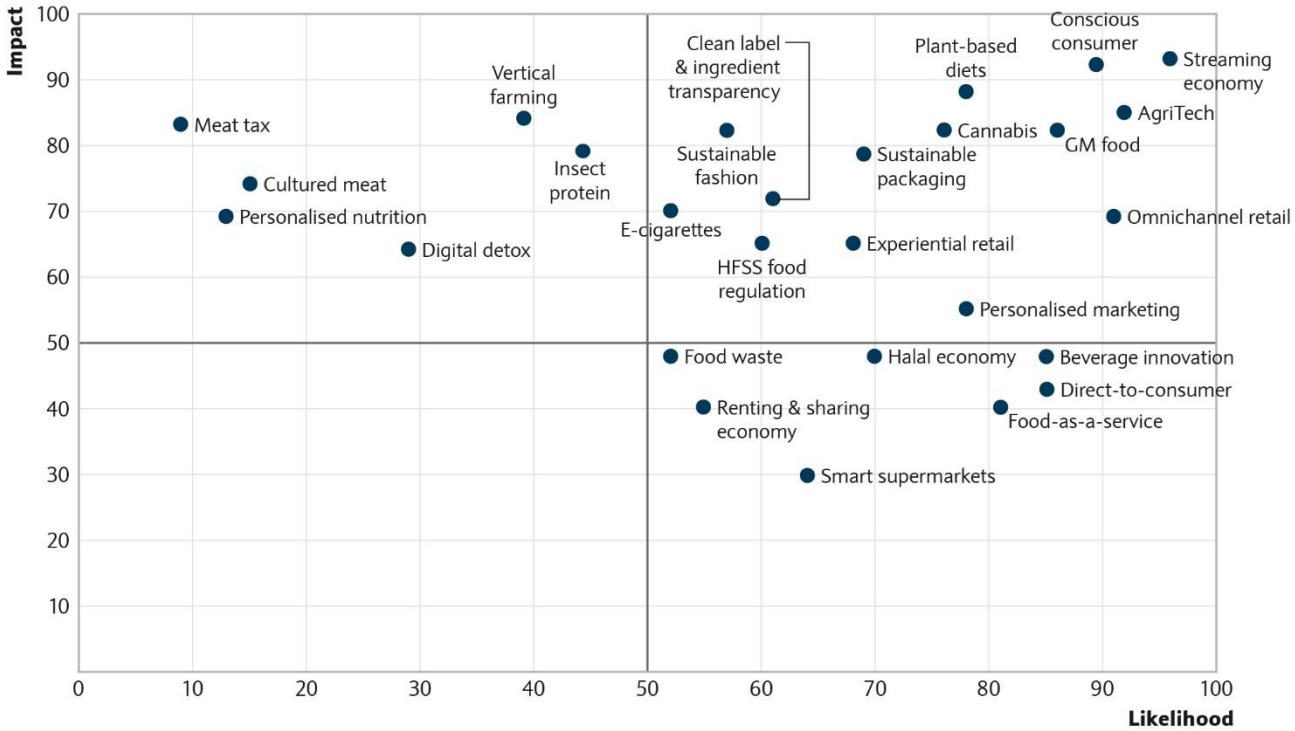
Health & wellness
Clean label & ingredient transparency
HFSS food regulation
Digital detox
E-cigarettes
Cannabis
Beverage innovation

Top 10 by Impact/Likelihood:
Sustainable packaging
Plant-based diets
Omnichannel retail
Conscious consumer
AgriTech
Sustainable fashion
Streaming economy
GM food
Cannabis
Beverage innovation

Biggest trends of today:
Streaming economy
Plant-based diets
Conscious consumer
AgriTech
Beverage innovation

Emerging trends of tomorrow:
Sustainable fashion
Halal economy
Insect protein

Key ESG & sustainability trends:
Clean label & ingredient transparency
Digital detox
Food waste
Sustainable packaging



Source: Barclays Research

3) Industrials, Manufacturing & Transportation

We selected 22 trends within Industrials, Manufacturing & Transportation – with our top ten including Smart Cities, Industrial Robotics, High-Speed Rail, Electric Transportation, Shared Mobility, Smart Buildings, Battery Technologies, Manufacturing/Construction Tech, Overseas Infrastructure Investment and 3D Printing. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 5. From an ESG/Sustainability perspective, we highlight Textile & Fabric Innovation and Industrial Robotics.

22 trends for 2030

We define **'Industrials, Manufacturing & Transportation'** as new technology and new business models in the Industrials, Manufacturing & Transportation space. This includes the development of new materials (e.g. Advanced Construction Materials, Textile & Fabric Innovation, Battery Technologies, 3D Printing and Hydrogen Fuel Cell), future modes of transportation (e.g. High-Speed Rail, Supersonic Travel, Electric Transportation, Commercial Drones and Hyperloop) and the application of emerging technology within infrastructure projects (e.g. Smart Cities, Smart Buildings and Connected Industrial Worker).

Beyond ride-hailing, how mobility is perceived is likely to evolve as access over ownership remains a consumer priority (e.g. Shared Mobility and Micromobility). The Tech giants continue to pursue new market opportunities (e.g. Space), and the application of emerging technology is changing how manufacturing and construction is done (e.g. Industrial Robotics, Manufacturing/Construction Tech, Overseas Infrastructure Investment, Housing 2.0 and Localised Manufacturing & Micro-Factories).

FIGURE 5
Industrials, Manufacturing & Transportation – 22 trends

Industrials, Manufacturing & Transportation

22 trends for 2030:

Advanced industrial technology
Industrial robotics
Battery technologies
Manufacturing/Construction tech
3D printing
Advanced construction materials
Hydrogen fuel cell
Textile & fabric innovation
Commercial drones
Localised manufacturing & micro-factories
Connected industrial worker

Infrastructure
High-speed rail
Electric transportation
Shared mobility
Overseas infrastructure investment
Micromobility
Autonomous vehicles
Supersonic travel
Hyperloop
Space

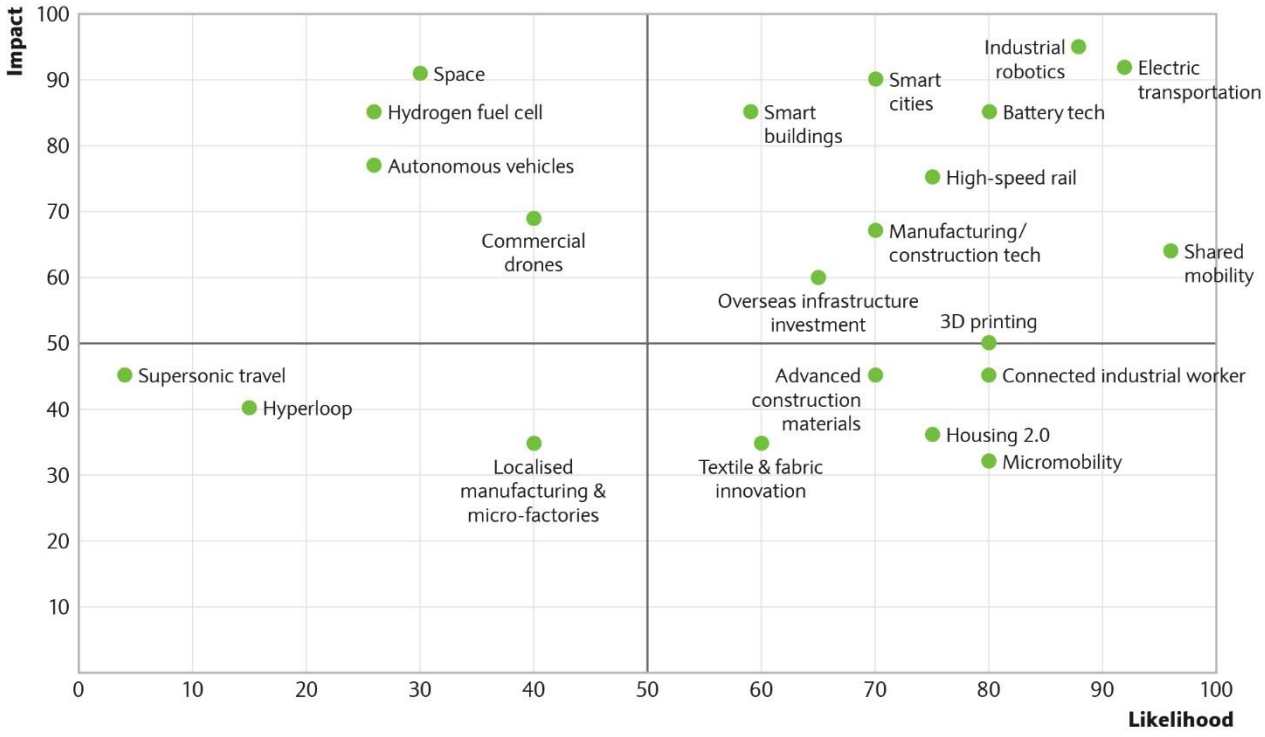
Smart society
Housing 2.0
Smart buildings
Smart cities

Top 10 by Impact/Likelihood:
Smart cities
Industrial robotics
High-speed rail
Electric transportation
Shared mobility
Smart buildings
Battery technologies
Manufacturing/Construction tech
Overseas infrastructure investment
3D printing

Biggest trends of today:
Smart cities
Industrial robotics
Electric transportation

Emerging trends of tomorrow:
3D printing
Manufacturing/Construction Tech
Housing 2.0
Space

Key ESG & sustainability trends:
Textile & Fabric Innovation
Industrial robotics



Source: Barclays Research

4) Health & Modern Science

We selected 22 trends within Health & Modern Science – with our top ten trends including Longevity Tech, AI Drug Discovery, Antimicrobial Resistance, US Healthcare Reform, Robotic Surgery, Personalised Medicine, Predictive Healthcare Analytics, Personalised Insurance, Opioid Epidemic and Wellness Economy. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 6. From an ESG/Sustainability perspective, we highlight US Healthcare Reform, Antimicrobial Resistance and Cloning.

22 trends for 2030

We define **'Health & Modern Science'** as the trends that point towards a future where our healthcare is monitored and provided continuously, wherever we are (e.g. Remote Patient Monitoring and Predictive Healthcare Analytics). Whilst the prior decade saw truly transformative change within healthcare, driven by the development of next-generation treatments for cancer (which resulted in the largest ever one-year drop in US cancer-related mortality; see: *American Cancer Society: Statistics 2020*), the trends we outline show the potential for even greater impacts in the 2020s.

We also see the advancement of new technologies which will fundamentally change how we prevent, diagnose and cure diseases (e.g. Robotic Surgery, Longevity Tech, Biohacking, 3D Bioprinting and Microchip Implants). Efficiencies will be created (e.g. AI Radiology and AI Drug Discovery) and the use of healthcare data will allow new mainstream services to emerge (e.g. Personalised Medicine and Personalised Insurance). The use of emerging technology in healthcare needs to be supported with an appropriate regulatory environment to ensure its use is for the good of society (e.g. Cloning, DNA Data Storage and Designer Baby).

Concerns regarding public funding remain, given ongoing demographic change, which may cause people in the developed world to be impacted by a potential change in provision (e.g. US Healthcare Reform, Medical Tourism and PAYG Social Care). Furthermore, we see trends within this paradigm being impacted by changes at the societal level including both positive and negative outcomes (e.g. Opioid Epidemic, Wellness Economy, Sleep Tech and Myopia Epidemic).

Reactive to proactive healthcare

The biggest structural change to the pharma/med tech industries today could be a shift from 'reactive' treatment strategies (i.e. only initiating treatment following the development of symptomatic disease) to more holistic approaches, which would potentially result in curative treatments (a potential benefit of personalised medicine) and/or lower disease incidence (a potential benefit of the wellness economy).

Within personalised medicine, gene therapy/gene editing

Like most of our trends, personalised medicine is in and of itself a broad category, but one example of this trend starting to come to fruition is the nascent commercialisation of gene therapy treatments. Within gene therapy, which seeks cure difficult-to-treat diseases by modifying genetic information, we've only started to see treatments approved at the end of the last decade, and this remains an area of intense focus in the biopharma community (for an overview of gene therapy/gene editing, see: *Gene Editing and Gene Therapy Overview*).

FIGURE 6

Health & Modern Science – 22 trends

22 trends for 2030:

Health tech
- Longevity tech
- AI drug discovery
- Robotic surgery
- Personalised medicine
- AI radiology
- 3D bioprinting
- Biohacking
- Cloning
- Microchip implants
- DNA data storage
- Predictive healthcare analytics
- Sleep tech
- Remote patient monitoring

Public health
- US healthcare reform
- Myopia epidemic
- Antimicrobial resistance
- Opioid epidemic
- PAYG social care

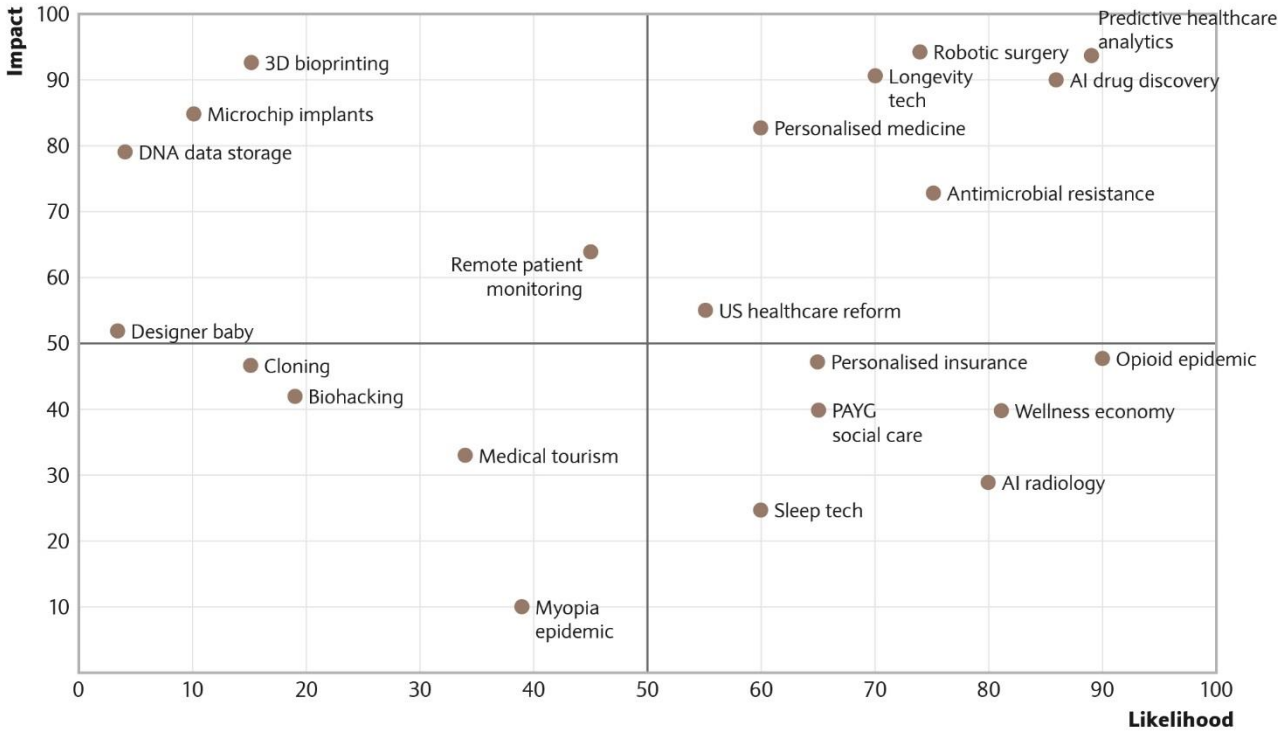
Clinical innovation
- Medical tourism
- Personalised insurance
- Wellness economy
- Designer baby

Top 10 by Impact/Likelihood:
- Longevity tech
- AI drug discovery
- Antimicrobial resistance
- US healthcare reform
- Robotic surgery
- Personalised medicine
- Predictive healthcare analytics
- Personalised insurance
- Opioid epidemic
- Wellness economy

Biggest trends of today:
- Robotic surgery
- AI drug discovery
- Opioid epidemic

Emerging trends of tomorrow:
- Predictive healthcare analytics
- Wellness economy
- Personalised medicine
- Longevity tech

Key ESG & sustainability trends:
- US healthcare reform
- Antimicrobial resistance
- Cloning



Source: Barclays Research

5) Energy & Environment

We selected 24 trends within Energy & Environment – with our top ten trends including Carbon Pricing, Renewable Energy, Biofuels, Climate Migration, Land Degradation, Natural Resource Scarcity, Sustainable Food Systems, Energy Storage, Ocean Economy and Waste Management. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 7. From an ESG/Sustainability perspective, we highlight Clean Water & Sanitation, Climate Migration, Energy Poverty, Sustainable Food Systems and Deforestation.

24 trends for 2030

We define **'Energy & Environment'** as the direct and indirect impact climate change is having on the environment and energy acquisition & production. This includes current threats to the environment (e.g. Natural Resource Scarcity, Deforestation, Land Degradation, Air Pollution and Biodiversity Loss) and the impact this will have on society (e.g. Energy Poverty, Sustainable Food Systems, Clean Water & Sanitation and Climate Migration). Much of the focus for the period to 2030 will be on to how to decarbonise the energy system and reverse the trend of rising CO2 emissions.

We see the case for alternative energy (e.g. Renewable Energy and Biofuels), although some remain controversial (e.g. Fracking and Nuclear Power) and others will require infrastructure investment in order to become a mainstream option (e.g. Energy Storage and Synthetic Trees) in the absence of overarching regulation (e.g. Carbon Pricing). Technologies that enable better management of existing networks and infrastructure are likely to grow in importance (e.g. Smart Grid, Waste Management, Carbon Capture & Storage, Distributed Power and Smart Meters). Heightened consumer awareness is also creating new market opportunities (e.g. Circular Economy, Ocean Economy and Plastic Alternatives).

FIGURE 7

Energy & Environment – 24 trends

Energy & Environment

24 trends for 2030:

Green energy
- Renewable energy
- Biofuels
- Fracking
- Nuclear power

Renewable infrastructure
- Carbon capture & storage
- Carbon pricing
- Synthetic trees
- Distributed power
- Smart meters
- Smart grid
- Energy storage

Resource efficiency
- Deforestation
- Ocean economy
- Land degradation
- Biodiversity loss
- Air pollution
- Sustainable food systems
- Circular economy
- Waste management
- Plastic alternatives

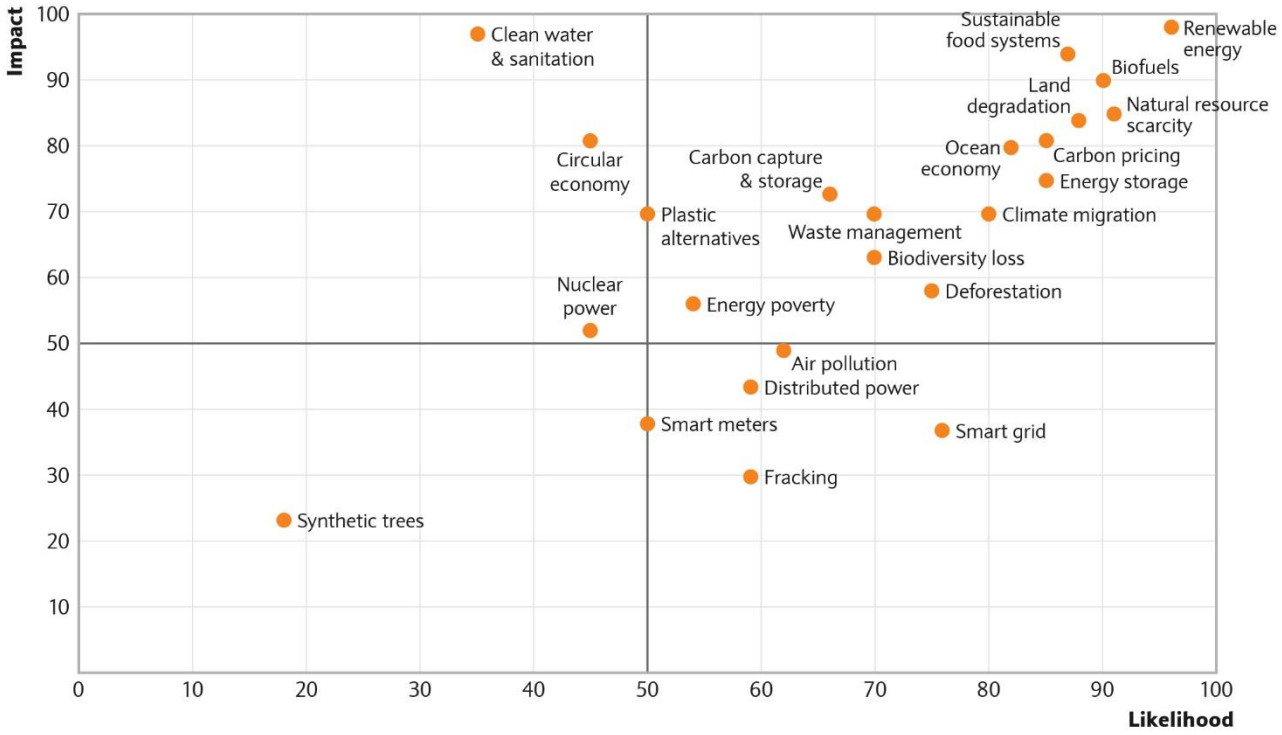
Environmental inequality
- Energy poverty
- Climate migration
- Natural resource scarcity
- Clean water & sanitation

Top 10 by Impact/Likelihood:
- Carbon pricing
- Renewable energy
- Biofuels
- Climate migration
- Land degradation
- Natural resource scarcity
- Sustainable food systems
- Energy storage
- Ocean economy
- Waste management

Biggest trends of today:
- Renewable energy
- Carbon pricing
- Biofuels

Emerging trends of tomorrow:
- Ocean economy
- Waste management
- Air pollution
- Circular economy

Key ESG & sustainability trends:
- Clean water & sanitation
- Climate migration
- Energy poverty
- Sustainable food systems
- Deforestation



Source: Barclays Research

6) Society & Culture

We selected 30 trends within Society & Culture – with our top ten trends including Ageing Population, Industry 4.0, Cyberterrorism, Deglobalisation, Urbanisation, Sustainable Tourism, Microfinance, Shifting Economic Power, Emerging Middle Class and Civil Unrest. Our analysis included confirmation of known mega trends, as well as trends that we expect to become more visible through 2030 – Figure 8. From an ESG/Sustainability perspective, we highlight Women's Empowerment, Obesity, Malnutrition, Societal Inequality and Environmental Protection.

30 trends for 2030

We define **'Society & Culture'** as overarching societal trends, influenced by both political, cultural and economic factors. These include ongoing demographic change (e.g. Ageing Population, Emerging Middle Class, Urbanisation, Mass Migration and Africa Rising) and contemporary societal issues (e.g. Fake News & Misinformation, Women's Empowerment, Gig Economy, Environmental Protection and Digital Influencers).

New technology and more specifically the rise in automation is changing the way education is perceived (e.g. Lifelong Learning) and the future of work (e.g. Competition for Talent, Crowdsourcing, Diversity & Inclusion, Industry 4.0 and Next-Gen Workforce). New business models have changed the way business is conducted (e.g. Global Tax Reform).

Despite significant progress in recent years, resources in society remain unevenly distributed (e.g. Societal Inequality, Malnutrition and Obesity). Within the political sphere, there is also scope for society to be impacted by ongoing political fragmentation and trade wars (e.g. Civil Unrest, Cyberterrorism, Deglobalisation, Shifting Economic Power, Modern Warfare, Social Credit System and New Superstate). We also see the potential for new market opportunities (e.g. Sustainable Tourism, Microfinance and Consumer-to-Consumer).

FIGURE 8
Society & Culture – 30 trends

30 trends for 2030:

Demographic trends
Ageing population
Emerging middle class
Africa rising
Urbanisation
Mass migration
Women's empowerment

Workforce 2.0
Gig economy
Industry 4.0
Competition for talent
Crowdsourcing
Diversity & inclusion
Next-gen workforce
Lifelong learning
Microfinance

Global development
Civil unrest
Shifting economic power
Cyberterrorism
New superstate
Social credit system
Societal inequality
Modern warfare
Deglobalisation
Global tax reform

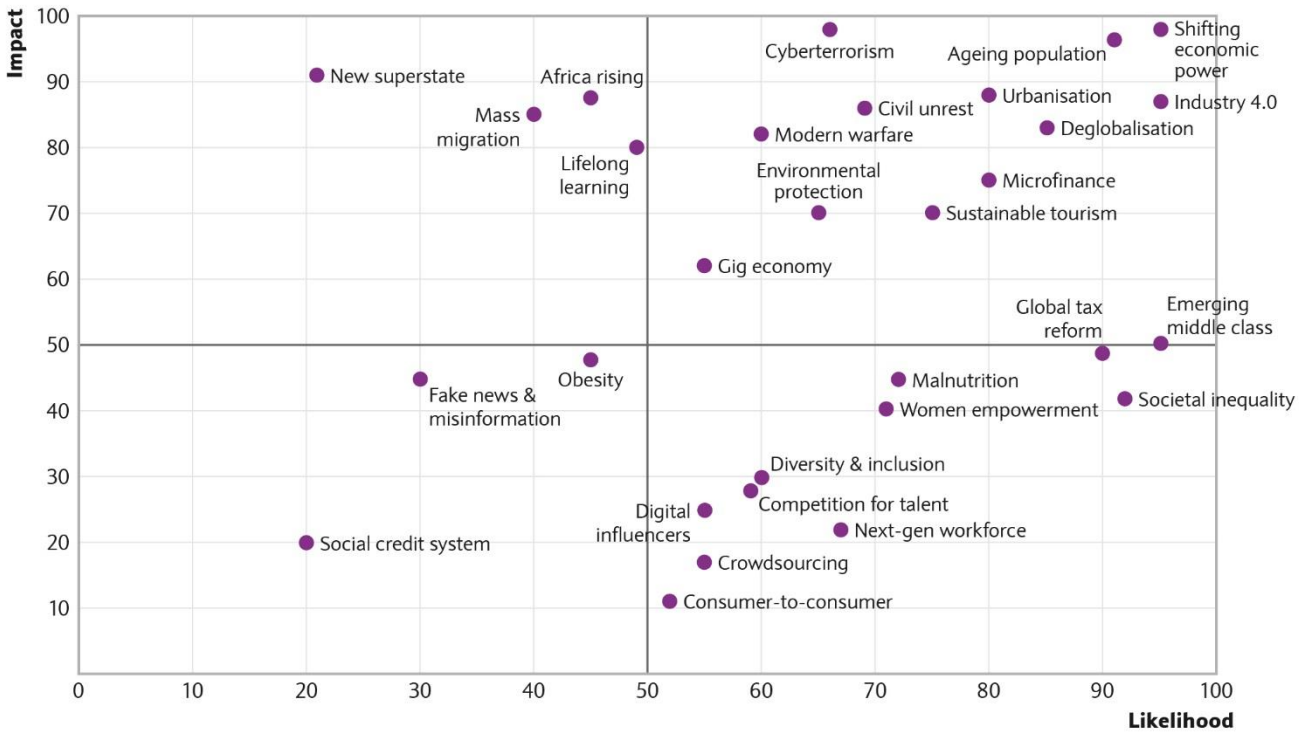
Societal shifts
Digital influencers
Consumer-to-Consumer
Sustainable tourism
Malnutrition
Obesity
Fake news & misinformation
Environmental protection

Top 10 by Impact/Likelihood:
Ageing population
Industry 4.0
Cyberterrorism
Deglobalisation
Urbanisation
Sustainable tourism
Microfinance
Shifting economic power
Emerging middle class
Civil unrest

Biggest trends of today:
Ageing population
Shifting economic power
Industry 4.0
Urbanisation

Emerging trends of tomorrow:
Gig economy
Next-gen workforce
Africa rising
Sustainable tourism
Cyberterrorism

Key ESG & sustainability trends:
Women's empowerment
Obesity
Malnutrition
Societal inequality
Environmental protection



Source: Barclays Research

DATA & INVESTMENT SCIENCES – TREND CLUSTER ANALYSIS

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To better understand how the trends are being discussed by corporates, we collaborated with our Data & Investment Sciences team to scan corporate transcripts for mentions of our 150 trends. Our hierarchical clustering algorithm grouped trends, regardless of their thematic paradigm, into *clusters* based on overlapping mentions of the different trends – Figure 9.

The purpose of this clustering analysis was to assess:

i) **Frequency and evolution of trend mentions: The extent to which the 150 trends are mentioned, scanning transcripts of c7000 corporates globally since 2001 (currently 43k/year), to find over 430,000 mentions.**

ii) **Concurrent trends: The extent to which multiple trends are mentioned within the same transcript by the corporates.**

iii) **Cross-sector impacts: The extent to which the trends impact multiple sectors (e.g. sector breadth).**

Refer to Appendix 1 for our Roadmap Methodology.

Key takeaways

We highlight 4 key takeaways from our clustering analysis:

- **Our 150 trends can be identified by three mega-clusters – Digital, Energy and Consumer & Society:** Our hierarchical clustering algorithm identified three large clusters for our 150 trends – *Energy, Digital* and *Consumer & Society*. The algorithm further identified additional sub-clusters including *Tech Enablers, Smart Society, Gen Z Influence, Health & Wellness, Decarbonisation & Green Energy and Clean Tech & Renewable Infrastructure* – Figure 9.

- **Many of our 'Emerging trends of tomorrow' and 'Key ESG & sustainability trends' see limited corporate discussion today:** For each thematic paradigm, we identified the emerging trends of tomorrow and key trends through an ESG & Sustainability lens in Chapter 1. Within the former, this includes Cybersecurity, Data Monetisation, Sustainable Fashion, Housing 2.0, Predictive Healthcare Analytics and Circular Economy. In respect to ESG/Sustainability, this includes Digital Ethics & Privacy, Sustainable Packaging, Energy Poverty and Sustainable Food Systems. We expect the frequency of corporate discussion and sector breadth of ESG trends to increase as the trend evolves through 2030.

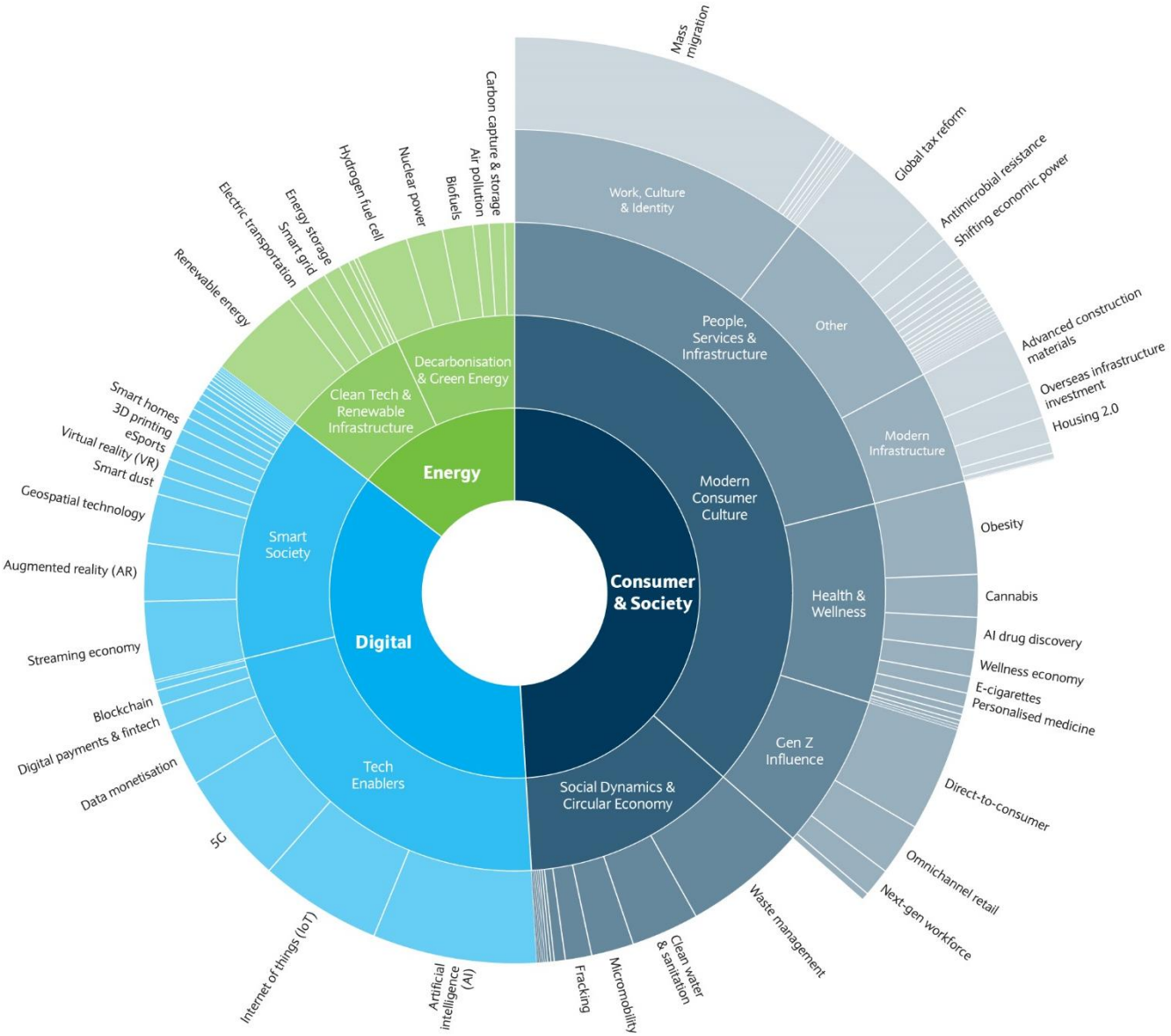
- **Maturity of trends is a key factor for 'tight' clusters:** We assessed the 'tightness' of clusters – i.e. how often trends within a cluster are mentioned together. We note that clustering works well when trends are based on energy and technology. However, disparate clusters around public behaviours, global challenges and societal trends are less tightly clustered. This may be due in part to the lower frequency of discussion, the immaturity of these trends and possible lack of common language.

- **Sustained discussion more meaningful than flash in the pan excitement:** For individual trends, we identify four broadly applicable archetypes of corporate mentions over time: 'steady rise', 'long discussion', 'sharp & sustained rise' and 'flash in the pan'. Within Digital, we contrast the short-lived 'flash in the pan' excitement over Blockchain and Cryptocurrencies with the 'sharp & sustained rise' in mentions of AI and 5G.

FIGURE 9

Clustering analysis of trends from corporate transcripts

Clusters are formed when trends are frequently mentioned concurrently. The clusters are then named to take into account the trends they contain. The width of each arc scales according to the number of mentions of the trends: the wider the arc, the more frequently the trends appear in the transcripts.



Source: Refinitiv, Barclays Research

Deconstructing our thematic paradigms…

The clustering analysis in Figure 9 depicts the trends that are commonly mentioned concurrently, regardless of their thematic paradigm presented in our 2030 Thematic Roadmap. The relationship between paradigms and clusters is shown in Figure 10 below.

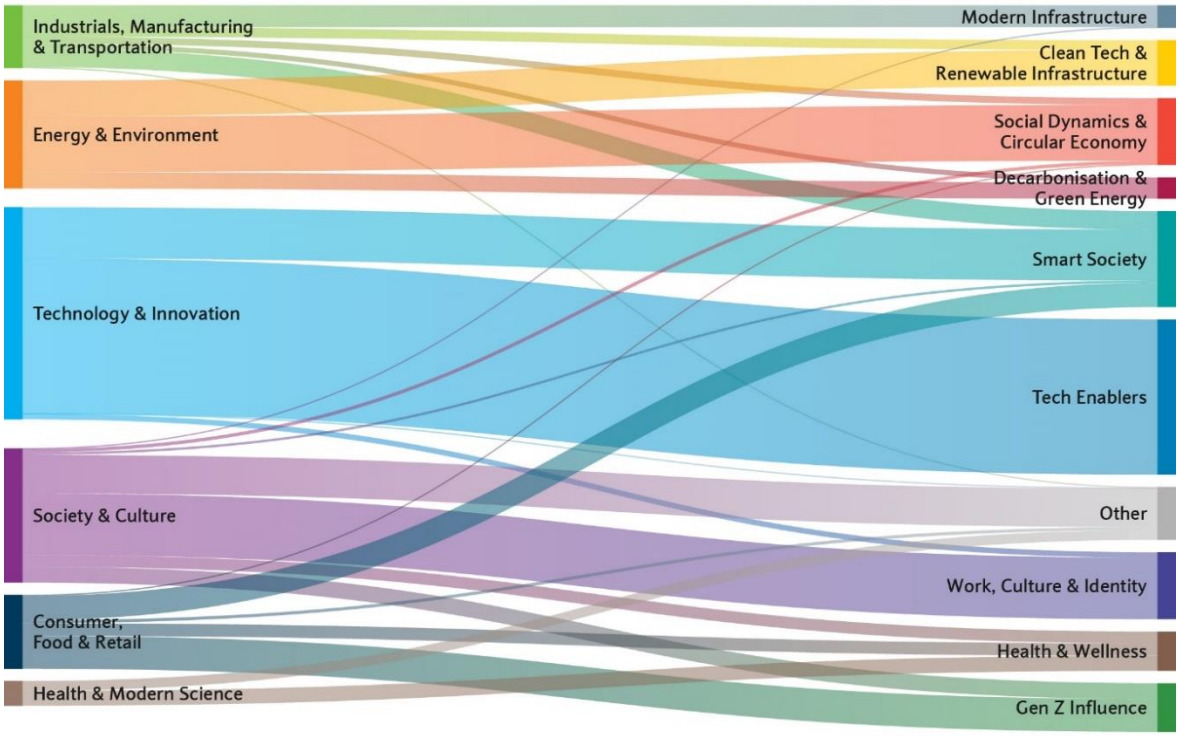
Based on our hierarchical clustering algorithm, the 'Energy & Environment' paradigm we present on page 18 can be seen to naturally divide into two distinct clusters: i) *Decarbonisation & Green Energy* and ii) *Clean Tech & Renewable Infrastructure*. Within the latter, corporate discussion on the Renewable Energy trend dominated, followed by Electric Transportation, Smart Grid and Energy Storage. We also see other trends relating to the broader environment (e.g. Clean Water & Sanitation, Waste Management and Mass Migration) appear in the *Social Dynamics & Circular Economy* cluster integrated within *Consumer & Society*.

Trends within the 'Technology & Innovation' paradigm (page 10) were spread amongst the clusters. We identify a second-level cluster of *Digital*, including *Tech Enablers* (AI, IoT and 5G) and *Smart Society* (Streaming Economy, Augmented Reality and Geospatial Technology). However, other trends within the 'Technology & Innovation' paradigm also appear within the *Consumer & Society* cluster (e.g. Digital Ethics & Privacy, Education Technology and Facial Recognition). This suggests that corporate discussion, in this instance, is concentrated on the end-user impacts rather than the underlying technology.

We believe the *Gen Z Influence* cluster, although small, reflects consumer interactions driven by the habits of younger generations, discussed further in *Generation Z: Step aside Millennials – 28/06/18*. We also observe that all the trends within this cluster have seen consistent growth in corporate discussion over the past five years, implying that these trends continue to gain prominence as the generational cohort grows in size and maturity.

FIGURE 10

Mapping the 2030 Roadmap paradigms (left) onto the transcript clusters (right)



Source: Refinitiv, Barclays Research

Introducing measures to assess corporate attitude

To further understand the attitude of corporates to these trends, we introduce measures that analyse the level of discussion across sectors ('**breadth**') and the strength of the cluster grouping ('**tightness**'). In brief, these measures show that *Energy* trends are tightly clustered, occurring together frequently, whilst also impacting a broad range of sectors. *Tech Enablers* is also tightly clustered and has a high volume of discussion, but is focused within a narrow range of sectors.

Breadth measures the spread of sectors discussing a trend

Breadth measures the spread of sectors discussing a trend, ranging from 1 (equal discussion across all sectors) to 0 (only discussed in one sector)

For each mention of a trend in a transcript, we identify the sector of the company involved. Hence for each trend, we can calculate a sector breadth, the dispersion of mentions across different sectors. We use an entropy measure, where fully equal dispersion is represented by a value of 1 and complete concentration in one sector by a value of 0 (Refer to Appendix 1 for our Roadmap Methodology).

In Figure 11, we highlight the top and bottom ten trends by sector breadth and the count of transcript mentions. We note that the broadest trends reflect high-level or holistic societal issues that apply broadly to most sectors. In contrast, the narrow trends tend to focus on a specific use-case of technology. We note that AI Drug Discovery is mentioned in only a narrow range of sectors (scoring 0.193 for sector breadth) as this is a specific use of technology for the healthcare sector. Whereas, Clean Water & Sanitation has the highest sector breadth score (0.957), given this trend impacts a broad range of sectors.

FIGURE 11

Top and bottom 10 trends in sector breadth and count of transcripts with sector identified

Breadth is an unweighted measure of the spread of sectors. A breadth value of 1 shows that a trend is evenly distributed amongst all sectors whilst a value of 0 represents pure concentration in one sector

Top 10 trends by breadth			Bottom 10 trends by breadth		
Trend	**Breadth**	**Transcript Count**	**Trend**	**Breadth**	**Transcript Count**
Clean Water & Sanitation	0.957	4069	Sustainable Packaging	0.450	148
Societal Inequality	0.917	513	Experiential Retail	0.427	101
Micromobility	0.912	1665	Microfinance	0.357	191
Global Tax Reform	0.910	6923	Predictive Healthcare Analytics	0.285	213
Fake News & Misinformation	0.909	378	Personalised Medicine	0.254	908
Circular Economy	0.904	403	Opioid Epidemic	0.250	452
Diversity & Inclusion	0.898	268	HFSS Food Regulation	0.240	152
Overseas Infrastructure Investment	0.886	2172	Myopia Epidemic	0.234	98
Emerging Middle Class	0.883	632	AI Drug Discovery	0.202	1089
Gig Economy	0.878	410	Smart Dust	0.193	641

Source: Refinitiv, Barclays Research

'Tightness' of trends within a cluster

In Figure 12, we show heat maps of the internal correlation of the trends within a cluster. Higher values of correlation signify that the trends appear more often in the same transcript. Hence, clusters with higher correlation measures, such as *Clean Tech & Renewable Infrastructure*, *Tech Enablers* and *Decarbonisation & Green Energy*, are more tightly clustered by the algorithm. For example, if a trend from the *Clean Tech* cluster appears in a transcript, there is a higher chance another trend from the cluster will also appear.

The maturity of trends is a key factor influencing our correlation analysis

Established trends with common language or buzzwords cluster better…

The three 'tightest' clusters focus on the energy sector and 'behind the scenes' technology, showing these trends are well identified and have plenty of overlap. However, the clusters with trends focusing on end-consumer use-cases or social phenomena are less tight. In some sense one can think of these trends as being more specific, but it may also be the case that these emerging trends are somewhat isolated due to their relative immaturity.

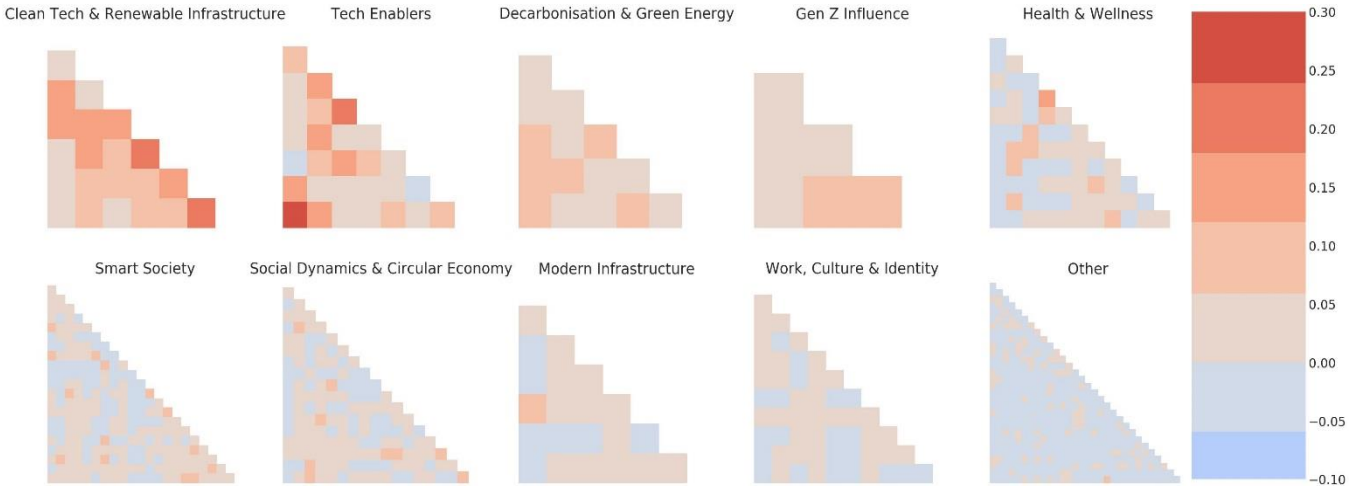
…whereas immature trends without common key language are harder to cluster

As we discuss further in Appendix 1, it is possible that some trends are harder to identify by a small number of keywords. This would lead us to undercount true discussions, resulting in 'looser' clusters. This may reflect an immaturity in common language or buzzwords around a trend.

We note that the trends in a lowly correlated or 'loose' cluster can still be very material in isolation, but these trends are not easily paired with others. The *Other* cluster is a collection of 31 trends that do not readily cluster. In part, this is because many of these trends occur too infrequently (e.g. Myopia Epidemic and Cloning). In some ways this presents a limitation of our dataset and clustering. Hence, whilst Global Tax Reform has appeared over 5,000 times in transcripts over the past two years, it is no more or less likely to appear if another *Other* trend is present.

FIGURE 12

For each cluster, heat maps of the trend-to-trend correlations. This is a measure of how often the trends appear in the same transcript. Clusters shown in descending order



Source: Refinitiv, Barclays Research

Clustering in detail – Digital

Trends within 'Tech Enablers' are commonly discussed together (tightly clustered), but somewhat limited to the tech sector

Trends within 'Smart Society' are broadly discussed across sectors, but less tightly clustered

Rather than discussing every cluster and trend in detail, here we discuss the *Digital* cluster in order to provide context for the clustering results.

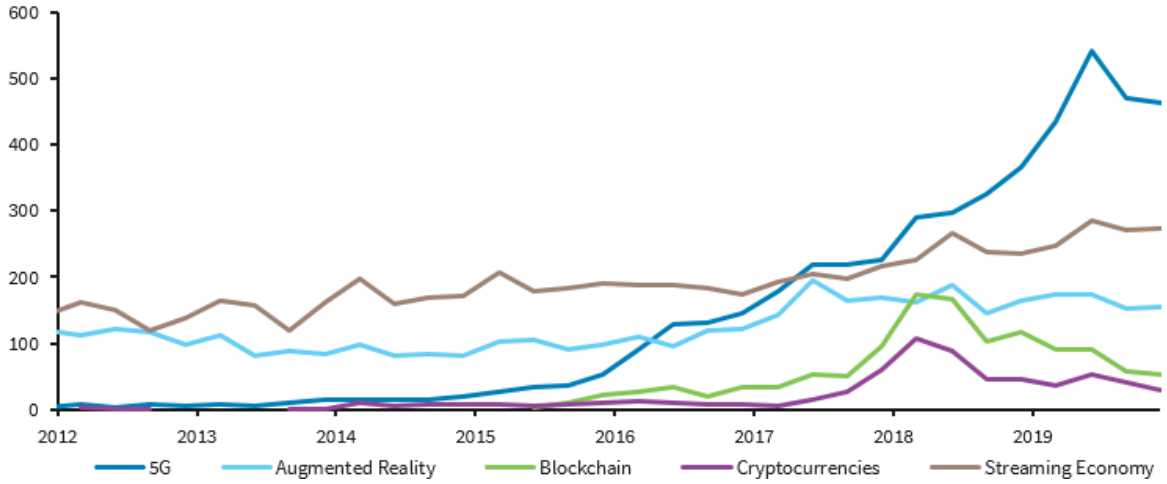
Our *Digital* cluster is made of two sub-clusters, *Smart Society* and *Tech Enablers*. The *Smart Society* cluster represents consumer-facing digital technology, both software and hardware. The second cluster (*Tech Enablers*) represents predominantly non-consumer-facing digital technologies, dominated by discussion around AI, 5G and IoT (77% of the discussion in 2019). This is also the single most discussed cluster of trends within the transcripts sample. Whilst *Tech Enablers* is frequently discussed, its sector breadth is amongst the lowest, with 43% of the 2019 *Tech Enablers* transcripts belonging to the Technology sector.

The consistency and growth of discussion can be helpful in assessing a trend's impact and in *Digital* we have identified four archetypes of trend time series (Figure 13):

- ***Steady rise – Streaming Economy:*** This trend has steadily risen since 2002, alongside an increase in the number of available transcripts.
- ***Long discussion – Augmented Reality:*** This trend has been readily discussed throughout the time period, without a step-change in level. 2019 saw 655 AR mentions, versus a prior peak of 608 in 2009.
- ***Sharp & sustained rise – 5G:*** Since 2016, 5G has become an increasingly relevant topic in transcripts and this has not abated. The AI trend also shows this behaviour, but with a much larger magnitude.
- ***Flash in the pan – Blockchain and Cryptocurrencies:*** In 2018, discussion of these two trends spiked significantly, but alongside waning public enthusiasm and decreasing cryptocurrency prices, the growth in these trends has not been sustained.

These patterns also occur, to varying degrees, in other clusters. For example, the trends contained in the *Gen Z Influence* cluster all display similar sustained rises. The most frequently mentioned trends in *Social Dynamics & Circular Economy* show a steady rise (e.g. Waste Management), long discussion (Clean Water and Sanitation) and to some extent a flash in the pan (Fracking). Over the past three years, the *Energy* clusters have seen strong growth in mentions of the Electric Transportation and Energy Storage trends; however, the enthusiasm for Biofuels seen in the early 2010s seems to have abated in corporate transcripts.

FIGURE 13 **Time series of quarterly transcript mentions of 5 trends in the digital cluster**



Source: Refinitiv, Barclays Research

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THEMATIC LIBRARY

To support our 2030 Thematic Roadmap, we summarise the main thematic publications from Sustainable & Thematic Investing and individual sector teams across Barclays Research in this chapter. For each publication, we provide:

i) **Report summary:** A summary of the theme, the market opportunity, the underlying structural drivers and the potential risk/opportunity across the value-chain.

ii) **Why should investors care?** A rationale for why we believe the topic of our publication should be on the investor radar. This includes highlighting the scope of sector collaboration (e.g. Equity vs. Global, Equity vs. Multi-asset).

iii) **2020 theme catalysts:** Our reports are typically written with a 5-10-year time horizon; however, we continue to monitor the near-term horizon for catalysts that may influence the underlying market opportunity.

Topics include: 5G, eRegulation, Generation Z, Cannabis, Smartphone Addiction, Future of Food Retail, Future of Tax, Food Waste, Education Tech, Micromobility, Plant-Based Dairy, Fake Meat, Plastic Waste, Insect Protein, Drones, Global Catering, Opioids Global Energy, Digital Payments & Fintech, manufacturingTech, Sustainable Tourism, Global Fashion and Utilities.

Fintech & Payments: Invisible payments pressuring incumbents

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We are entering a world where payments will gradually become invisible – the need for a specific financial 'handshake' at the end of a transaction will disappear and payments will morph into a digital ID process. This will have broad ramifications across the ecosystem, with entry barriers being eroded, resulting in an increasing number of new entrants and pricing pressure on the commodity parts of the value chain. All participants will be affected; with the payment user experience becoming digital, infrastructure will lose its differentiation and be de-bundled and the merchant relationship will be software-led. Hardware vendors will see dedicated payment form-factors, such as the payment card or terminal, become redundant. Issuers and schemes will experience a fresh wave of new user experience competition in the form of wallet and P2P providers, whilst acquirers will have to step up innovation and become software developers and marketplace specialists.

In the report *Invisible payments pressuring incumbents (18/7/18)*, we take a deeper dive into the current payment ecosystem and how this is changing across regions. We assess the impacts on different market participants and provide a view upon who the 'winners' and 'losers' will be from the trends impacting the industry. Country-by-country overviews are provided addressing regional differences as well as providing specific insights to the current infrastructures and key players by market share.

Why should investors care?

The digitalisation of industries is driving innovation, new market entrants and is leading to increased competition across many financial service verticals (lending, wealth/asset management, banking, etc). The area where we have seen the greatest innovation to date is within payments. Cash is increasingly being substituted for digital payment forms for a number of reasons. The transition to digital payment forms differs by region and some regions are transitioning faster than others. It is important for investors to understand the supply (e.g. regulation) and demand (e.g. consumer preference) factors stimulating these changes, as well as the regional differences to why they are occurring. These changes are giving rise to a number of new business models, disrupting the status quo of finance. As new market entrants and opportunities arise, incumbent players are increasingly affected. We are seeing incumbent players such as banks having to invest, divest or partner across their asset bases to effectively compete in these changing market conditions.

2020 theme catalysts

- **Consolidation of consolidators:** The first wave of consolidation was around country scale and commercialisation of payment assets. The second wave brought functional consolidation, whereby payment players were acquiring more digitally focused assets to enhance their online offering for capitalising on rising ecommerce spend. Cross-border consolidation is likely to follow as players look to gain greater scale and functionality in new regions. Into 2020, we expect the consolidators up until this point to begin to merge with one another as they further look to scale and broaden their services to overcome the commoditisation of pure core payment processing.

- **Regulation and government incentives:** One of the key accelerators driving the digital payments transition has been regulation. As governments increasingly see the benefits of digital payments, more regulation and incentives are appearing. Italy is the prime example for 2020 whereby max limits have been reduced on cash transactions, and €3bn was set aside for incentives for digital payers. A full breakdown of the new regulations set out for 2020 in Italy can be found in this note: *Strategic deal boosts upside (15 January 2020)*.

FIGURE 14
Why would you invest in payments?

Key trends driving the payments investment case

Cash penetration remains high but is steadily declining, providing a long and sustainable growth backdrop for digital payments

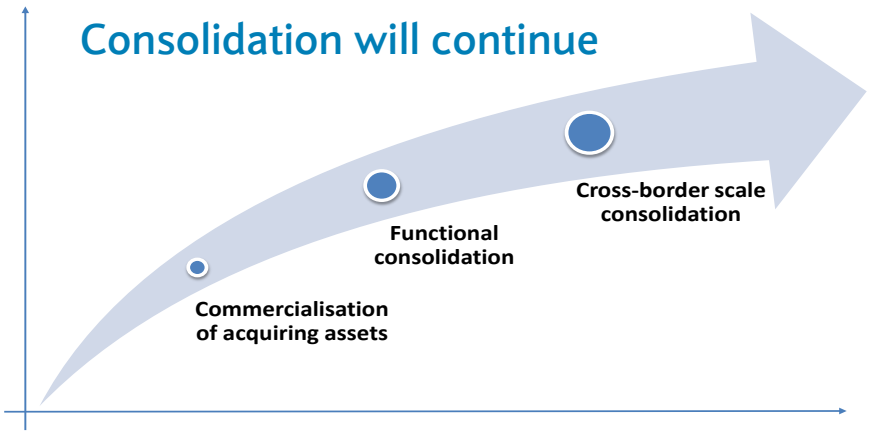
Regulation supportive of digital payments
EU Directive "PSD2" or Italian government providing incentives are examples

Cheaper hardware and user friendly set up increase acceptance
The increase in mPOS, small terminals that work with a phone, expand the addressable market

Invisible payments are enabled by new payment methods and technology
We expect that over the long-term the 'financial handshake' disappears in many cases

Driven by 1) an increase in in-app payments (i.e. Uber) or stored-payment details for recurring transactions primarily online for now (i.e. Amazon)

Driven by 2) alternative payments and new technology (i.e. Biometrics, further advances in ApplePay, etc)



Source: Barclays Research

5G: A new dawn

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5G could become a General Purpose Technology: Just like Information Technology, 5G has the potential to transform economies through its ability to drive improvement and spawn innovation, adding value across a range of industries. 5G will significantly improve access to fast internet of up to 1-10Gbps and its capabilities should allow it to become pervasive across a vast number of industries beyond TMT (see Figures 15 and 16). We see mobile video streaming and virtual reality as key applications but also expect far-reaching commercial opportunities across a variety of markets such as IoT, healthcare and autonomous vehicles. Industrial applications are increasingly tested in pilot co-operations between Telco/Tech hardware providers and major industrial operators. Additionally, we see opportunities for fixed-wireless substitution with the advent of 5G as we discuss in *5G – The Return of Fixed Substitution* (9/9/19, Figure 17). Whilst this could put the importance of traditional broadband at risk (and provide opportunities for mobile challengers), it also offers a chance to 'connect the unconnected' with high-speed internet in developing markets and rural areas (Figure 18).

In the report *5G – A new dawn* (9/9/16) we assess the business case and capacity that 5G can offer, along with the technology roadmap and operational challenges likely to accompany it.

Why should investors care?

We expect the increasing availability of 5G and 'smarter' network infrastructure to impact companies in various industries, offering opportunities to increase productivity or providing the essential, underlying infrastructure for new technologies (e.g. autonomous driving, smart cities). For Telecom operators, we see substantial investment is needed to acquire spectrum frequencies and materially densify networks. We view mobile network sharing as a potential way to facilitate the roll-out as we discuss in *The future of telecom infrastructure* (18/7/19) and TowerCos as well positioned to benefit from this. Separately, industrial players are pursuing private 5G networks to optimise production. Vertically, political uncertainty around the role of Chinese manufacturers in the supply chain is shaping the outlook for hardware providers in the roll-out of 5G and poses medium-term capex risk for mobile network operators.

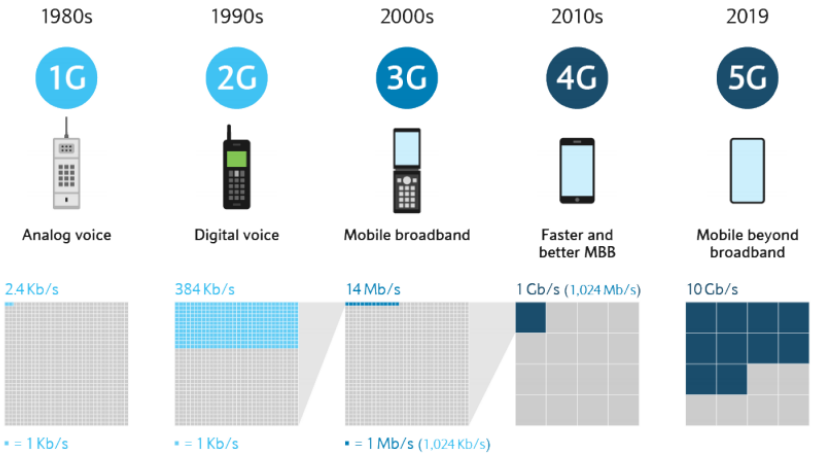
2020 theme catalysts

- **Huawei debate:** As we discuss in *5G Leadership: Huawei in Context* (5 June 2019), the role of Huawei in the roll-out of 5G services remains uncertain and far-reaching political decisions are likely in 2020. Global telecom operators (except in the US) have rapidly deployed internet infrastructure equipment supplied by Huawei, often displacing Western providers. This remains a concern for the US administration and has become a point of friction between the US and some of its allies, including Europe, with the latter pushing back against requests to restrict the use of Huawei equipment. In our view, restrictions could cause a temporary dislocation in the global smartphone market, impact the semiconductor industry and affect the pace/costs of global 5G deployment.

- **Industry co-operations:** Various industrial players have already started co-operations with telecom operators or hardware providers to explore 5G benefits. The 5G factory by Daimler in collaboration with TEF DE is one of the examples for manufacturing, but tested applications also include mobility (e.g. Volvo/Audi/PSA), mining (Boliden), gaming (Niantic), shipping and healthcare with different telecom operators. We expect more cross-industry collaborations to be established over the course of 2020, highlighting new business fields and efficiency sources arising from 5G.

FIGURE 15

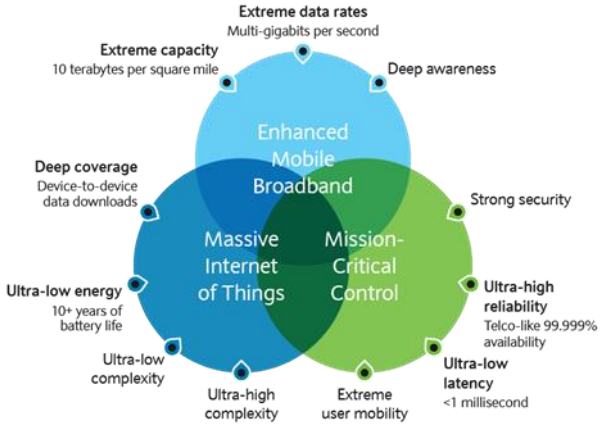
Evolution of Wireless Technology Across Generations



Source: Qualcomm, Barclays Research

FIGURE 16

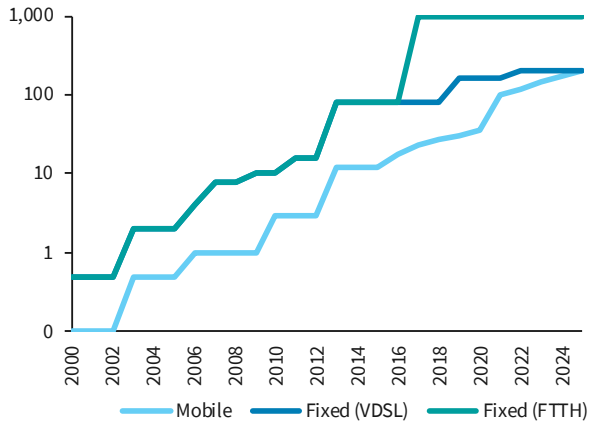
5G capabilities



Source: Qualcomm, Barclays Research

FIGURE 17

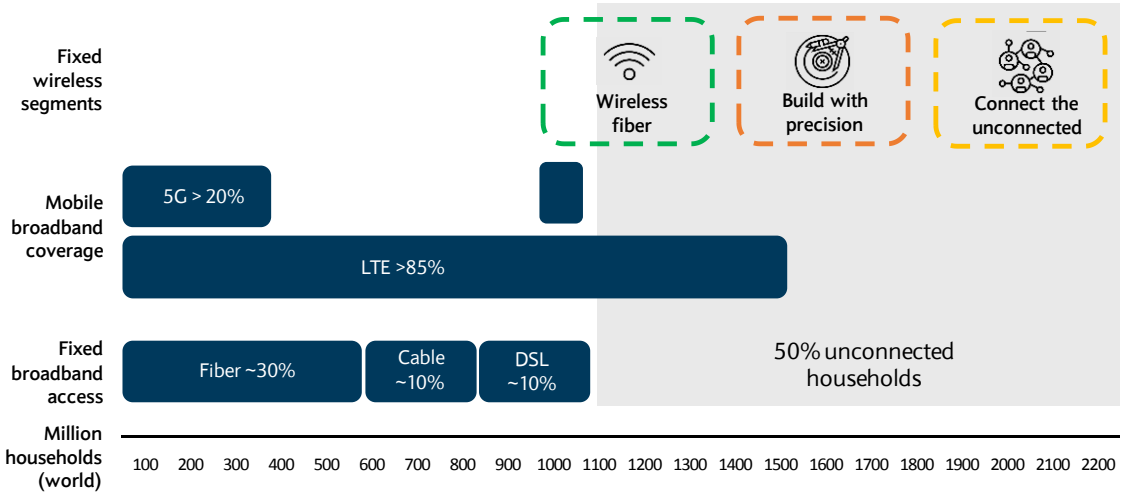
5G Mobile speeds catching up (mbps)



Source: Barclays Research estimates

FIGURE 18

5G FWA disrupts fixed and extends coverage, particularly so for emerging markets/rural areas



Source: Ericsson Fixed Wireless Access Handbook, 2018

The rise of e-regulation

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We believe we are seeing the dawn of a new secular trend: the rise of e-regulation. The EU's new General Data Protection Regulation (GDPR) – which came into force on 25 May 2018 – marks a significant milestone, representing a profound shift in how personal data is valued and processed. We believe it will be followed by further regulation, both in Europe and the US. The rise of e-regulation may be underestimated by some, but we see GDPR both as a key catalyst in raising awareness of the subject and as a significant opportunity for both businesses and consumers to manage a truly 21st century business risk. We consider the key beneficiaries from this trend to be the solution providers in an increasingly regulated world of data, particularly insurance companies with a strong presence in cyber-insurance and IT software & services companies with a focus on cyber security.

In the report *The rise of e-regulation (31/5/18)* we explore GDPR and potential future regulations in detail, we assess their likely implications across sectors, and explain how individual companies will be able to differentiate themselves by their approach to the challenges of data security and increased regulation.

Why should investors care?

Increased e-regulation will mean greater compliance costs for B2C companies collecting and processing personal data; however, it will also create opportunities for them. The more progressive companies will take this as an opportunity to re-evaluate their entire data security framework and establish themselves as data-driven organisations ready for a secure digital future. Since GDPR has been implemented, significant fines have been levied on numerous companies including British Airways (£183.39m), Google (€50m) and Marriott (£99m). The EU is looking to implement more data protection regulations and more countries are looking to establish their own version of GDPR.

2020 theme catalysts

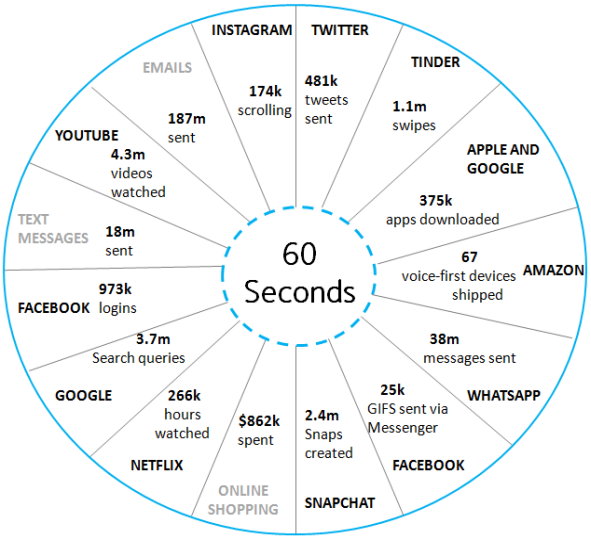
- **Global privacy standards emerging:** Europe has been the global leader in terms of enshrining data protection rights through legislation, namely the General Data Protection Regulation. Since the law entered into effect in May 2018, several countries have announced they intend to implement similar measures. The State of California is implementing a data protection regulation in January and the Indian government announced its intention to implement its own data privacy laws.

  In January 2020 the California Consumer Privacy Act (CCPA) entered into effect. The legislation gives Californian's rights over their personal data and also imposes additional requirements on companies handling the personal data of residents of California. Unlike GDPR, breaches of CCPA result in a fine per violation – which could easily mount. Although there are no signs of a federal standard being implemented, the CCPA is significant due to the sheer number of consumers covered by the law.

- **Further data protection legislation in Europe expected – the ePrivacy Directive:** Europe is set to implement further data protection regulations in the coming year. The ePrivacy Directive has been subject to controversy and has been under review for well over a year. The regulation aims to govern the use of cookies and other forms of data not captured by GDPR. The final legislation has still not been settled on, but could be particularly disruptive to targeted advertising.

FIGURE 19

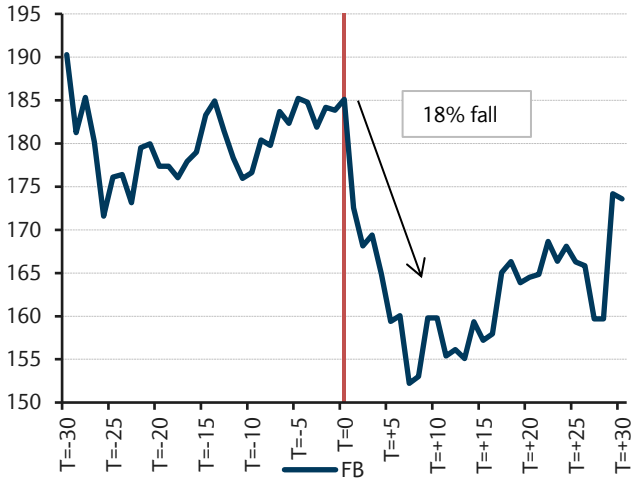
Online activity in just 'one global internet minute' in 2018



Source: virtualcapitalist, One Internet Minute 2018

FIGURE 20

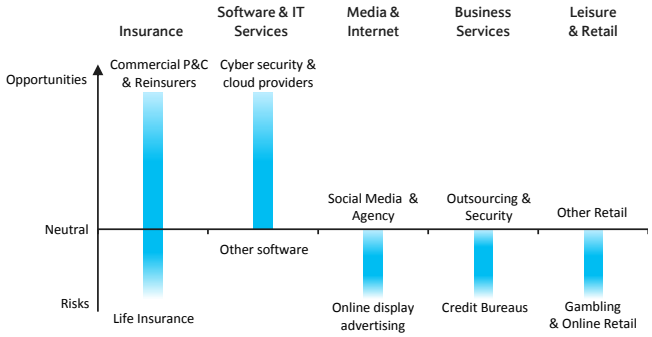
Facebook – impact of data breach on share price ($)



Source: Barclays Research, Datastream (March 2018)

FIGURE 21

Barclays Research: The impact of GDPR across subsectors



Note: This schematic is our qualitative interpretation of the commentary included in this report – please refer to Fig 19 in the full report for more details.

Source: Barclays Research

FIGURE 22

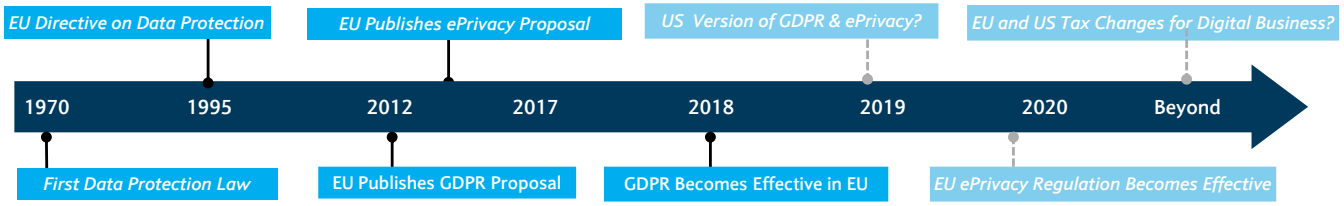
Solution providers: Potential beneficiaries of e-regulation

European Insurance	U.S. Software (cont'd)
Munich RE	Fortinet, Inc.
U.S. Insurance/Non-Life	Palo Alto Networks
American International Group	Rapid7
Chubb Limited	Symantec Corp.
European Software & IT Services	Varonis
Atos	CyberArk Software
Capgemini	Mimecast Ltd.
SAP SE	Microsoft Corp.
U.S. Software	Oracle Corp.
Check Point Software Tech. Ltd	ServiceNow, Inc.
FireEye	Talend S.A.

Source: Barclays Research

FIGURE 23

The rise of e-regulation – a timeline



Source: Barclays Research

Generation Z: Step aside Millennials

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Sorry Millennials, your time in the limelight is over. Make way for the new kids on the block – Generation Z – a generational cohort born between 1995 and 2009, and larger in size than the Millennials (1980-1994). The current fixation with Millennials makes them the most studied generation, which in turn has caused the use of this term to simplify to a label for anyone that may be *young* today. The irony here is that Millennials are not necessarily young anymore and we run the risk of overlooking the next cohort – Generation Z – who are now coming *of age*. We believe this coming of age is worth capitalising on now, with Generation Z in the US already having $200bn in direct buying power and $1tn in indirect spending power as they command significantly more influence on household purchases than prior generations.

In the report *Generation Z: Step aside Millennials (28/6/18)* we draw on portrayals and perceptions of Generation Z from a range of sources, and attempt to gauge the potential impact of this generational 'shift' on key Gen Z consumer-facing industries such as Financial Services, Retail, Internet and Media. We analyse the impact Generation Z will likely have on existing and potential new business models, before assessing which companies are likely to succeed based on our Generation Z Tiering Methodology.

Why should investors care?

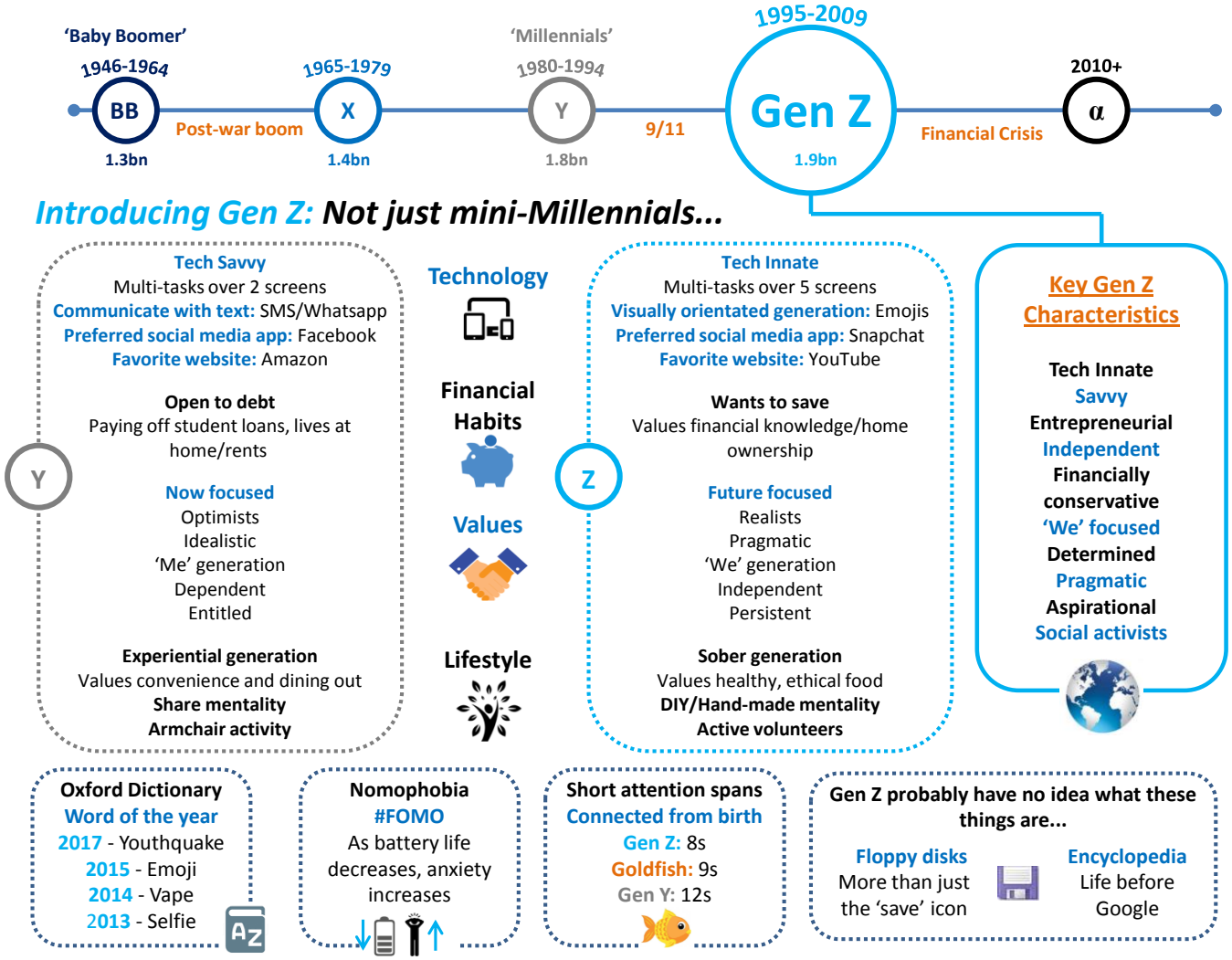
For those new to the discussion on generational behaviour, we believe there is value to be had from analysing *who* is driving technological disruption in addition to *what*. We argue there are fundamental differences separating Generation Z from the Millennials, material enough for marketplaces to take note today. And yet, even as Generation Z enter adulthood, many companies have yet to prepare for their arrival. We fear they are either still trying to adapt their business models to the Millennials or hoping simply to re-use whatever strategies they've developed for Millennials on Generation Z. We conclude investors with exposure to these consumer industries stand to benefit from understanding this cohort and how their behavioural traits are redefining consumption patterns in the post-digital realm.

2020 theme catalysts

- **Ongoing social activism to impact consumer-facing industries:** More so than the Millennial generation, we continue to see Generation Z demanding greater things from companies, society and policymakers. In 2019, we saw climate change being a key area of focus, with various protests being organised by school students as well as high-profile climate activists like Greta Thunberg gaining international recognition. We expect this to continue in 2020, with various other consumer-facing industries likely to face pressure including travel & tourism, food and fashion.

- **Gen Z are maturing – entering the workforce, buying houses:** At c.2bn individuals, Generation Z is the most populous cohort of all time. According to the UN, Generation Z represents 25% of the global population (vs. 24% Millennials) and have particular weighting in areas such as the US, India, China, South East Asia and Africa. Based on the latest UN population data, by 2020 c. the majority will be of adult age (>18) and thus have voting power. The maturity will not only influence upcoming elections, but also traditional forms of ownership (e.g. more likely to buy cars and houses), financial products (e.g. more likely to take on personal debt/credit) and the workforce.

FIGURE 24
Generation Z: Step aside Millennials



Source: Population Data: UN – World Population prospects 2017 Revision (*June 2017*), Number of screens for multi-tasking: Sparks & Honey (*June 2017*), Ideas in Digital (*2015*), Vision Critical (*2017*), Forbes (*2017*)

Cannabis Inc: Buy the rumour, sell the news

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Interest in the cannabis sector surged in 2017 and 2018 in anticipation of recreational legalisation in Canada on 17 Oct 2018. Vast amounts of capital flowed in – from existing CPG companies (notably, Constellation's investment in Canopy and Altria's investment in Cronos), public markets (~200 companies listed globally), and private funding markets. Operational performance has vastly undershot expectations with revenues, profitability and production targets continually being missed. Part of this is attributable to the strong prevalence of the black market as the rollout of retail stores in Canada, particularly in the most populous province, Ontario, has been much slower than expected. The industry has also been hampered by its connection with the US EVALI crisis. As Rec 2.0 rolls out, some provincial boards are taking a harsher stance on vape products.

In the report *Cannabis Inc: A growing industry* (3/9/18) we showed that 11 US states had legalised recreational cannabis and 33 states had legalised medicinal use. Canada and Uruguay remain the only countries to legalise recreational use at a national level. We believe it's unlikely that the US will legalise cannabis federally in the near-term. Europe, however, is increasingly taking the lead on medical legalisation, with medicinal cannabis now legal in Germany, UK, Italy and France.

Why should investors care?

The growth of cannabis poses the threat of disrupting existing staples industries – in particular alcoholic beverages and tobacco. Whilst data so far remains inconclusive, as legalisation continues the impact on traditional industries will be closely watched. In beverages, excitement remains over the potential for disruption through products ranging from THC infused spirits to CBD infused sports drinks. The beverages sector has seen the most investment activity from traditional staples companies, including Constellation Brands, Molson Coors and ABI. Most recently, Canopy Growth started production of 11 cannabis beverages which it is launching in Canada in early 2020.

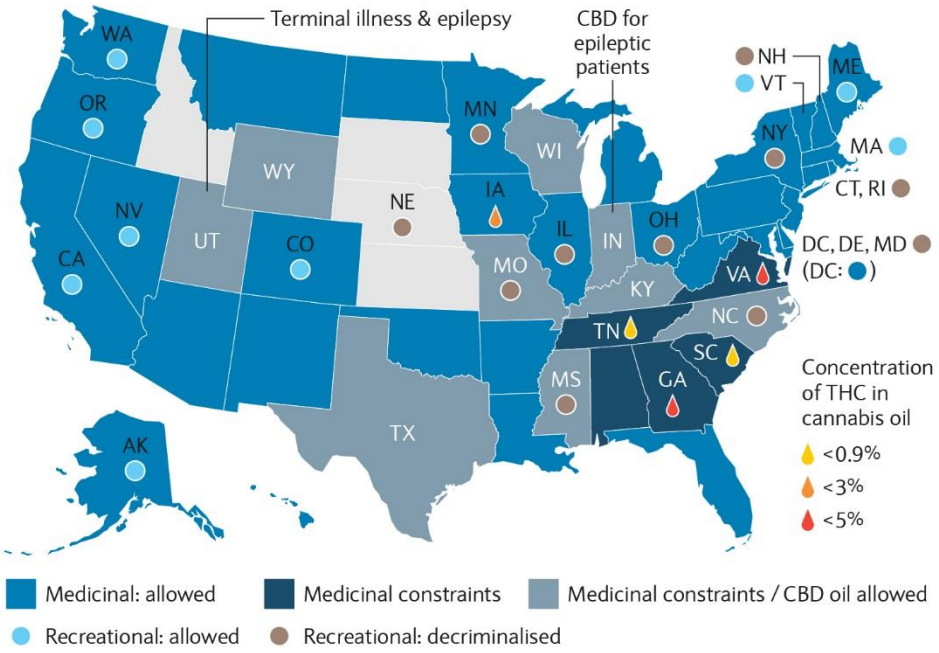
Tobacco companies have also entered in the space with Altria investing $1.8bn for a 45% stake in Cronos Group and Imperial Brands announcing an R&D partnership with Auxly, that will see the cannabis company granted global licences to Imperial's vaping technology. There is further scope for cannabis to disrupt the food sector, as an ingredient and through the development of edibles, and HPC, through cannabis-infused cosmetics.

2020 theme catalysts

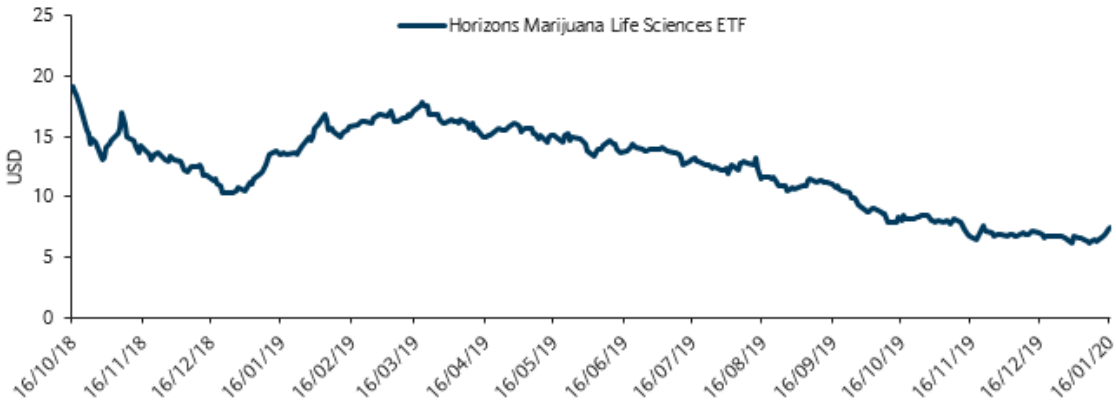
- **2020 is the first year of Canada's legalisation 2.0:** Whilst Canada originally legalised recreational cannabis in Oct 2018, it was not until Oct 2019 that cannabis edibles, beverages and vaping products were made legal. With US legalisation still fragmented at a state level, Canada will provide the first full year of data at a country level in 2020.
- **US regulation:** The EVALI (e-cig, or vaping, associated lung injury) outbreak has brought THC vaping products under scrutiny with 80% of patients reporting the use of (black market) THC. In the US, the Marijuana Opportunity Reinvestment and Expungement Act of 2019 is to be debated in the House. If passed, the Act would de-schedule cannabis, making it federally legal. Past federal cannabis convictions would also be expunged.
- **The growth of EU legalisation, particularly medical:** So far, 17 EU countries have legalised cannabis for medicinal purposes, yet none of these countries have legalised recreational use. In 2020 that could change with Luxembourg seeking to fully legalise cannabis. The common school of thought is that once one country legalises cannabis it will become more acceptable and then lead to increased legalisation throughout Europe.

FIGURE 25

Recreational cannabis is legal in 11 states and medicinal cannabis is legal in 33 states, though it remains federally illegal



Cannabis stocks have suffered since Canada's legalisation in Oct 2018



Source: Barclays Research, *Colorado ballot paper*, Bloomberg

Smartphone Addiction: The need for digital detox

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The smartphone is increasingly becoming our go-to medium for everyday life, changing the way we interact, work and learn in contemporary society. However, for all the advances smartphones have made in boosting productivity and convenience, smartphone addiction is on the rise. We define this as excessive dependency or obsession that interferes with daily activities and promotes distress and anxiety upon withdrawal. Children are the most vulnerable and are not helped by the rise in persuasive technology and the 'magic of maybe' thanks to social media and mobile gaming. Research warns that over-usage can impact adolescent development as well as increase the risk of loneliness, obesity and depression; yet the average age for children owning their first smartphone continues to fall. We acknowledge that not all usage is necessarily bad and is in most cases life-enhancing, but the evidence so far suggests some form of action is required to ensure our smartphone use remains beneficial for society going forwards.

In the report *Smartphone addiction: The need for digital detox* (19/9/18) we argue the technology industry needs to take a wider view of its responsibility for device usage and societal wellbeing. In conjunction with our sector analysts we outline sector implications for internet & social media, online gaming, gambling and telecom operators. Our ESG framework outlines the importance of ethical design and digital wellbeing within long-term product development, especially when it relates to safeguarding young users.

Why should investors care?

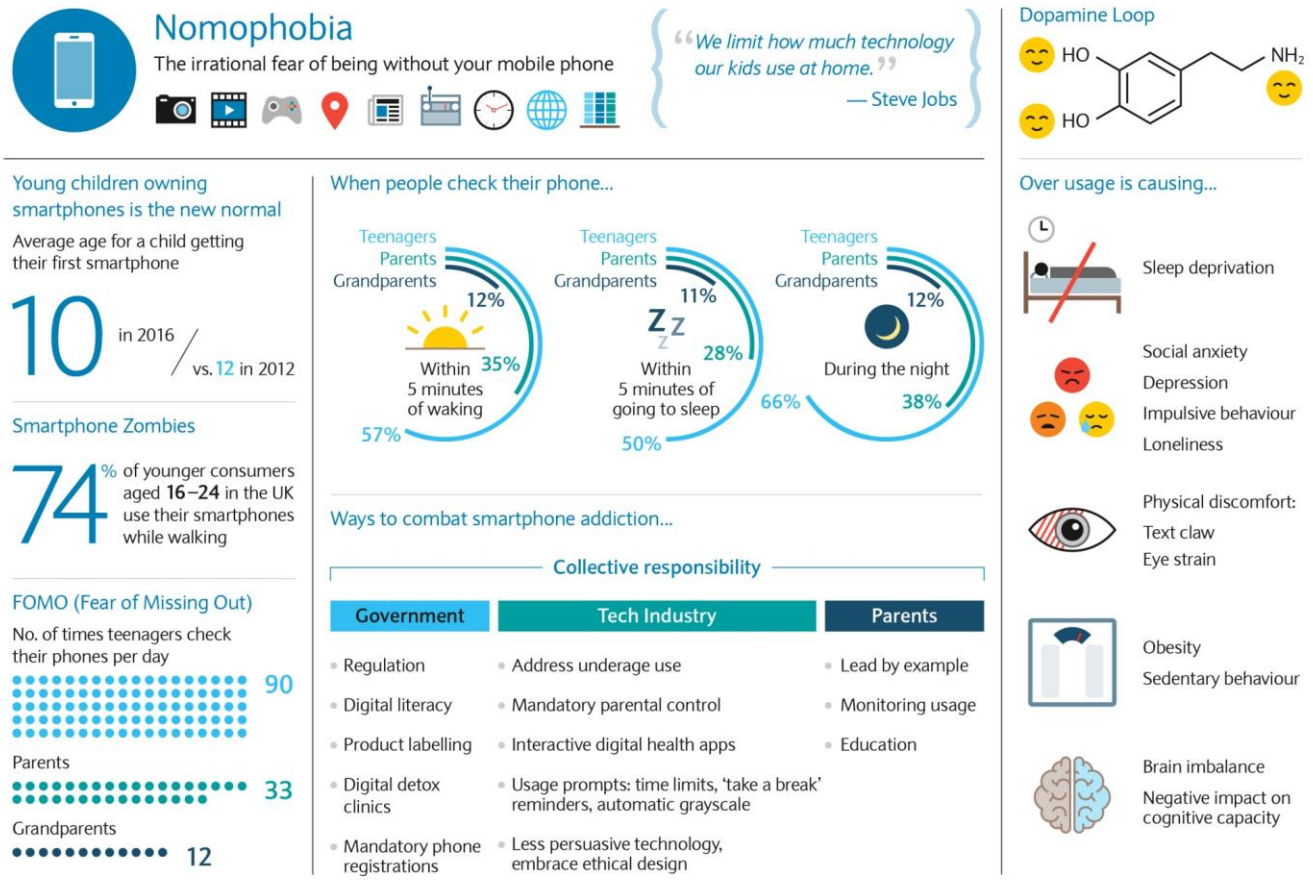
The objective of this report is to highlight why the tech industry needs to take a wider view of its responsibility for device usage, particularly the impact that persuasive technology can have on children. We acknowledge that asking tech companies to remedy smartphone addiction may seem counter-intuitive; however, it would be the lesser of two evils when considering the impact more intrusive regulation, additional shareholder pressure or societal backlash could have if action is not taken. This may require a shift in how success and user engagement is measured in the industry, fuelled by the growing prominence of ESG analysis in mainstream investing.

2020 theme catalysts

- **Backlash against vanity metrics and digital detox will force tech companies to adapt:** In 2019 there was various newsflow supporting our debate on screen time and the associated impact its overuse is having on society (e.g. depression, obesity, sleep deprivation). Within social media, we saw a backlash against vanity metrics with Instagram and Facebook announcing the decision to remove the 'like' feature in certain markets. This change will likely impact the way advertising and marketing is monetised by brands, but is also the start of business models having to pivot within the technology industry. For example, the CEO of Facebook commented at the F8 conference in April 2019 that the "Future is private."

- **Additional regulation on digital wellbeing:** The Chinese government announced a range of measures during 2018 to curb gaming addiction, which was then followed by the WHO officially classifying gaming disorder in its International Statistical Classification of Diseases (ICD) handbook. This means public healthcare systems around the world will now have to provide treatment and in October 2019, the NHS launched its first clinic for children addicted to video games. We see scope for additional regulation on digital wellbeing, with the UK Online Harms Paper establishing a new duty of care towards users, especially children and other vulnerable groups.

FIGURE 26
Smartphone Addiction: the need for digital detox



Source: Influence Central's Digital Trends Study (*2016*), Deloitte's 2017, Mobile Consumer Survey (*2017*), Steve Jobs was a low-tech parent – The New York Times (*2014*), Barclays Research

Future of Food Retail: Long live clicks and mortar

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Brick and mortar will play a key role in the successful food retail strategy of the future, but the stores will not look as we know them today. The traditional online/offline dichotomy will be replaced by an omni-channel experience across mobile, online and in-store, transforming brick and mortar stores into experience hubs as well as localised distribution centres for click and collect and home delivery. Despite the hype surrounding online's high growth within food retail, we believe there is a ceiling to online's market share due to structural consumer preferences for inspection and inspiration. A blinkered approach, focusing attention solely on online, will miss the potential to transform the chore of in-store food shopping into a pleasurable lifestyle activity where customers can learn, socialise and be inspired. We outline three key areas of focus for brick and mortar stores to generate a successful proposition: 1) productivity, 2) convenience and 3) customer experience.

In the report *Future of Food Retail: Long Live Clicks and Mortar* (12/10/18) we analyse which public and private food retailers are focusing on innovation under the three key categories of productivity, convenience and customer experience. We highlight examples of innovation at each of these companies and discuss their relative competitive positioning. Our analysis of the Grocery Tech Landscape should also enable investors to understand potential future developments in the food retail industry.

Why should investors care?

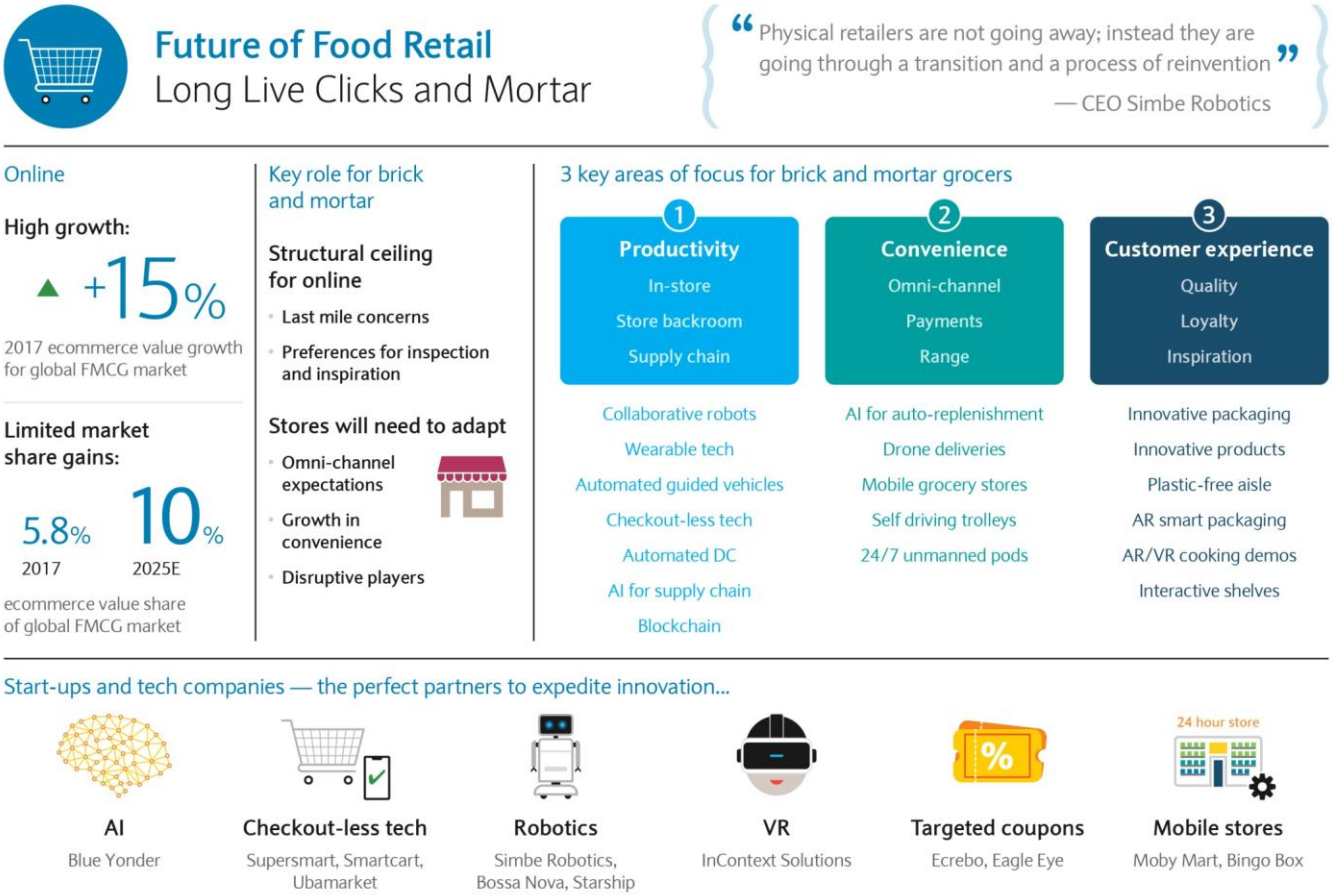
We think there is value in understanding the current pressure points for brick and mortar and highlight the catalysts for change: increasingly omni-channel expectations, the growth in convenience and the rise of disruptive players. Amazon's moves into brick and mortar food retail are clear signals of disruption, but based on our discussions with start-ups and tech companies we question the scalability of Amazon Go's technology and instead see it as an important catalyst for innovation within the wider industry.

2020 theme catalysts

- **Amazon Go store openings and checkout-less tech trials:** Amazon first launched its checkout-less concept, Amazon Go, to the public in January 2018 and has since opened a number of other locations. We argue that Amazon Go has acted as a catalyst for the wider food retail industry and other major players (such as Tesco, Sainsbury, Ahold Delhaize, Walmart and Kroger) have been experimenting with checkout-less technology to improve both the customer experience and reduce the operational burden of running checkouts. In 2020, we expect to see greater development in the checkout-less space and will be looking out for further movement from Amazon.

- **Greater adoption of robotics:** In 2020 we expect to continue to see the major food retailers testing the use of robotics both in-store and for home delivery. Grocers including Ahold Delhaize and Walmart have been testing shelf-auditing robots to more efficiently analyse stock levels and grocers such as Kroger and Tesco have been trialling autonomous delivery robots to help reduce the logistical burden of last mile delivery. We highlight some companies specialising in robotics for food retail in our Grocery Tech Landscape on page 31 of the full report.

FIGURE 27
Future of Food Retail: Long live clicks and mortar



Source: E = Kantar Worldpanel estimates. Source: Barclays Research, Kantar Worldpanel Winning Omnichannel Report June 2018, Kantar Worldpanel: The Future of E-Commerce in FMCG November 2017

Future of Tax: The need to be lean, green and employing machines

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The tax debate is evolving: it is no longer a question merely of whether companies are paying enough tax, but of how companies are taxed, with reference to both the growth of asset-light/digital businesses and the impact of a company's operations on society. Despite recent significant tax changes in the US and Europe, we believe that international tax policy will – and needs to – change further in the near future to address the challenges posed by globalisation, technology and growing environmental concerns.

In the report *Future of Tax: The need to be lean, green and employing machines (24/10/18)* we look at current tax trends, the latest policy discussions and global tax data to determine how future tax policy might evolve and how this could impact on business models and corporate decision-making.

Why should investors care?

The international tax regime is primed for reform, which will have widespread implications, particularly for large multinational companies. The report highlights focal points of current international tax debate and alerts investors to potential changes to the tax profile of some companies – such as the US 'Big Tech' firms. Some of the key changes to corporation taxes that we foresee include: (i) ensuring taxes on services are more aligned with the location of customers, rather than where operations are based; (ii) increasing scrutiny over transfer pricing, particularly for large vertically integrated multinationals; and (ii) further reducing interest deductions in Europe.

2020 theme catalysts

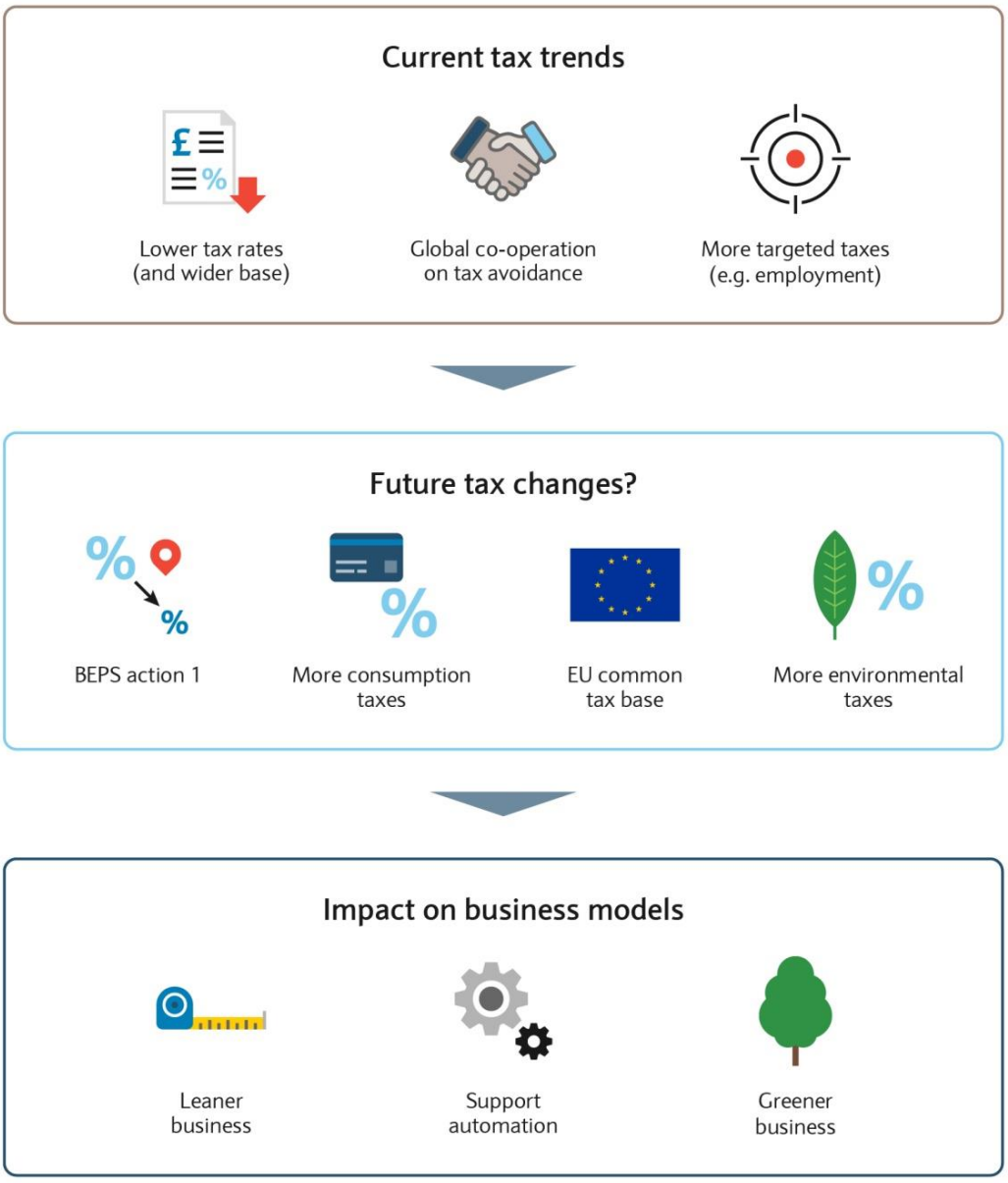
- **OECD global forums:** 2020 will be a pivotal year for international tax reform, given that the OECD has committed to reform international tax policy by the end of the year. In late 2019, the OECD opened public consultations into its Base Erosion and Profit Shifting Proposals. One of the proposals that has raised the most questions is the OECD's view that profits of internationally operating businesses should be subject to a minimum rate of tax.

  In January delegates from over 100 countries met to discuss how a unified approach can be reached. If this goes well experts will be able to start formulating a technical tax standard, which could be implemented by the end of 2020. It should, however, be noted that there are already some disagreements and concerns surrounding the OECDs proposals. It will take significant work to reach a global consensus.

- **Digital service taxes:** 2019 was the year of many countries unilaterally implementing/ or announcing their intention to implement a digital service tax. Countries include: France, the UK, Italy and Turkey. To date these taxes, have been viewed as predominantly targeting large US multinational FANG companies (Facebook, Amazon, Netflix and Google) – which has prompted strong reactions from the US government.

  The OECD is also looking to implement a global standard to remove the need for multiple digital service taxes – however, given the differing views of many countries it will be incredibly challenging to reach an agreement.

FIGURE 28
Future of Tax: The need to be lean, green and employing machines



Source: Barclays Research

Food Waste: Ripe for change

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We currently waste 1.3 billion tonnes of food per year, about one-third of all food produced for human consumption. This represents a loss of around $1 trillion dollars annually, a figure estimated to hit $1.5 trillion by 2030. Such massive waste is simply unsustainable in a world far off course from our two-degree climate change limit and one where an expanding population is putting ever-increasing pressure on resources. We think food waste is a greatly overlooked driver of climate change, accounting for as much as 8% of global greenhouse emissions, and an area ripe for transformation. The UN's Sustainable Development Goal 12.3 targets halving food waste by 2030, but without decisive action, the world risks failing to meet this goal. Companies are starting to see food waste as an opportunity, rather than simply a by-product of doing business, and this is particularly true in the developed world where most waste occurs at the consumption stage. We question the current dynamics of the food value chain and see the need for collaboration across key stakeholders, with a clear role for innovation to accelerate change.

In the report *Food Waste: Ripe for Change* (4/3/19) we assess the global impacts of increasing food waste awareness across the value chain. We see Food Retail and Leisure as the sectors most at risk, whereas we see greatest opportunity in the Food Manufacturing and Agribusiness sectors. We think food waste also has implications for Packaging, Energy, Chemicals, Food Delivery and Transport.

Why should investors care?

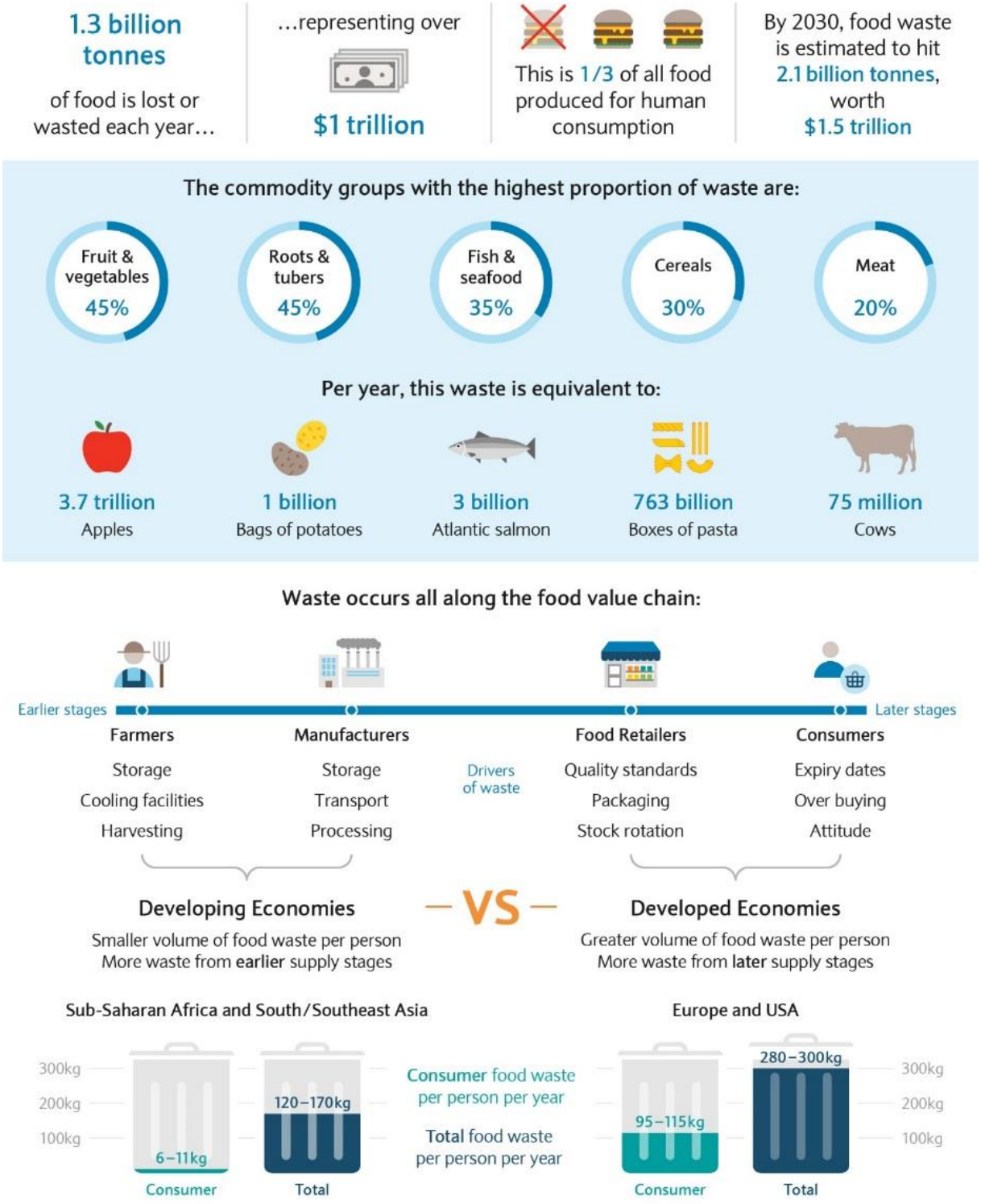
Viewing companies through a sustainable lens, investors should ensure that food waste is firmly on their radar. If a company does not take appropriate action on food waste, its relevance in an ethical and sustainable long-term portfolio may come into question. We argue that increasing awareness around food waste highlights the risks of significant regulatory change and consumer backlash. As such, investors should be putting pressure on companies to prioritise efforts to tackle this problem. Similar to the current spotlight on plastics, we believe food waste will be a key focus in the coming years and see awareness continuing to grow.

2020 theme catalysts

- **UK National Food Strategy:** In 2019, Henry Dimbleby was tasked with leading the first major review of the UK food system in nearly 75 years. The UK's National Food Strategy is set to be published in 2020 and will investigate the entire food system, from farm to fork, and recommend what changes are needed to ensure a more sustainable food system for the future. We will be looking at the recommendations given to reduce the UK's food waste and whether policy will be influenced by this publication, hence impacting businesses operating across the food value chain.

- **Country legislation updates:** In 2020, we will also be looking out for further policy change across the world on the topic of food waste. France extended its food waste law (that bans supermarkets from throwing away edible food) to agrifood and catering companies in January 2020 and we expect the policy pressure to remain. This is particularly true given the latest Champions 12.3 report on food waste is calling for greater policy action on the issue in order to meet SDG 12.3's 2030 target of halving food waste.

FIGURE 29
Food Waste: Ripe for change



Source: *FAO* 2011, *BCG* 2018

Education Technology: Out with the old school

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Global education is no longer fit for the 21st century. We need an urgent rethink of how education is provided if we are to keep up with the evolving needs of modern society. The World Bank has already warned of a global learning crisis, and as the modern learner demands new forms of education delivery, it has become more apparent that a one-size-fits-all approach no longer works. The key question today is how we can build an education system that best prepares the workers of tomorrow. We believe the automation era will redefine how society views education. It will no longer just be about 'knowing', instead the emphasis will be on a broader set of skills that are continually developed through lifelong learning. The industry is ripe for disruption and we believe education technology – EdTech – will play a large role. According to HolonIQ, total global education expenditure is expected to reach $10tn by 2030 (+4% CAGR 2018-30). Within this EdTech is likely to play a large role, with spending forecast to reach $342bn by 2025 (+12% CAGR 2018-25).

In the report *Education Technology: Out with the old school* (12/3/19) we propose four entry points for investors wanting to gain exposure to EdTech within our Investor Guidebook (page 33): i) Invest in EdTech start-ups, ii) Invest in listed EdTech specialists, iii) Invest in traditional education providers and iv) Invest in tech giants. Our discussions with the VC community suggest investor sentiment has improved followed the recent wave of IPO and M&A activity. Our EdTech landscape (page 5 in the main report) highlights companies with emerging exposure to education and EdTech, including listed and private companies by region.

Why should investors care?

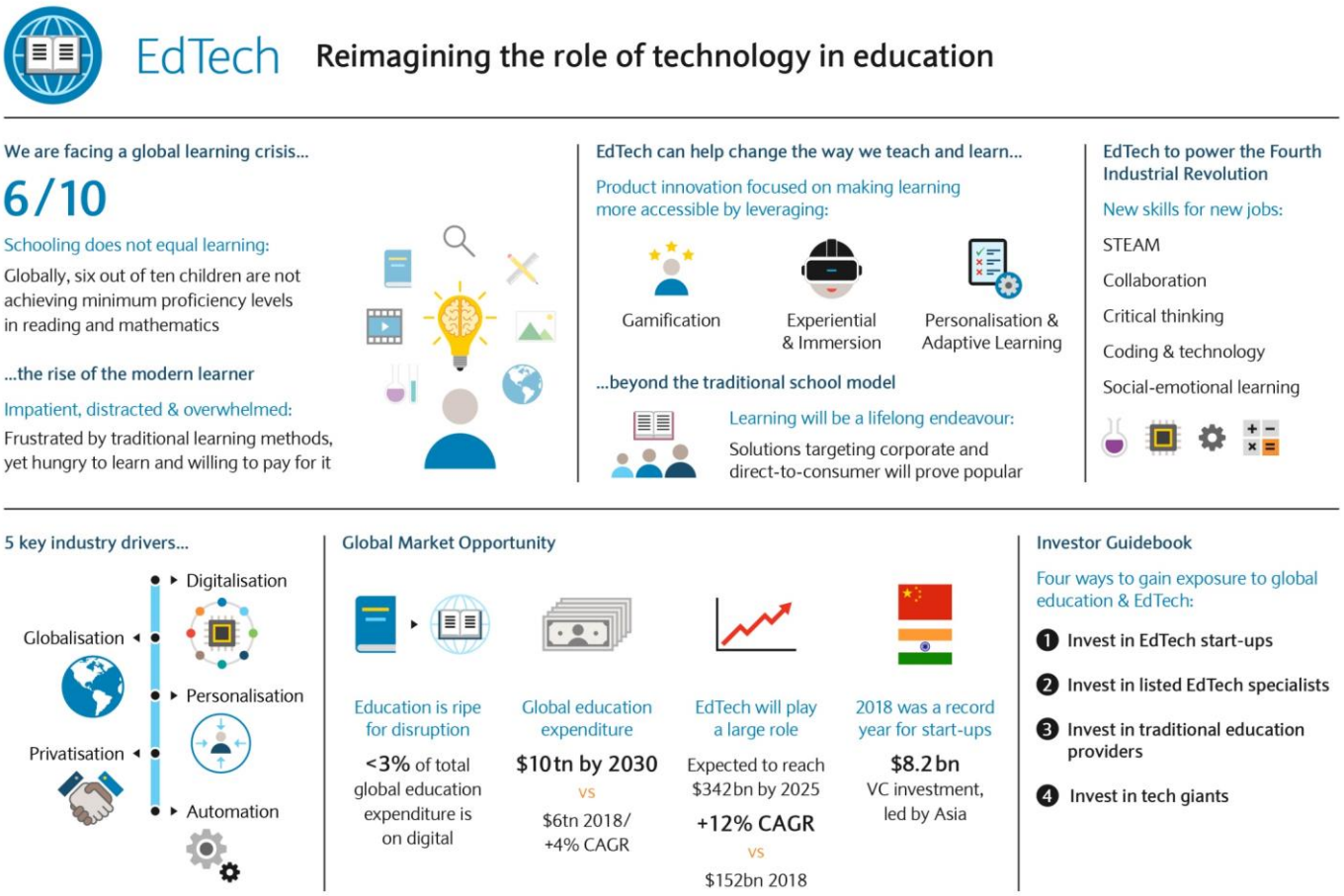
Education is arguably one of the last sectors to be disrupted by technology, despite its increasing socio-economic significance. We acknowledge EdTech was previously viewed as a difficult market to enter because of concerns regarding monetisation and the willingness of education systems to adapt to this new architecture. However, in recent years, its addressable market has expanded by region, by customer and by product, which has provided the sector with additional opportunities to gain scale. We see consumer-facing education apps proving popular in after-school and adult learning, as well as seeing value in virtual learning environments and online degrees. In the long run, these technologies could redefine the role of the teacher, question the relevance of higher education and transform the traditional career path.

2020 theme catalysts

- **Pressure to respond to skills shortages & demographic change:** We anticipate newsflow supporting our view on the global learning crisis to increase, led by skills shortages, talent wars and the rise of the modern learner. Employers and governments will need to respond, which is likely to support our view that the addressable market for education is expanding beyond schools as B2C and corporate demand grows.

- **Additional IPO and M&A activity:** We expect ongoing consolidation as the large EdTech players seek scale and international presence. Education IPOs remain at an all-time high with over 40 companies listing in the last 3 years according to HolonIQ. By region, a significant proportion of this growth can be attributed to Chinese companies listing in the US to take advantage of increasing investor interest. VC activity is expected to remain favourable, starting the year with 14 EdTech unicorns including BYJU's, VIPKid, iTutorgroup, Yuanfudao, Duolingo, Coursera, Udacity and Age of Learning.

FIGURE 30
EdTech: Out with the old school



Source: Barclays Research, HolonIQ – Smart Estimates January 2019

Micromobility: Fast, cheap & good solutions for 'smart cities'

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City planners need to develop smarter cities that can transport an additional 2.7bn urban commuters by 2050. We see micromobility (e-bikes, e-scooters, e-velomobiles and any other low-speed electric vehicles, LSEV) as the trigger for an 'iPhone moment' in urban personal and commercial transportation. There were 3.3 trillion passenger miles travelled (PMT) in the US in 2017, ~30 trillion globally. ~60% of these trips were less than 5 miles in length and yet in developed countries more than 70% of those short-distance trips were taken by car and only 2% by micro-vehicle (mainly bicycle). But why use a 1,500kg vehicle to transport a passenger load of 100kg? Urban areas are becoming denser and more congested, with average speed in many cities below 10mph. We see the potential for 1.1tn of the 18tn <5miles PMT globally to shift to micromobility modes, which implies $800bn of global revenue based on our proprietary Micromobility model.

In the report *Micromobility: Fast, Cheap and Good Solution for 'Smart Cities'* (20/3/19) we delve deeper into a new mode of mobility – micromobility – and define what it encompasses and why we believe it addresses fundamental issues surrounding urban mobility. By building a global addressable market for micromobility (using data from the NHTS to build a proprietary, theoretical model for the US which we scale to the global market), we analyse the impact micromobility could have on existing and potential new businesses models. We attempt to gauge the impact this mobility 'shift' could have on different sectors, including Property, Construction, Tech, Oil, Autos, Retail, Internet & Ecommerce, Media, Leisure and Business Services.

Why should investors care?

City policymakers should embrace the adoption of micromobility. With congestion worsening and spending on vehicle infrastructure rising substantially, we think city planners will move from disapproval to positive encouragement for a mode of mobility that requires significantly less infrastructure (10 bikes or 20 scooters can fit into 1 car space and throughput is even better given faster speeds), helps to reduce greenhouse gas emissions and can support existing public transport infrastructure by providing seamlessly integrated multi-modal mobility. City planners hold the power to adapt regulations and allocate mobility permits but will need to show a flexible approach to encourage innovation.

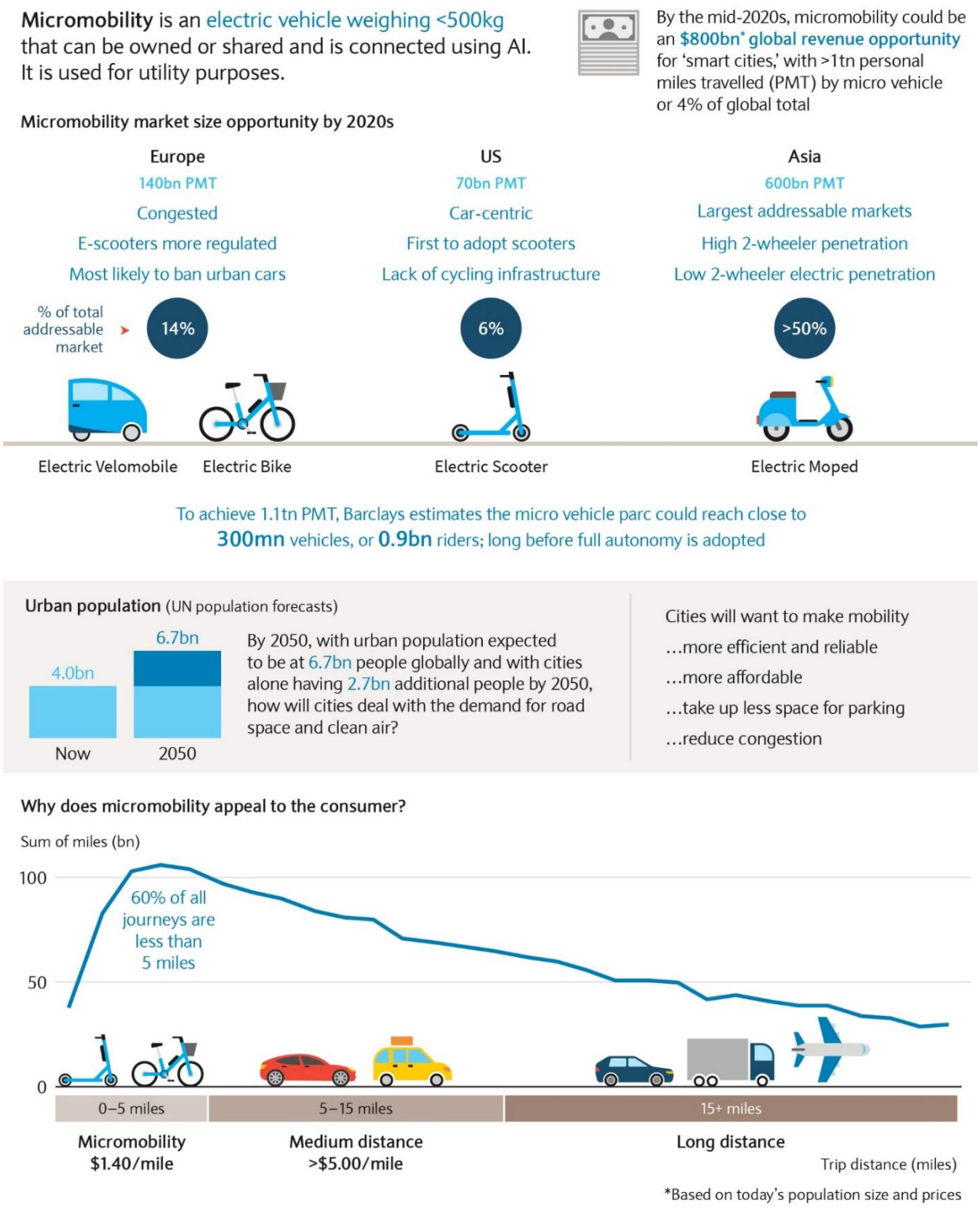
2020 theme catalysts

- **Micromobility operators to gain scale and profitability:** We see ongoing consolidation across the global micromobility landscape as operators gain scale in key cities. For example, in 2019 we saw Bird's acquisition of Scoot for $25m and Ojo Electric's acquisition of Gotha Mobility. Increased focused on scale is likely to aid improved profitability, which will provide shared mobility as an investment opportunity additional momentum within the VC community.

- **City planners to focus on safety as car-free zones become more widely considered:** We expect additional cities to discourage car use in urban areas throughout 2020. In addition to passenger and pedestrian safety, operators will also need to consider broader social and environmental issues following negative headlines in 2019 regarding sidewalk congestion and waste/vandalism. We expect product innovation to include self-reporting sensors, increased battery life and anti-tipping hardware.

- **Payments & Micromobility:** Beyond scale and safety, we see payment functionality as an additional source of product differentiation as operators consider new services.

FIGURE 31
Micromobility: Fast, cheap & good solutions for 'smart cities'



Source: Barclays Research

Global Food: I can't believe it's not meat

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We estimate that the market for alternative meat can reach ~$140bn over the next 10 years, with alternative meat players capturing ~10% of the ~$1.4tn global meat industry, based on our analysis. Although today we believe that there are inherent barriers to successfully replicating certain animal-based consumer favourites (e.g., T-bone steaks), what has been achieved so far in terms of 'meatless' ground beef, sausage and hamburger products has yielded positive initial consumer reaction, which should bode well for the alternative meat sector to grab its fair share of the global meat market.

In the report *Global Food: I Can't Believe It's Not Meat* (22/5/19) we lay a basic foundation for the different types of alternative meats and their processes, the key players in the space, the market opportunities, and the main drivers of alternative meat consumption. In our view, adopting a diet with less animal based protein is motivated by a combination of different reasons, but we identify three main drivers: animal welfare, health & wellness, and environmental concerns.

Why should investor care?

Consumers in general care about the healthiness aspects of what they eat, but they especially care about how their food tastes. Nonetheless, as a growing portion of the population becomes more conscious of the ingredients list on products, the perception of naturalness is also a relevant decision factor for consumers. While alternative meats are generally looking to create profitable and sustainable food options to solve the long-term problem of food availability and environmental challenges that lie ahead, it is crucial that they do so while answering to what consumers today are demanding to satisfy their cravings and nutritional needs in the short-term.

2020 theme catalysts

- **The taste & price differential is set to narrow further:** The two key issues to further expand alternative meat penetration in the past have been inferior taste compared to the real product at a higher price. In 2020 we see potential for further product development by key players, such as BYND, Impossible Foods, Nestle, among others to further improve the taste profile and while gaining scale reaching a closer per pound price compared to 'real meat'. While global animal based protein supply in 2020 is expected to be down ~7% (due to the African Swine Fever outbreak in China), we believe the price equality can be reached even earlier than initially expected.

- **We expect bolder marketing efforts by producers, retailers and most importantly restaurant operators:** While alternative meats are still niche, and yet to be turned into a mainstream category, we have seen more foodservice companies and retailers aggressively promoting products such as Beyond Meat or Impossible Burgers. We expect to see a big announcement from the world's largest QSR operator by sales (McDonalds) to introduce some sort of alternative meat offering in their key market the United States, to further promote sales of meat alternatives, which are not just another veggie burger.

FIGURE 32
Global Food: I can't believe it's not meat

Whether called cultured, clean, fake, mock or meatless, the range of alternative meat products is steadily expanding and could reach 10% of the global meat market in 10 years.

Present

Plants such as soybean, tofu, mushrooms, lentils and a range of fruits are being used to replicate meat in ground beef, hamburgers and sausages, as well as breakfast bowls, burgers, wings, tacos, breakfast sausage patties, and bacon strips.

Future

Lab-grown or more precise cell-based meat, produced from cell cultures, is likely to hit supermarket shelves in a decade.

Appetite for meat alternatives: 3 reasons consumers could bite

Animal Welfare: Less than 1/3 of consumers are fully knowledgeable of the animal-based meat production process.

Sustainability: Eating less meat is good for the environment. Cattle produce more GHG emissions than cars.

Health & Wellness: Consumers are increasingly scrutinizing their meat consumption because of the risk of high blood cholesterol and heart diseases associated with red meat in particular.

What will it take for substitute meat to go mainstream?

To turn this niche into a mainstream category, a joint effort is required by food producers, retailers and restaurants to educate people about the benefits of alternative meat. So what can these players do to whet the appetite for meat eaters?

Retailer supply

Retailers could become a powerful ally to increase alternative meat consumption by increasing availability and in-store placements on meat counters and in butchers.

Restaurant demand

Alternative meats could drive significant sales at **fast food outlets** and casual dining **restaurants,** but especially in QSRs, where these substitutes could be viewed as the "healthier" option on the menu.

Food producer marketing

For meat alternatives to succeed, **companies** need to appeal to the biggest meat eaters: males aged 14 to 70.

Source: Barclays Research, Consumer Image Index, FAO, International Food Information Council

European Food: A thirst for plant-based dairy

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One of Large Cap Food's major challenges currently is to grasp the pace and scale of the 'food revolution' and adapt brand portfolios. Younger consumers have a fundamentally different relationship with the food they consume, and sustainability, convenience and authenticity are all increasingly influencing purchase decisions. Based on estimated plant-based penetration in each subcategory, i.e. milk, yoghurt, etc., our base case is that the market could reach $72bn by 2030, with milk and yoghurt accounting for c.40% of it. Our bull case estimates the market could reach $110bn.

In the report *European Food: A thirst for plant-based dairy* (24/5/19) we see health as by far the biggest driver of change in food consumption habits globally. According to Nielsen, 47% of the younger generation are eating healthier and ~30% are willing to pay a premium for healthier food and, >70% of a family's food spending is being influenced by Gen Z consumers. In the United States, as many as 50% of consumers are now seeking more plant-based foods in their diet and 40% are open to reducing their traditional meat consumption, according to Paul Grimwood, Nestlé USA Non-Exec Chairman.

Why should investors care?

In addition to the need to respond to the 'food revolution', the desire for plant-based alternatives provides an economic opportunity for Big Food. Early data from Danone shows that the growth of plant-based alternatives has led to increased spending by consumers. In the UK, the basket spend in the dairy category of a shopper buying plant-based products is 36% higher per trip than a non-plant-based basket. In the Netherlands, this increase in spend was 26%. In the US, plant-based shoppers have on average increased their value of grocery basket by 74%. In France, this number is as high as 2.4x. Importantly, plant-based products are not cannibalising dairy products with 80% of Danone's Alpro plant-based yoghurt sales in Spain being incremental.

2020 theme catalysts

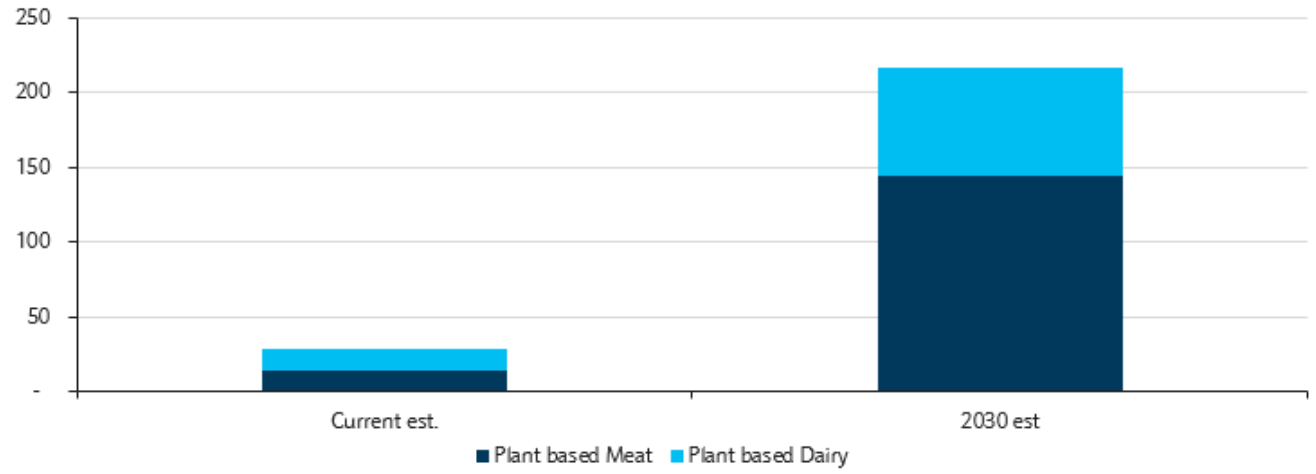
- **Big brands implement learnings to launch new products:** 2019 was the year that saw Big Food introduce their plant-based products to the market following acquisitions in recent years (Danone acquired WhiteWave in 2016 and Unilever brought The Vegetarian Butcher in 2019). We think 2020 will see big brands rollout the lessons they have learnt across their existing portfolios. For example, in the US, Danone has announced the launch of a plant-based version of Activia, its largest dairy brand, whilst Nestle has launched a new sub-brand under Nesquik called GoodNes (oat-based chocolate milk).

- **Expansion of non-soy alternatives, especially oat-based milk:** We think oats will be the plant-based dairy trend of 2020. Future Market Insights estimates the oat milk market will grow at an 8.2% CAGR between 2018 and 2027. We estimate that oats account for <5% of the plant-based dairy market, but the category is growing rapidly and could triple to >15% by 2025 as it becomes mainstream with early adopter coffee shop advocates driving a change in consumption habits at retail.

  The potential health benefits of oats increasingly appeal to consumers. Unlike soy, which can separate in milk and has something of a bitter aftertaste, this isn't the case with oats, which have more of a velvety consistency. Consumers haven't been put off by its relatively low protein or high carb and fat content (vs other plant-based alternatives), demonstrating taste and consumer perception is key.

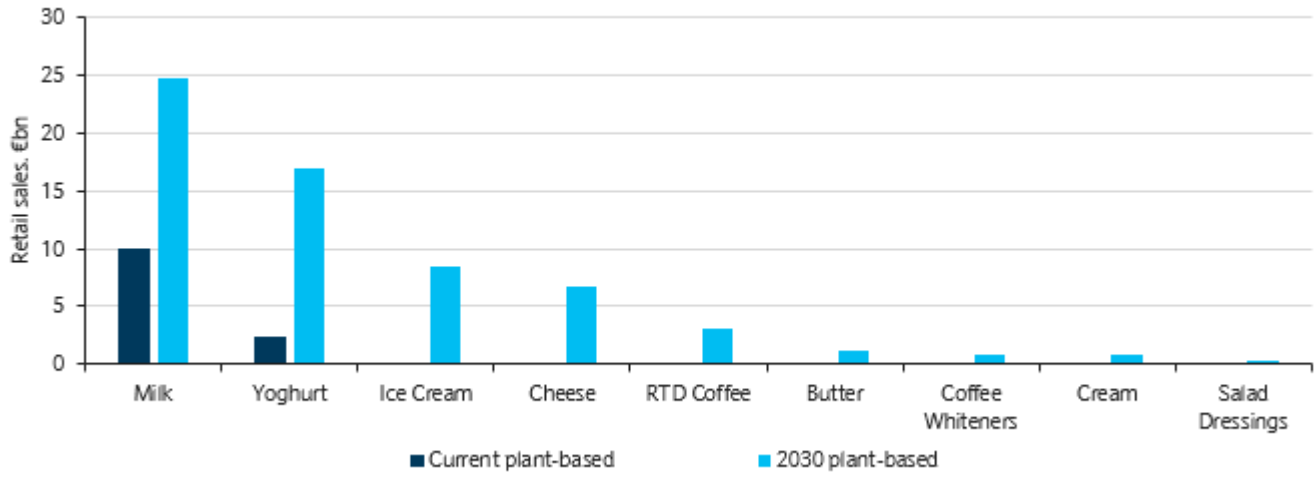
FIGURE 33

We expect PB food to grow from ~$30bn in 2019 to $220bn in 2030E



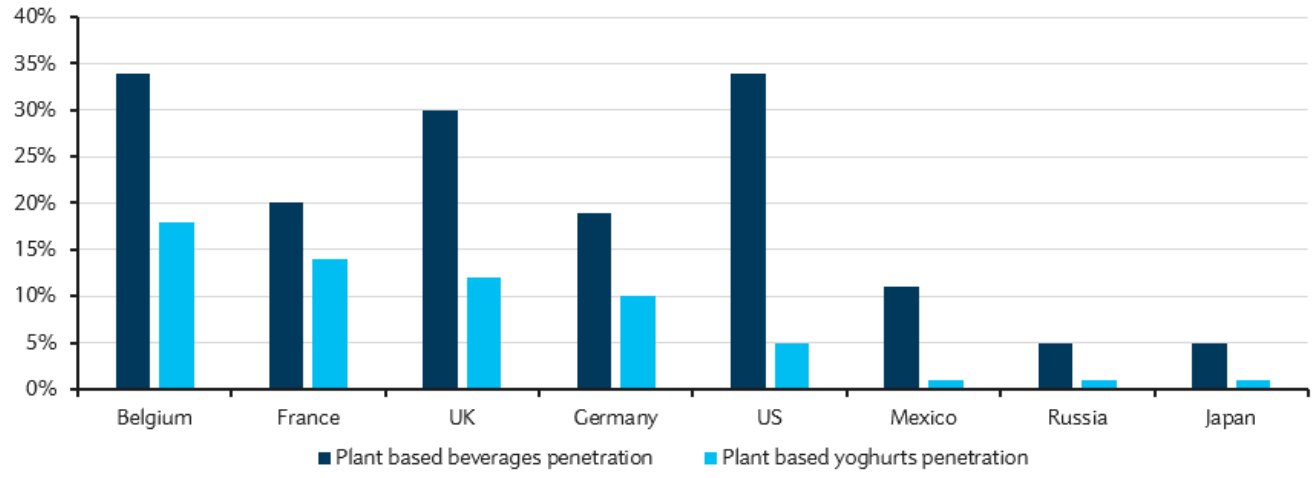
Source: Barclays Research, Euromonitor

We estimate that PB milk will grow by a factor of 2.5x in 10 years, PB yoghurt by 8x, among others



Source: Barclays Research, Euromonitor

Plant based beverages and yoghurt penetration by country



Source: Company reports

Plastic Waste: Don't lose your bottle

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The plastics industry is undergoing a revolution as it seeks to address the c160m metric tonnes of plastic waste which leaks into the natural environment or ends up in landfill each year, representing more than 55% of the total plastic waste produced. We view PET plastic packaging – and in particular beverage bottles – as pivotal to this issue: it constitutes more than 10% of plastic waste. However, since PET bottles provide significant advantages (weight, durability and versatility) over alternative materials, we believe that they are here to stay, unlike other single-use plastics which have been subject to widespread bans. Heightened consumer awareness is forcing companies and governments to set ambitious recycling targets, but PET waste management will have to adapt in order for these targets to be met. To boost low collection rates and poor PET recycling yields, we view a Consumer Deposit Scheme (CDS) as the policy instrument of choice, further supported by emerging technology. In this report we focus on PET plastic packaging and the recycling infrastructure required to support its long-term use within the circular economy. We argue PET should be viewed as an opportunity, with the demand for high-quality recycled PET likely to incentivise investment across the PET waste management value chain.

In the report *Plastic Waste: Don't lose your bottle (19/6/19)* our Investor Guidebook assesses the impact of growing PET waste awareness on sectors across the value chain. We map out the companies exposed to the plastic waste theme: 1) CDS beneficiaries; 2) emerging recycling technologies and 3) companies exposed to changing attitudes towards PET waste. In light of the UK's CDS consultation, we model the potential opex and capex costs to companies in our coverage.

Why should investors care?

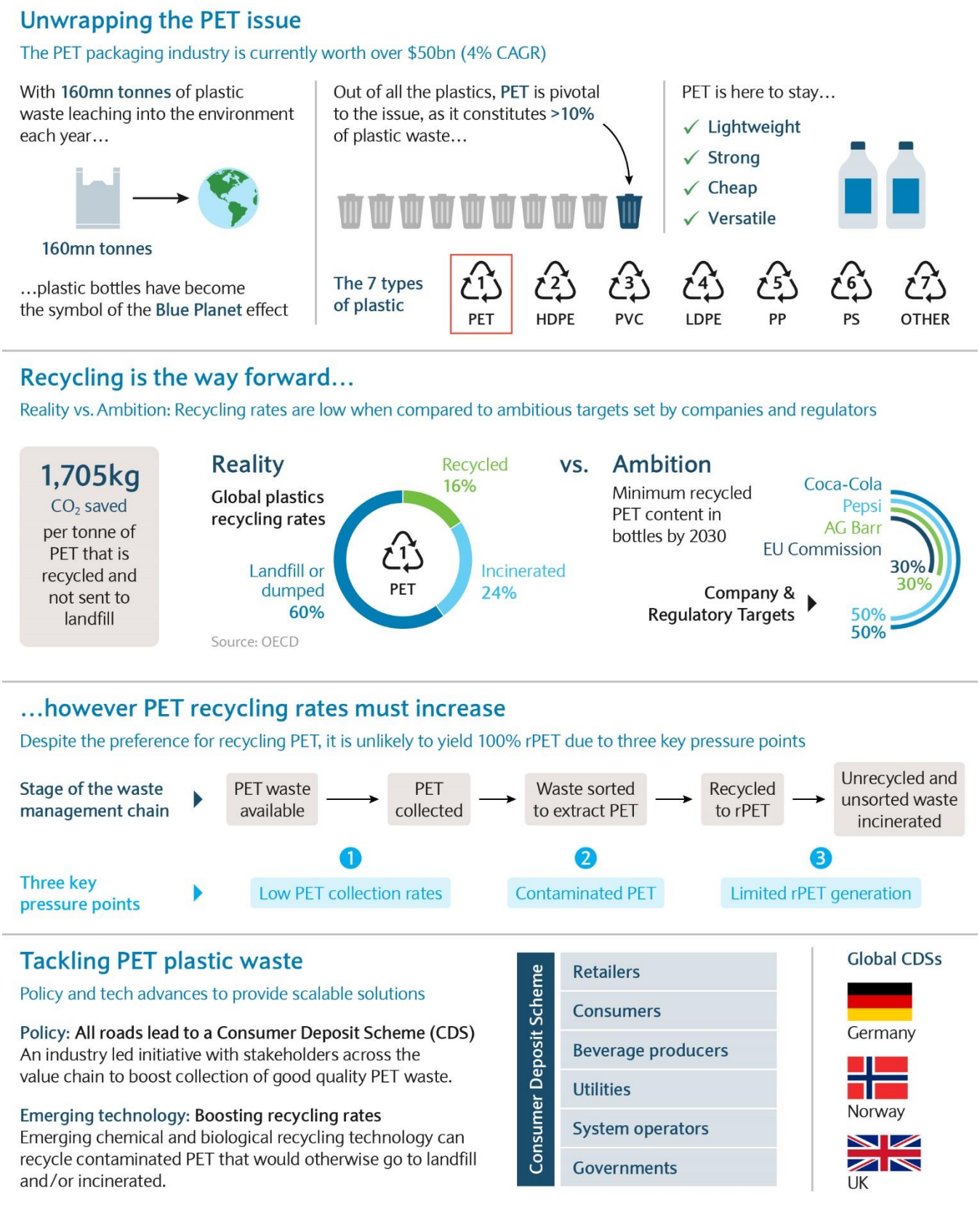
Concerns surrounding single-use plastic and plastic waste reached an all-time high in 2019. The theme has been particularly relevant for investors because of a raft of legislation that was passed in 2019 which has prompted change in both the waste management sector and packaging sector. In Europe PET plastic beverage bottles will need to contain at least 25% recycled content by 2025, which has changed the economics of recycling plastics and put pressure on the beverage industry to secure a supply of food grade recycling PET.

2020 theme catalysts

- **Legislation surrounding Consumer Deposit Schemes:** The Single Use Plastic Directive was passed in Europe in mid-2019. The law requires, amongst other things, European Member States to ensure that at least 90% of single-use plastic waste is collected by 2029. The regulation mentions that Consumer Deposit Schemes can be employed as a policy tool as they can boost collection rates for PET plastic bottles. In 2019 the UK, France, New Zealand and numerous other countries announced their intention to implement Consumer Deposit Schemes. 2020 will be an important year, to follow how they will be structured and most importantly, who will pay for setting up the system.

- **Commercialisation of emerging recycling technology:** The use of chemical recycling has proliferated in 2019, with several small companies reaching the headlines for their innovative PET recycling technology. Although the technology works, in December 2019 Coca-Cola unveiled plastic bottles made from chemically recycled PET plastic, 2020 should be the year for scaling up and commercialising the technology, as significant volumes of food grade recycled PET will be required by the large consumer brands over the coming years.

FIGURE 34
Plastic Waste: Don't lose your bottle



Source: Barclays Reports, Company statements, EU Commission, OECD,

Insect Protein: Bitten by the bug

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With the global population estimated to increase to 10 billion by 2050, and food production needing to increase by as much as 70% to meet growing demand, serious challenges are posed around the sustainability of our food production systems, particularly in regards to meat. Our colleagues published a report exploring the potential for plant-based alternatives and cultured meat (*Global Food: I Can't Believe It's Not Meat*, 22/5/19), and we continue this discussion with another option – insects. We see scope for insects to reduce the environmental burden of our food system as an alternative for both animal feed and food for human consumption. Although there are numerous hurdles to overcome, notably regulation, price and cultural acceptance, we see insects as a viable middle ground for consumers wanting to make their diets more sustainable without going entirely plant-based as well as offering a more sustainable source of animal feed. The insect protein market could be worth up to $8bn by 2030 (+24% CAGR) and we see upside if the supply and demand factors continue to develop favourably, similar to what we have seen in the plant-based space.

In the report *Insect Protein: Bitten by the bug* (24/6/19) we assess the impact of the insect protein trend on Food Retail, Agribusiness, Food Manufacturing and Leisure. Similar to what we have seen with other food trends such as plant-based meats and dairy alternatives, we see small brands disrupting the current landscape and acting as a catalyst for change within the mainstream food industry.

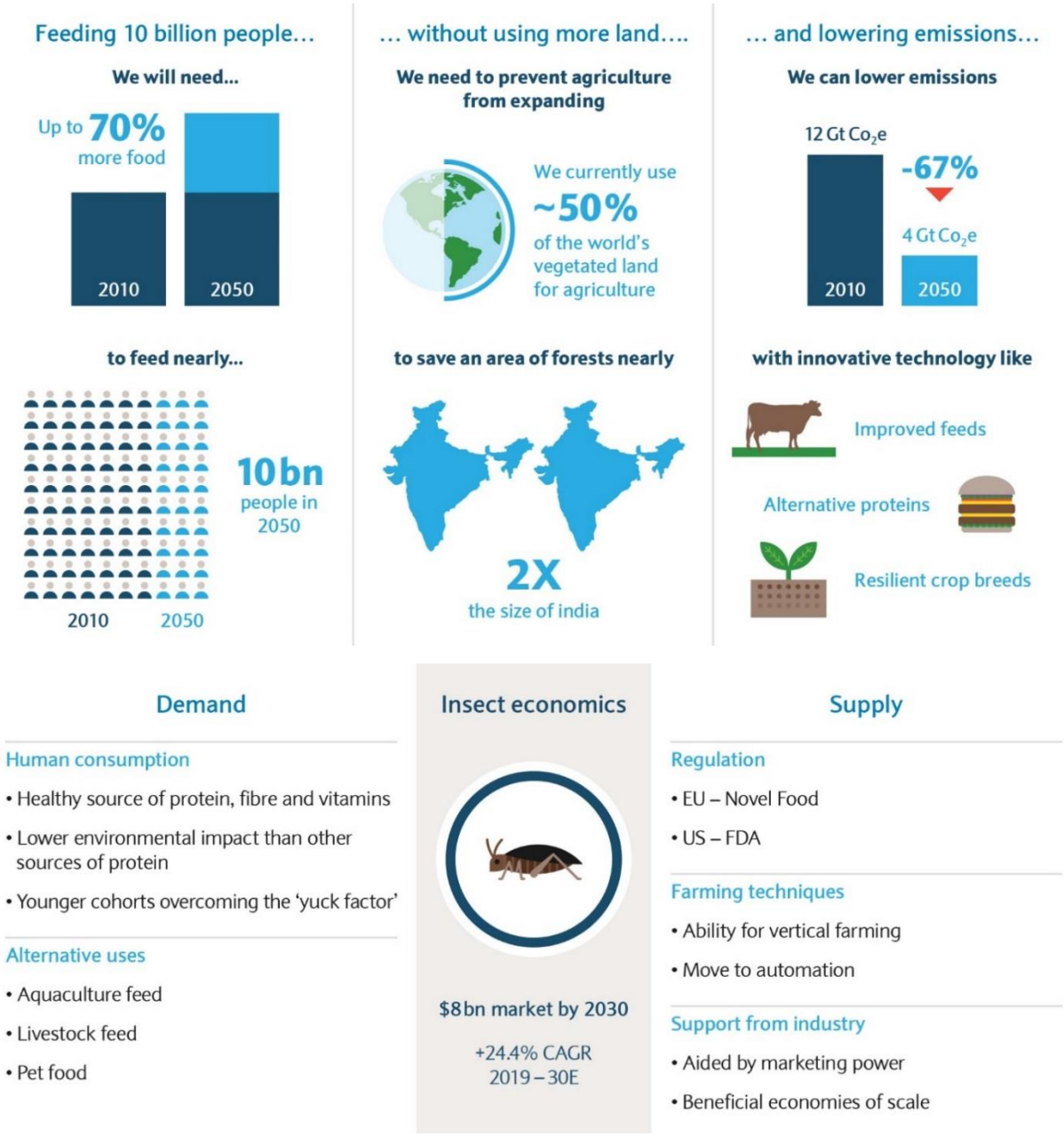
Why should investors care?

We present insects, such as crickets and mealworms, as another meat alternative to improve the sustainability of global food production. We see plant-based meat alternatives as the current source of disruption within protein and see cultured meat as a longer-term option. However, we see future potential for insect protein to also be added to the menu – another alternative that has received less attention thus far.

2020 theme catalysts

- **EU Novel Foods:** Insects fell under the scope of the EU Novel Foods legislation as of 1 January 2018. The EU is currently considering which insects will be included in its list of authorised 'novel' foods and we will be waiting to see if this decision is made in 2020.
- **Falling prices for insects:** In our research we spoke to insect snack producer Entis Finland, who told us that the wholesale price of cricket powder has already fallen significantly over the past 2 years (see Figure 12 in the *full report*) and they expect the price to continue to fall as the industry scales and utilises further automation. Therefore, in 2020 we will be looking for indicators that the price of insects has reduced and hence lessening one of the current barriers to mainstream adoption.
- **Further product launches:** In 2020 we expect to continue to see new and innovative products containing insects for human consumption as well as increased adoption of using insects as animal feed and for pet food.

FIGURE 35
Insect Protein: Bitten by the bug



Source: Barclays Research, Adapted from the *World Resources Institute*, 70% from *FAO, Meticulous Research*

Drones: As drones rise, costs fall

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Commercial drones provide an avenue for cost reduction ($100bn) and safety improvement which will drive widespread adoption in the coming years. This wave of uptake provides an opportunity for investors in the form of sensors, cameras and processing units. The convergence of technology themes, including 5G, remote computing and AI, set the stage for widespread commercial drone deployment in the coming years. Uptake is being driven by cost-reduction potential and safety improvements, rather than large incremental revenue opportunities. Initially, we expect the market to be focused on the drone body itself, but the longer-term angle is componentry. Pervasive drone deployment is not just a technology strategy but could upend the way business is conducted.

In the report *Global Technology: As Drones rise, costs fall* (30/7/19) Barclays analysts from US IT Hardware, US Semiconductors, US Internet, US Software, North America Power & Utilities, US Homebuilding & Products, US Insurance/Life, North America Transportation, US Chemicals, North America Oilfield Services & Equipment, European Integrated Oil & Refining, and North America Metals & Mining assess the impact of the theme on their sector coverage.

Why should investors care?

For companies implementing drones into their operations, there is an opportunity for significant cost reduction, which we forecast reaching $100bn by 2024. We expect the most rapid acceptance to occur within the agriculture, infrastructure (oil & gas, telecom and utilities), construction and insurance spaces, as opposed to oft-discussed logistics & delivery applications. In our view, the most investable angle for the drone ecosystem is not the drone body itself but rather the associated sensor, camera and processing technologies. Specifically, we expect innovation in areas such as LiDAR, imaging and GPUs to play a critical role in enabling safe, effective commercial drone usage, especially as drones become increasingly autonomous. Consequently, we expect companies such as NVIDIA, Intel and a host of private vendors to benefit from this transition over the long term.

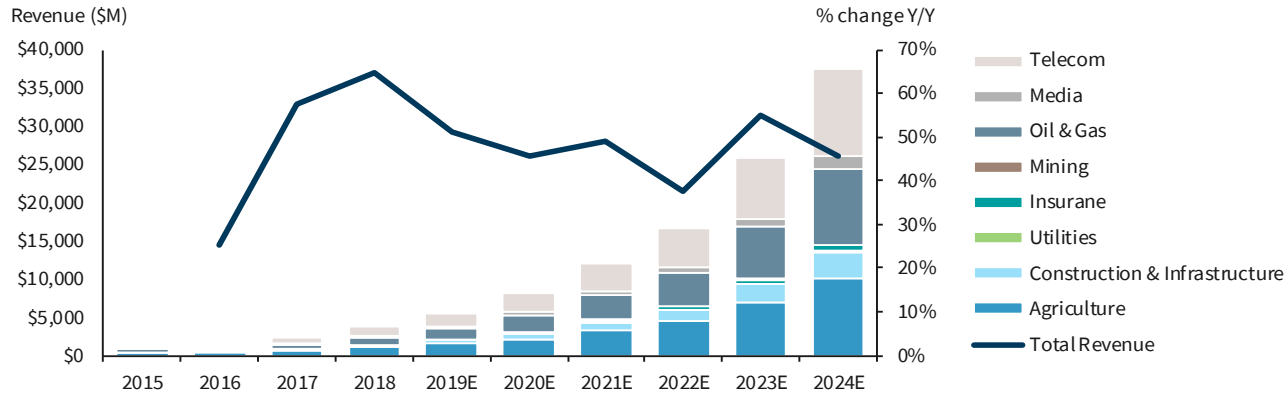
2020 theme catalysts

- 5G: New technology will be required to provide the connectivity, on-board processing capabilities and intelligence (image processing) to enable increasingly autonomous operations. In terms of connectivity, 5G will provide the low latency, high reliability and peak data rates necessary for both the command and control link as well as the vast majority of drone applications. Importantly, network slicing will be enabled by 5G, which will allow drone operators to specify their requirements (pay for what they need) and allow service providers to deploy their network resources toward the highest priority applications (better match investments to identifiable opportunities).

- Artificial Intelligence improvements: The software capabilities necessary to 'understand' the data being collected will be enabled by artificial intelligence, which for the purpose of this report we limit to image processing. Artificial intelligence has been made possible due to the improvement of machine learning algorithms, availability of data (computer vision, voice recognition and natural language processing building blocks are being provided by companies such as Amazon, Microsoft and Google) and ability to analyse massive quantities of data vis-à-vis the public cloud.

FIGURE 36

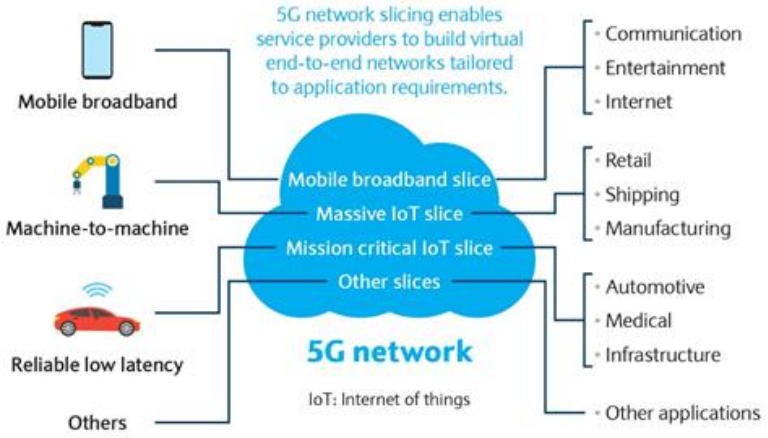
Commercial drone revenue nears $40Bn by 2024



Source: Gartner, DJI and Barclays Research.

FIGURE 37

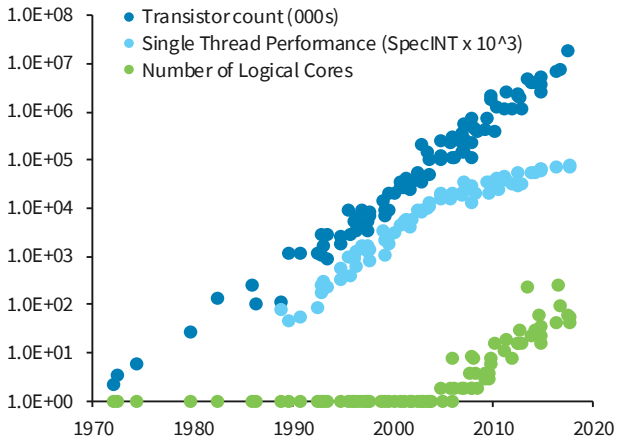
Network slicing enables drone operators to tailor coverage based on their requirements



Source: Barclays Research.

FIGURE 38

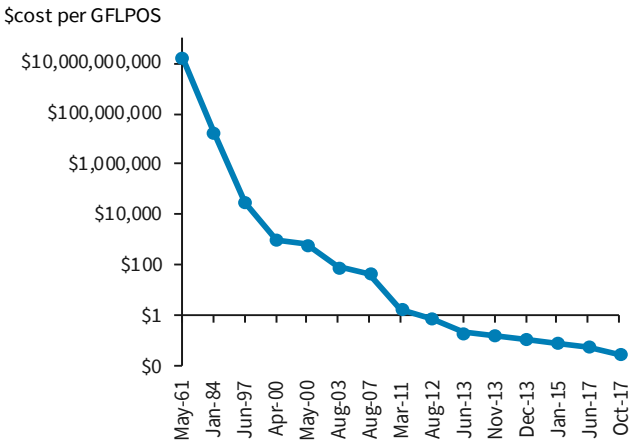
Moore's Law: exponential growth in computing power



Source: Gartner and Barclays Research.

FIGURE 39

Calculations: cost per billion is now <$1



Source: Gartner and Barclays Research

Global Catering: Catering in a delivery world

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Until now the impact of food delivery on the catering sector has been limited, in large part as delivery groups have focused on B2C rather than B2B and the current delivery offer to the workplace is too expensive/inconvenient to seriously rival canteens. This is changing quickly, however, with major European delivery companies acquiring B2B platforms and numerous start-ups developing a workplace offer (e.g. Dejbox which is being acquired by Carrefour). Meanwhile, food production and delivery costs are gradually being reduced and the reach of delivery both in terms of healthy/varied lunchtime-specific offers and geographic coverage is increasing. In short, things are moving quickly in a direction where delivery has the potential to both more viably compete with canteens and also open up new B2B opportunities in smaller businesses that currently lack any canteen offering.

In the report, *Catering in a delivery world* (6/9/19), we see food delivery as both a threat and an opportunity for the caterers. Overall we see more negatives than positives currently. We see c.34% of catering revenues as vulnerable with risks to volumes, outsourcing rates and more immediately to margins. However, we also see opportunities.

Why should investors care?

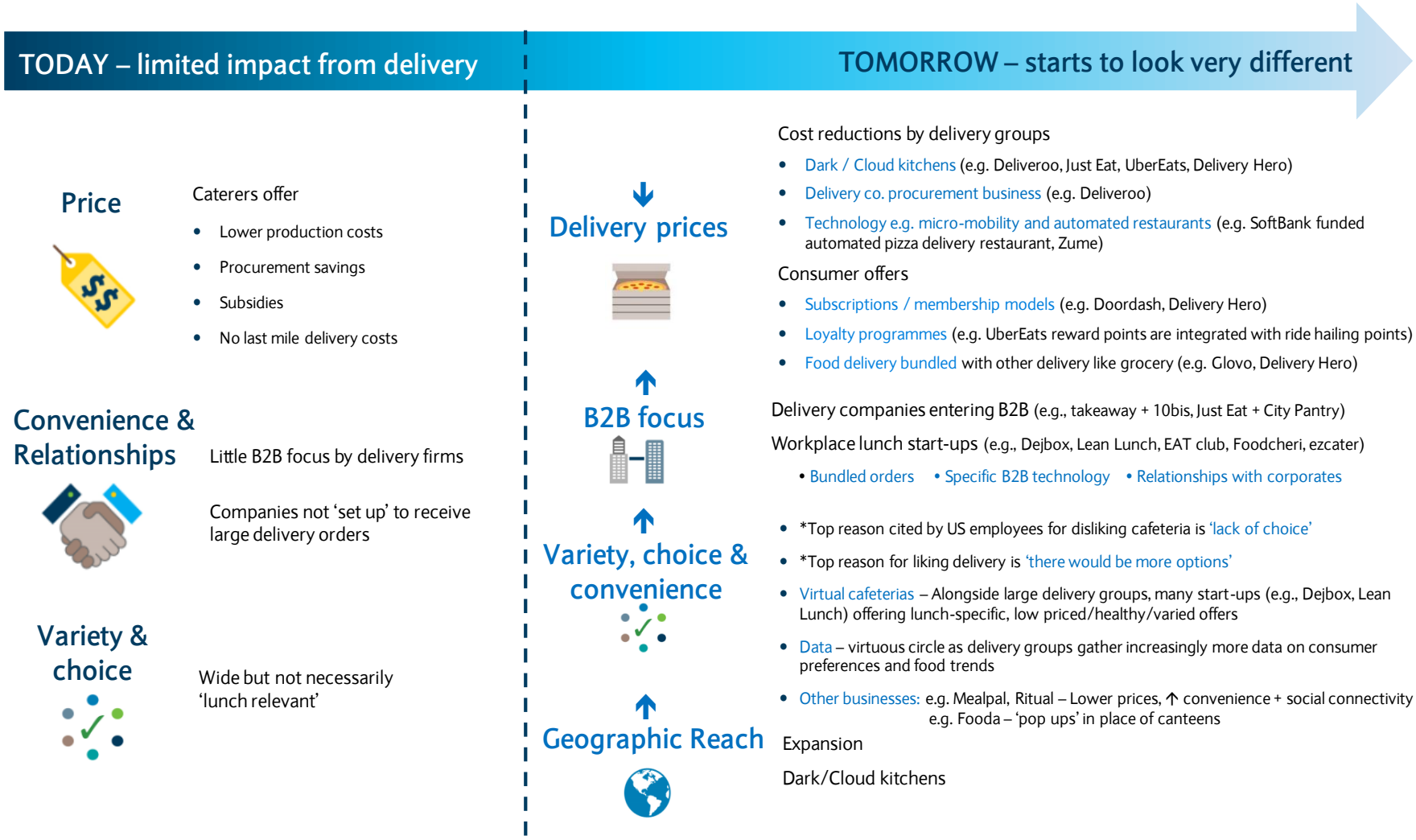
We believe the impact for catering groups will largely be a function of 1) how relevant and attractive (health/variety/digital etc.) their offer can be – for those who can 'get it right', we also see the potential for higher volumes and increased share gains from smaller/less relevant players; 2) the extent to which they choose to partner with delivery firms to extend their reach (e.g. to SMEs) and/or enhance their offer. Could a tie-up between a food delivery group and a caterer for the provision of workplace food delivery be the next obvious step, with the caterer offering food production, procurement advantages and corporate relationships to the delivery groups? It is not obvious that the caterers will want to step outside of their core expertise – captive market catering – but we have already seen some (Sodexo, Aramark) make small forays into this space via acquisitions/investments. From a food delivery perspective, we see a €500bn TAM in 2025E, with c€20-25bn from B2B in a segment that, importantly, could be highly profitable (>40% EBITDA margins).

How to play the theme?

Overall we see more risks to caterers and believe the opportunities are more skewed to food delivery groups. We see Compass as the best placed among the caterers. By contrast we think groups that are currently investing to fix the core issues (e.g. too few relevant brands) and that have promised the market margin growth may struggle to also find the capacity to adequately invest in/focus on these areas at this critical time. Consequently, we see this theme as more of a relative risk for Sodexo, Elior and Aramark. Sodexo is most exposed, in our view, among these names as we see risks in particular to consensus margin growth projections with the group needing to invest back into the core food offering as well as these emerging areas. In the broader business services space, we see Edenred as a beneficiary as meal vouchers bring 'subsidies' to workplace delivery and the trend could lead to increased penetration. Among the food delivery names, Takeaway.com has made the most interesting strides into B2B up until this point.

FIGURE 40

Impact from delivery on catering limited so far…but things are evolving quickly



Source Barclays Research. Note: *Barclays/YouGov survey of 2,688 US-based employees

Plastic Bottles: Reinventing for the circular economy

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Following our inaugural report, *Plastic Waste: Don't lose your bottle* (19 June 2019), the debate on single-use plastics has continued to intensify. In this follow-up we present the Barclays Sustainable Packaging Matrix, which assesses the green credentials of PET plastic bottles, aluminium and glass as packaging materials. Although we conclude that on balance PET plastic is the most sustainable material, we note that consumer preference and government legislation will be the two main factors determining its future. With this in mind, we propose three progressively severe outlooks for PET bottles: redesign; substitute; and ban – the latter being the least likely, in our view. We discussed our findings during site visits at two PET recycling facilities operated by Viridor and Indorama, which highlighted the benefits of redesigning the bottle and the need to prepare for the risk of substitution. Our analysts in Metals & Mining, Beverages and Industrials look at how companies are responding to growing questions around the sustainability of beverage packaging.

In the report *Plastic Bottles: Reinventing for the circular economy* (2/10/19) in the Investor Guidebook (page 30) Barclays analysts from European Metals & Mining, Global Beverages and LatAm Industrials assess the impact of the theme on their sector coverage. Key company mentions include Norsk Hydro, Coca-Cola and Pepsi-Co, Alpek, Indorama (not covered), Corbion (not covered) and BASF.

Why should investors care?

Following extensive marketing and Premier Events, investors continue to question the sustainability of various packaging materials. We believe our Sustainable Packaging Matrix and recent site visits further extend our discussion on PET plastic by outlining three future outlooks (redesign, substitute, ban). Companies across the value-chain will need to consider the possibility of all three outlooks as we transition to a circular economy.

2020 theme catalysts

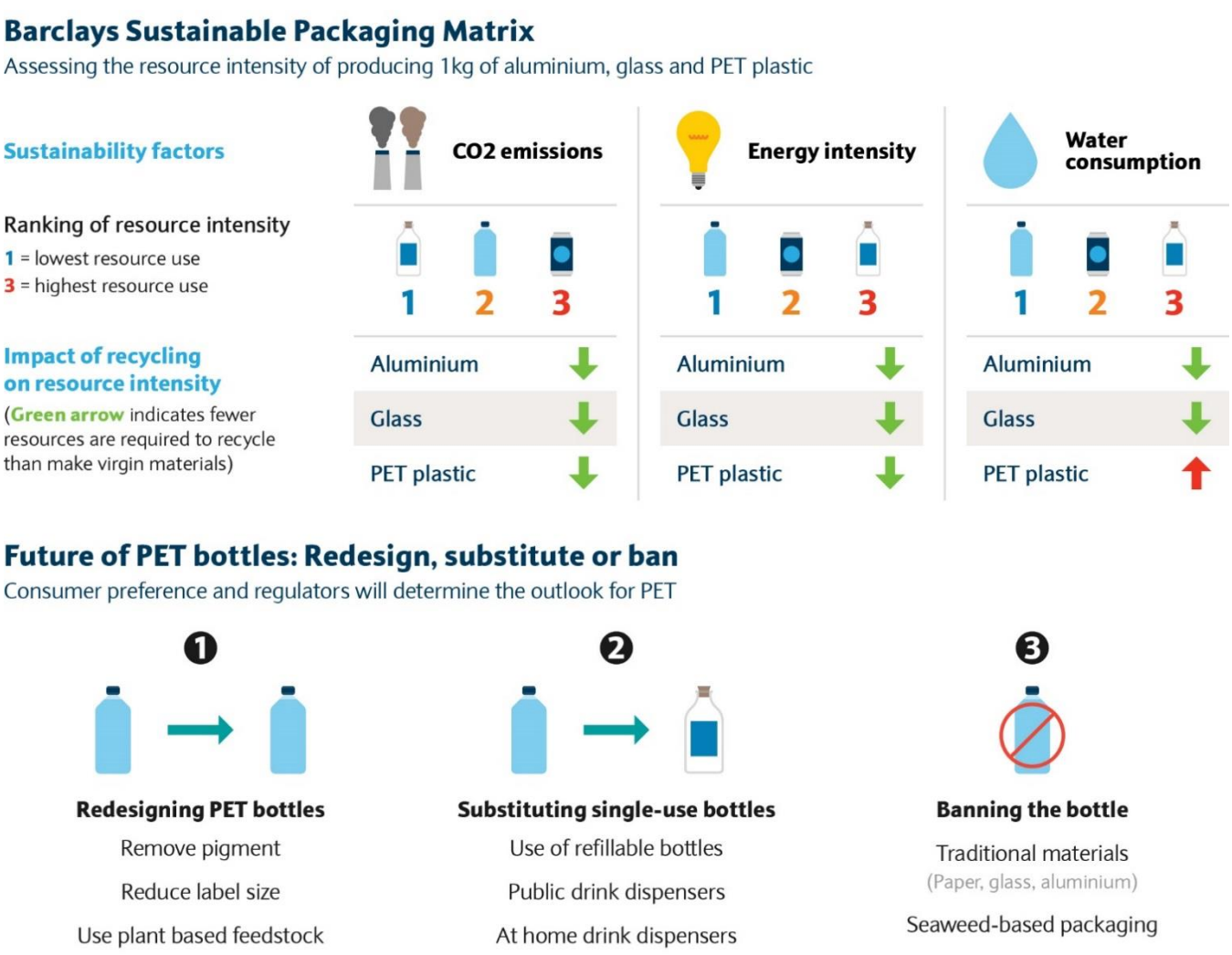
- **Innovation in packaging materials.** As consumer brands and packaging companies seek to boost the recyclability of their products, we expect hard to recycle materials to be phased out. The plastic sleeves around bottles and the shrink packaging used in multipack cans and bottles are the first areas likely to be improved.

  There has been a significant amount of innovation in packaging, and we expect to see more in 2020. In our report, we noted a few small companies trying to make a bottle out of paper. Since we published the report, Heineken unveiled a prototype for paper beer bottles. Seaweed packaging and bio-plastics are all being experimented with. 2020 may bring a new sustainable material to the market.

- **Consumer preference shifts.** The beverage industry has been trailing a number of its products in a range of packaging materials: glass; plastic; and aluminium. Despite the negative sentiment surrounding plastic in 2019, this had not materialised in any noticeable shifts in consumer preference. We expect to see some signs of consumer preference in 2020 as consumers get more accustomed to their favourite beverages being offered in a range of packaging materials.

- **Packaging-free beverages.** The most ambitious and arguably the most sustainable solution, is to offer beverages without packaging. Coca-Cola and Pepsi have been investing in R&D to cater to the growing number of consumers using refillable bottles. Several other companies have announced their endeavours into packaging-free beverages, and we may see the commercialisation of this product in the coming years.

FIGURE 41
Plastic Bottles: Reinventing for the circular economy



Source: Barclays Research, The Waste and Resources Action Programme, British Glass, Clean Metrics, Recycle Now, The Association of Plastic Recyclers and AluPro

Opioids: A multi-decade crisis

US Specialty Pharmaceuticals
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The prolonged rise of opioid prescriptions over the past three decades reached a peak in October of 2017, when the US government officially declared the opioid epidemic a public health emergency. Opioid prescribing began in the early 1990's and increased post-Purdue's FDA approval of OxyContin in 1995. Following this approval, OxyContin Rx for non-cancer related pain increased by 10-fold from ~670k in 1997 to ~6.2M by 2002, as healthcare providers reliance on opioids for pain treatment grew.[1] In May 2007, Purdue pled guilty to criminal charges of misbranding OxyContin by claiming that it was less addictive and less subject to abuse. Currently, a wide range of manufacturers, distributors, retail pharmacies and physicians are now involved in the thousands of opioids related cases throughout the US.

The public health fallout from increased prescriptions has been an increase in age-adjusted drug overdose death rates, which rose over 1999-2016 (particularly those associated with heroin, synthetic opioids and natural/semi-synthetic opioids). Specifically, the rate of opioid overdose deaths per 100,000 people increasing from ~3 in 2000 to ~15 in 2017.[2] Higher opioid overdose death rates occurred amongst persons aged 25-64 as compared to those aged 15-24 and people over the age of 65.

Proprietary ARCOS Data Analysis: Aggregate analysis from 2006-2012
Related to pharmaceutical manufacturers in our US Specialty Pharma coverage, we analyzed ARCOS data and note: 1) three companies Mallinckrodt, Teva and Endo constituted the largest volume exposure 2) however, their products were largely generics comprising 90%+ of total opioid volumes, with the brunt of public focus being on Purdue and its role in marketing the drugs aggressively.

Why should investors care?

Focus has intensified over the past few years around pharmaceutical manufacturers with exposure to opioid sales, leading to large swings in equity values. Numerous lawsuits from cities, states, and counties were aggregated into a multi-district litigation (MDL), with the first set of trials to be heard in Ohio. Manufacturers have settled ahead of this bellwether trial, but large potential penalties continue to act as an overhang to share prices. We believe an eventual outcome could take time, with substantial cash outflows tied to it. We envision aggregate penalties could reach upwards of $50-$75bn, or even higher in certain cases.

2020 theme catalysts

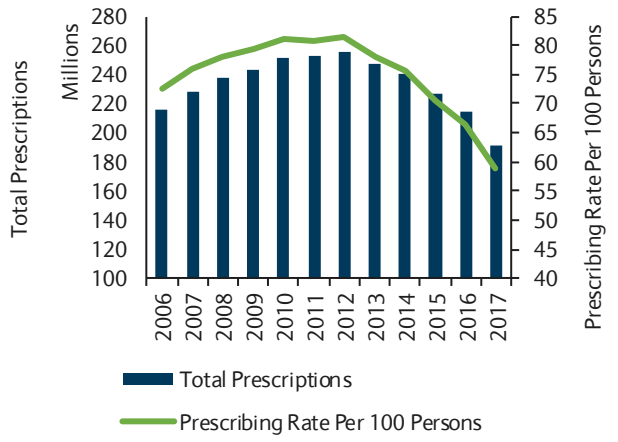
- **Rising need for opioid-free alternatives creates a sustainable investment theme:** One such drug is Pacira's Exparel, a liposomal bupivacaine and is the only FDA approved opioid-free, long-acting local and regional analgesic. Exparel sales have grown from $266m in 2016 to $408m in 2019.

- **With ongoing litigations, opioid-exposed names in Specialty Pharma are still risky:** The ongoing opioid uncertainty, along with fundamental headwinds in the generic drug space – including a oligopsony of generic drug purchasers and intense competition from foreign manufacturers – poses long term challenges. As such, we remain muted in our recommendations across our generic coverage universe, with our investment thesis tied to aforementioned generic headwinds and risks from opioid exposure. We also anticipate that any potential resolution to the opioid crisis would take time.

[1] A Brief History of the Opioid Epidemic and Strategies for Pain Medicine. Pain Ther. 2018 June; 7(1): 13-21
[2] CDC National Center for Health Statistics, National Vital Statistics System, "Overdose Deaths Involving Opioids, by Type of Opioid, United States, 2000–2017."

FIGURE 42

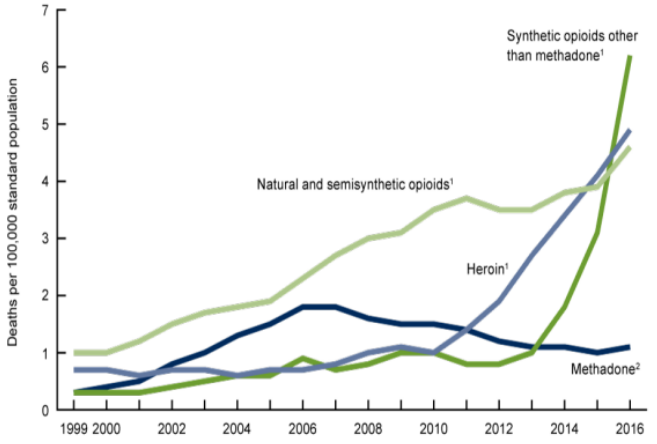
Total number and rate of opioid prescriptions dispensed: US, 2006–2017



Source: CDC

FIGURE 43

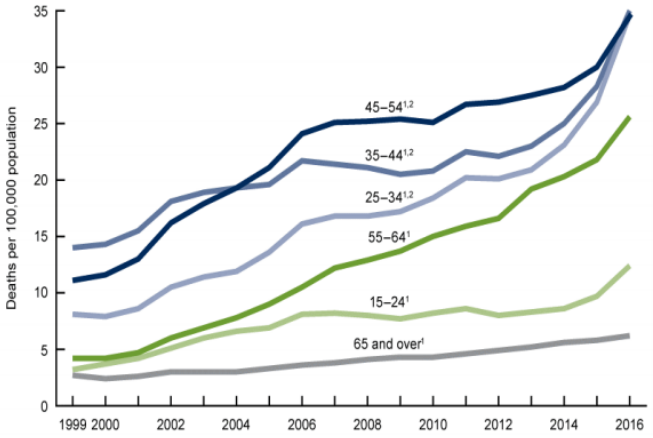
Age-adjusted drug overdose death rates, by opioid category: US, 1999–2016



Source: CDC

FIGURE 44

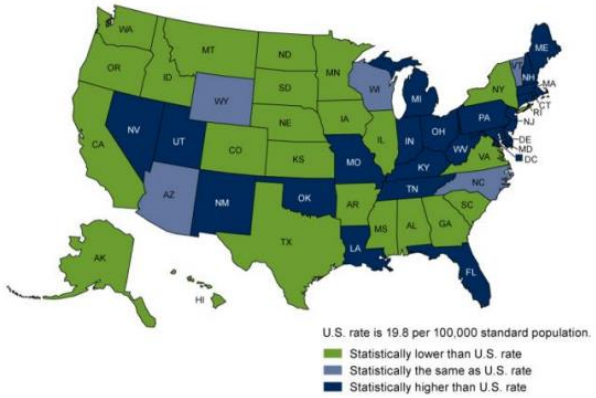
Drug overdose death rates, by selected age group: US, 1999–2016



Source: CDC

FIGURE 45

Age-adjusted drug overdose death rates, by state: US, 2016



Source: CDC

FIGURE 46

Summary ARCOS Table: Volume breakdown by manufacturer, 2006-2012

	MNK	TEVA	ENDP	P-Purdue	AMRX	MYL	Other	Grand Total
By Dosage (% of Total):								
Generic	37.8%	31.6%	11.9%	0.5%	2.4%	0.5%	6.4%	91.2%
Branded	0.0%	0.3%	3.6%	2.9%	0.0%	0.0%	2.0%	8.8%
TOTAL	**37.9%**	**31.8%**	**15.5%**	**3.4%**	**2.4%**	**0.5%**	**8.5%**	**100.0%**
By MME (% of Total):								
Generic	22.3%	27.4%	8.3%	0.9%	1.0%	9.6%	10.0%	79.6%
Branded	0.1%	0.8%	3.9%	10.9%	0.0%	0.0%	4.8%	20.4%
TOTAL	**22.4%**	**28.2%**	**12.2%**	**11.8%**	**1.0%**	**9.6%**	**14.8%**	**100.0%**

Source: ARCOS data

Global Energy: Rewarding low carbon

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Our Impact Series report *Oil in 3D: the demand outlook to 2050 (7/5/19)* investigates how oil demand could evolve in the coming decades through three different scenarios. The report considers how the energy landscape may evolve over coming decades and investigates how much of the largest current source of energy, oil, the world might need by 2050.

In the report *Global Energy: Rewarding Low Carbon (7/11/19)* we combine this analysis with our assessment of the large cap energy companies positioning to provide a guide to investment in a lower carbon system.

Energy demand reached its highest-ever level in 2018, and with 85% of that energy sourced from fossil fuels, carbon emissions also reached an all-time high. Energy demand is set to rise 30-90% in the period to 2050 and at least 50% of that is to come from oil and gas. The inescapable conclusion is that the world is not currently on a pathway that is consistent with the Intergovernmental Panel on Climate Change (IPCC) aim to limit temperature increases to less than 2°C above pre-industrial levels, and make efforts to limit increases to 1.5°C. Rapid change is needed across government, companies, investors and consumers with the delivery of energy in a lower-carbon way now a key objective. Those companies that lead the delivery of such improvements in a profitable way are likely to be the most sustainable over the coming decade.

Why should investors care?

The question of what role oil and gas companies should have in investor portfolios, or whether they belong at all, has never been more pressing given the intense societal pressure. From an industrial perspective the energy sector appears to be as well positioned as it has been for the past two decades. Returns are improving, production is growing, capex discipline has remained firmly intact. Yet, despite this, the sector has refused to re-rate, with the SXEP underperforming the wider SXXP market index in 2019 by nearly 10% and offering dividends in excess of 6%.

The challenge for the oil and gas industry and investors alike is what changes this, or are these valuations the 'new normal' with increased requirements for portfolio decarbonisation meaning that the main returns shareholders can expect are through dividends with little capital appreciation. Our view is that the sector can recover towards historical relative valuations (a 20-40% move higher from here) with sustained capex discipline and more focus on renewable energy.

2020 theme catalysts

- **Legislation surrounding carbon pricing:** Data is likely to show that carbon emissions rose again in 2019. With COP26 in Glasgow in November 2020 we see the sense of urgency to take action on global emissions growing and we expect increasing legislation around carbon pricing.
- **Increased renewable investment from megacap energy:** Renewable energy is the fastest growing of all the energy sources and we expect growth of 8-10% per year all the way out to 2050. A key theme we expect from 2020 is an acceleration in the pace of investments from the megacap energy companies. As an example, Repsol recently announced that it intends to be zero net carbon in 2050 on what is essentially a scope 3 business. This sort of announcement may have significant implications for the energy sector as we head through 2020.

FIGURE 47
Global Energy: Rewarding low carbon

Source: Barclays Research

ManufacturingTech: Age of hyperconnectivity & automation

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We are at the dawn of a new super cycle in manufacturing. While advances in artificial intelligence and robotics steal the headlines, it is the combination of those technologies with better and cheaper sensors, internet-of-things platforms and increasingly capable software that will shape manufacturing in the decades to come. This cycle should result in significant productivity gains, a disaggregation of the manufacturing value chain and the ability to manufacture customised products for the mass market. It will not be without costs, with the potential for mass unemployment, significant re-onshoring of manufacturing capital to the developed world and concentrated wealth accumulation. The age of hyperconnectivity will fundamentally change the world of manufacturing, as well as the world of work.

In the report *manufacturingTech primer vol:1: Age of hyperconnectivity and automation (22/10/18)*, we identify five waves within this coming supercycle, the first of which has already begun. These waves are integration and connectivity, accelerated robotic advancement, localisation and customisation of production, modular and distributed manufacture, and finally autonomous and synchronised manufacture. In a further report, *manufacturingTech primer vol. 2: Deep dive into constructionTech (14/11/19)*, we analyse the architecture, engineering and construction (AEC) vertical. The software market in this vertical is nascent, offering growth and efficiency gains in an industry where digital adoption remains low, which has led to massive waste generation through over-ordering of building material, inefficient processes, cost overruns and project delays.

Why should investors care?

We expect the digitalisation trend within manufacturing and construction to be a structural tailwind to the industrial software peer group at large over the coming decade at least, as firms increase their software spend to remain competitive and boost productivity. The Age of hyperconnectivity, nanomanipulation and machine automation will fundamentally change the world of manufacturing and construction, as well as the world of work more broadly. The manufacutringTech stack is largely built around proprietary on-premise technology and is dated. To deliver productivity benefits, there will have to be closer integration between the different components and this will result in a prolonged upgrade cycle. We estimate that the software component will see a gradual increase in weighting and we see this underpinning a 10-year software manufacturingTech double-digit CAGR. Therefore, the industrial software sector, in our view, offers an attractive way for investors to gain exposure to this structural digitalisation trend.

2020 theme catalysts

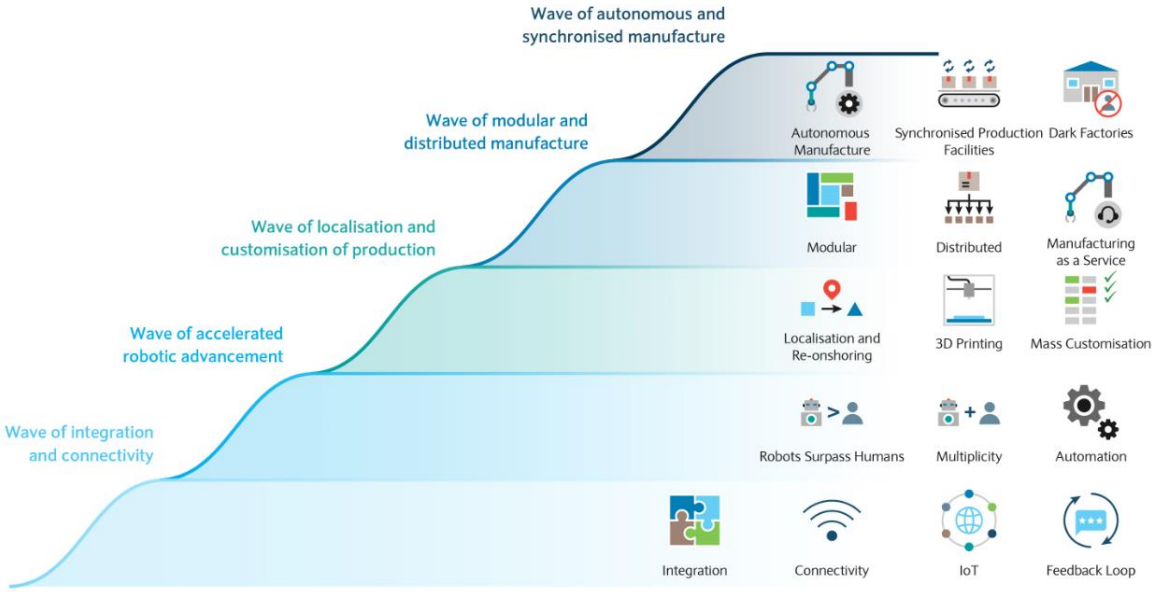
- **Government regulation to accelerate the uptake of software and technology:** We are seeing evidence that where digital adoption remains low, governments around the world are trying to increase the use of software and technology to remain competitive, reduce waste and increase efficiency. Within construction, building information modelling (BIM) regulation and making the use of software mandatory for public AEC projects has been, or is in the process of being, implemented in countries including Germany, the UK, the US and Singapore, among others.

- **The fear of missing out on digitalisation:** Across the board, we observe that companies are experiencing anxiety of falling behind on technology. Digitalisation and the move towards integrated systems will be supportive of a prolonged upgrade cycle both within manufacturingTech and constructionTech, as companies fear to fall behind on efficiency.

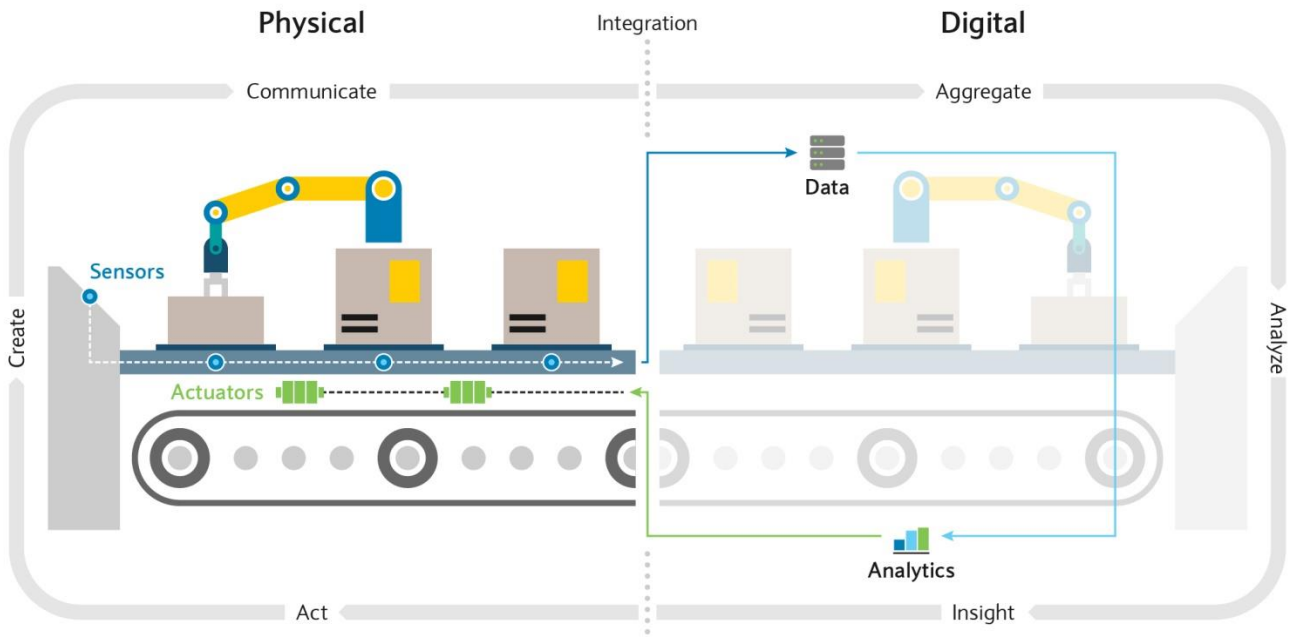
FIGURE 48

ManufacturingTech: Five waves of the coming supercycle, a new paradigm in manufacturing

The move to fully autonomous factories is in its early stages but will have broad ramifications for society over the coming decades



manufacturingTech is about a new paradigm in manufacturing:
Moving from an analogue world to a digital world, making use of data and AI



Source: Barclays Research

Sustainable Tourism: A worthwhile journey

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Tourism is a significant pillar of economic development (contributing $8.8trn to global GDP in 2018), but the associated environmental and social costs make it a double-edged sword. Our Barclays Sustainable Tourism Consumer Survey shows that awareness of tourism's impact is widespread and many are taking action to reduce these costs. The flight-shaming movement and 'Greta effect' are adding to the consumer momentum and policymakers are starting to take action to enable the tourism industry to become more sustainable. Some destinations are having to take radical measures to combat the direct effects of over-tourism, including visitor quotas, temporary closures and tourist taxes. We see the new world of tourism being dominated by factors such as carbon offsetting, slow travel, staycations, sustainable aviation fuel and green certification, among others. Whilst companies are already making changes that are aligned with both sustainability and cost-saving goals, we see scope for industry to move ahead of further policy change and use sustainability practices as a point of differentiation.

In the report *Sustainable Tourism: A worthwhile journey* (4/12/19) we assess the impacts of sustainable tourism across nine sectors. Although we acknowledge that Airlines are taking action, we consider this sector to be most at risk due to cost and capex implications from policy change. However, we see Energy, particularly renewable fuel producers like Neste, as having the most to gain due to greater demand for sustainable aviation fuel. We think sustainable tourism also has implications for Aviation Infrastructure, Cruise Companies, Aerospace & Defence, Hotels, Tour Operators/Concessions, Online Travel Agencies and Ride Hailing.

Why should investors care?

Within discussions around how to reduce our environmental impact, historically there has been a hesitancy to put too much focus on tourism, due to its importance for both personal and economic development. However, recent newsflow around flight shaming, over-tourism and the 'Greta effect' have opened up this previously 'ring-fenced' area. In this report we shine the spotlight on the broader tourism industry by considering the factors influencing the future of Eco-Travel and Eco-Tourism. Although the industry is starting to change, the pace of this will largely depend on regulation, the scalability of emerging technology and how consumers adapt their purchasing behaviour.

2020 theme catalysts

- **Corporates taking action on travel policies:** In 2020 we expect to see a greater number of corporates focussing on business travel policies as flight shaming and the 'Greta effect' continues to grow. Hence we expect corporates to feel pressure from consumers, employees and investors to report indicators such as air miles and to incorporate sustainability factors into their travel policies.

- **Updates on frequent flyer eco-taxes:** In 2018, Sweden introduced an airline tax specifically for environmental reasons and France has since announced that it plans to launch an eco-tax on flying, with revenues to be spent on other forms of transport such as trains Following these examples, in late 2019, the Ministers of Finance for the Netherlands, Germany, France, Sweden, Italy, Belgium, Luxembourg, Denmark and Bulgaria having submitted a joint statement to the European Commission asking for a tax to neutralise the environmental damage caused by aviation. In 2020 we will therefore be looking out for new legislation imposing taxes on aviation for environmental reasons.

FIGURE 49
Sustainable Tourism: A worthwhile journey

Tourism

is an **$8.8trn industry** and
set to grow to **$13trn by 2029**

In **2018**, tourism represented:

- **10.4%** of global GDP
- **1 in 10** jobs globally
- **3rd largest** export category

With tourism split:

- Domestic **71%** / International **29%**
- Leisure **78%** / Business **22%**

But tourism is a **double-edged sword**, with negative environmental and social impacts:

Environmental

- **5–8%** of GHG emissions
- Natural resource depletion
- Pollution and waste

Social

- Over-tourism
- Crowding and congestion
- Tourist and resident division

Barclays Sustainable Tourism Consumer Survey — UK and US adults

- **74%** Know about the environmental or social impact of their holidays
- **24%** Are impacted by negative attitudes towards travelling when booking holidays
- **20%** Are taking fewer flights to reduce the environmental and social impacts
- **21%** Are willing to change their mode of transport to reduce the impact
- **37%** Are willing to change their accommodation to reduce the impact

We see **Gen Z** and **Millennials** driving the consumer push for sustainable tourism

We see **consumers, policymakers** and **industry** driving the new world of sustainable tourism, which we break down into:

Eco-Travel

Direct:
- Airlines
- Aviation infrastructure
- Cruise lines
- Cars/coaches
- Rail

Indirect:
- Energy
- Transport manufacturing

Eco-Tourism

Direct:
- Tour operators
- Hotels
- Restaurants
- Activity providers
- Ride hailing

Indirect:
- Online travel agencies

Source: Barclays Research, WTTC, UNWTO

Global Fashion: Green is the new black

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Global fashion's immense water-consuming, energy-exhausting, and wasteful supply chain practices are creating an environmental and social concern that we can no longer afford to ignore. While the fashion industry promotes self-expression, enables creativity and contributes to the global economy, its current production practices are unsustainable. Fast-fashion has exacerbated the problem while driving a decline in clothing utilisation – an estimated $500bn in value is lost per year due to underutilisation and lack of recycling. Although modest progress has been made, we argue that greater action is needed given the industry is on track to consume 25% of the world's carbon budget by 2050. With global fashion set to reach $3.3trn by 2030 (+5% CAGR), we believe that growing profitability risk, looming regulation, and increased public scrutiny create a clear incentive for the industry to radically transform its supply chain. We view 'Sustainable Fashion' as a clear business opportunity going forwards as the scale-up of experimental materials, emerging technologies and new business models (resale & rental) enable circularity.

In the report *Global Fashion: Green is the new black* (15/1/20) we assess the impact across 11 sectors. We see ASOS/Boohoo as relatively more exposed to our discussion on sustainability than Zalando given their reliance on fast-moving trends. Primark is focused on sustainable cotton sourcing, and with no transactional online presence, it doesn't endure the environmental impact of home delivery. We see Luxury players Kering and LVMH being at the forefront of industry sustainability efforts. We see growth in new business models including second-hand and subscription – leaving Ebay and Stitch Fix well positioned. On the waste management side, we see Suez, Veolia and Pennon likely to benefit as textile waste is increasingly seen as a valuable feedstock. We also see implications for EU Cap Goods, Utilities, US Chemicals & Latam Industrials.

Why should investors care?

We see sustainability as being the next major pressure point for fashion, as increased awareness has revealed that the industry has a lot of catching up to do. In our view, there is an urgent need for the industry to rethink its linear 'take-make-dispose' model, predicated on overproduction and underutilisation. Therefore, by identifying key issues across the fragmented global supply chain, we propose four solutions to aid the move towards sustainable fashion.

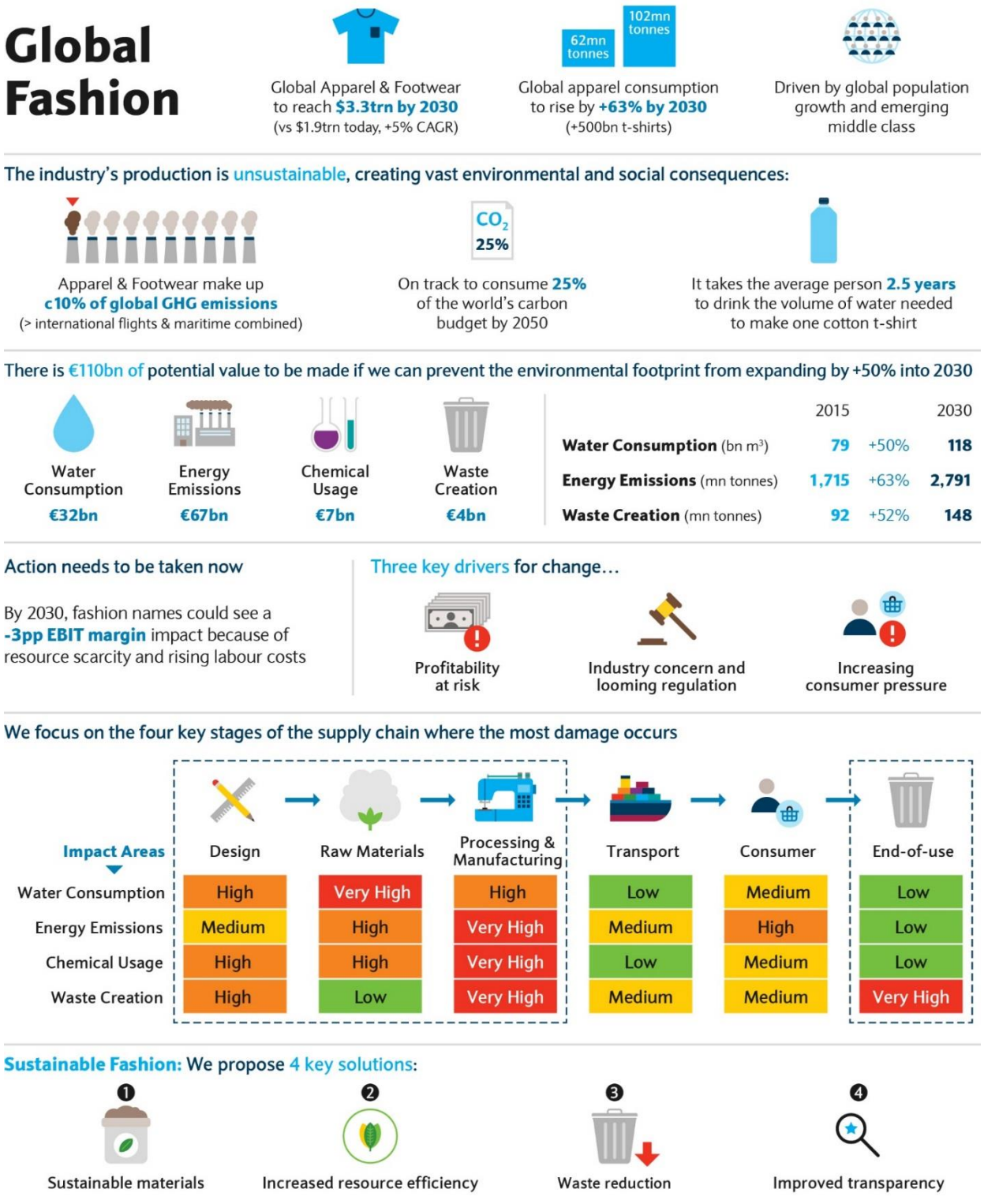
2020 theme catalysts

- **Copenhagen Fashion Summit:** In May 2020, Global Fashion Agenda (GFA) will host its annual fashion summit. It is widely recognised within the industry for holding agenda-setting discussions on the key environmental and social issues facing the fashion industry. We expect the event to stimulate increased awareness and debate, putting pressure on fashion brands to make sure they are contributing to creating change, as well as providing an update on where progress has been made so far.

- **2020 Circular Fashion System Commitment:** GFA's initiative to accelerate the industry's transition to a circular fashion system comes to a head this year and so we expect to see its signatories increasingly disclose its progress in waste management and recycling. We argue that this is likely to include investment in emerging recycling technology (we highlight Loop Industries and Carbios in the report).

- **Experimental materials:** Given the bold company targets that many companies have announced; we expect to see increased investment in experimental materials such as pineapple leather, orange fibre and lab-grown fibres in order to meet these targets.

FIGURE 50
Global Fashion: Green is the new black



Source: Barclays Research, Boston Consulting Group, Global Fashion Agenda, McKinsey, Ellen MacArthur Foundation

Utilities & Energy: Net growth from Net Zero

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We believe the EU's and UK's ambitious targets to achieve 'Net Zero' emissions by 2050 are achievable, placing utilities at the forefront of a €3.7 trillion investment boom, and making the sector a key beneficiary of the coming industrial revolution. We believe that the energy transformation revolution will need bits of everything and a holistic approach (and enabling regulation) is needed. No single technology will become dominant and different regions will develop different solutions. The UK and Spain are the 'Saudi Arabia' of offshore wind and solar, respectively. France is rich in both. We see France, Iberia and Italy adopting a higher electrification strategy, whilst Italy and France will also focus on hydrogen delivery. The UK and Germany will also likely make use of the large CCS capacity of the North Sea.

In the report *Utilities: Net Growth from Net Zero* (3/2/20) we outline four investment themes in reaching 'Net Zero.' Key beneficiaries within these themes include: 1) Renewable generators – Acciona, Drax, EDF, EDP, Enel, Iberdrola, RWE, SSE; 2) Power infrastructure enablers – EDF, Enel, E.ON, Iberdrola, National Grid, SSE; 3) Hydrogen and CCS – Equinor, Drax; 4) Gas Transmission decarbonisation – Engie, National Grid, Snam; and 5) Services – Aker Solutions, Saipem, Subsea 7, Maire Tecnimont.

Why should investors care?

We see four investment themes in reaching 'Net Zero': 1) Decarbonising power – achieved through a switch to gas and renewables, 2) Electrification of the economy – increasing electrification of transport and heating, 3) Decarbonisation of other fuels – hydrogen can replace natural gas and 4) Storing/removing carbon – carbon capture & storage. We see total investment needs of up to €3.7 trillion by 2050. Utilities are poised at the start of a 30-year structural growth phase in this coming industrial revolution.

2020 theme catalysts

- **Upcoming company announcements:** There will be several key company announcements in the space in 2020. For example, in February 2020, the new BP CEO has promised to outline ambitions for the company, which could include a strategic shift towards energy transition. Both E.ON and RWE will host important Capital Markets Days in March 2020, which will provide first-time financial targets for the new companies, including their growth strategies. Iberdrola will also host a Capital Markets Day in May 2020 that should receive significant investor attention.

- **Country-level regulation:** We expect further action at the country level including new German renewable energy legislation, finalisation of the Arenh reform in France, UK CCS commercial scale trial and the UK New Energy Act – to name a few.

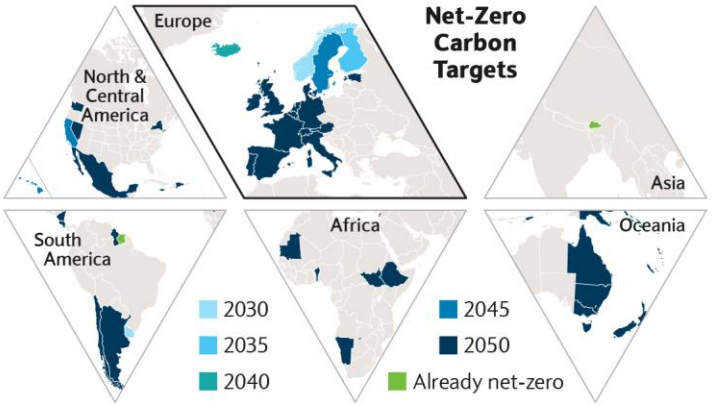
- **UK Round 4 Crown Estate Licence:** The UK's Crown Estate's Round 4 tender process commenced in October 2019 and will run until autumn 2020. The Round 4 projects will span at least three bidding areas, with a maximum of 3.5 GW within any one area. This is a very important auction as the final announcement will highlight important potential growth capex projects for Europe's key renewables players.

- **COP26:** The 2020 UN Climate Change Conference (26th session of Conference of the Parties – COP 26) taking place in Glasgow is seen as a major event as the expectations are for this to be the most important climate summit since Paris COP21.

FIGURE 51
Utilities & Energy: Net growth from Net Zero

Who is planning for decarbonisation?

Very few countries have already hit net-zero targets. We see Europe being able to get to net zero carbon by 2050 as European utilities is now officially a growth sector with €3.7 trillion of required Capex.

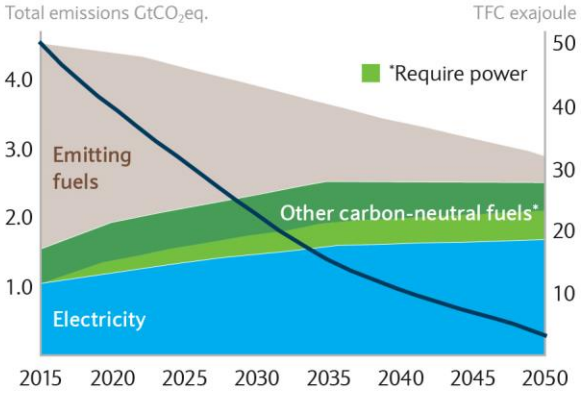


Source: Energy and Climate Intelligence Unit, Barclays Research

Who else thinks this is possible?

We are not the only ones that are seeing this trend towards decarbonisation in the EU.

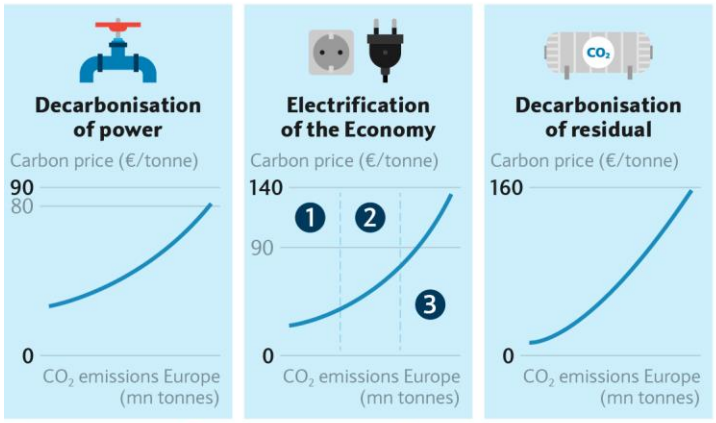
EU decarbonisation example



Source: Eurelectric, Barclays Research

How do we get there?

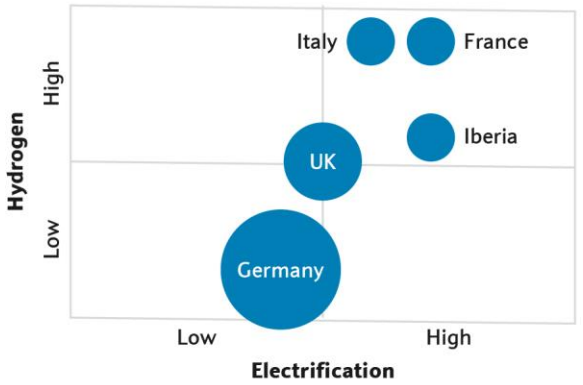
Renewables will dominate power markets of the future as decarbonisation happens in different steps.



1 Heat pumps 2 Electric Vehicles 3 Electrification of the Economy

Source: BNEF, Barclays Research

Ways of decarbonizing will differ by country



Size of the globes + residual CCS

Source: BNEF, Barclays Research

What are the investment opportunity scenarios for the sector in electrification?

While hydrogen technology exists today, there is a learning curve in order to scale up.

Electrification	Hydrogen (CCS residual)		
	High	Medium	Low
High	3,701	3,281	2,583
Medium	3,562	2,975	2,000
Low	3,468	2,752	1,562

Source: BNEF, Barclays Research

Source: BNEF, Barclays Research

Who are the winners and losers?

Big structural growth rates are very positive for European utilities. In this scenario of high investment requirement, we believe scale will prevail over profitability and strong balance sheets over already highly-leveraged smaller players. We favour high market capitalisation utilities over small renewable players.

Winners

Renewable generators: RWE, Iberdrola, EDP, SSE, Drax, Enel
Power infrastructure: NG, E.On
Gas transmission infrastructure: NG, Snam
Hydrogen/CCS: Drax, Equinor
Services: Aker Solutions, Maire Tecnimont, Saipem, Subsea 7
Capital goods: Schneider and ABB

Losers

Gas distribution infrastructure: Italgas, Naturgy
Power transmission solar networks: Red Electrica, Terna

Source: Barclays Research

APPENDIX 1 – ROADMAP METHODOLOGY

Selecting & plotting 150 trends

We acknowledge the subjectivity inherent in conducting an exercise of this magnitude and thus we outline below the factors we considered when determining the positioning of each trend within the 2030 Thematic Roadmap – Figure 52.

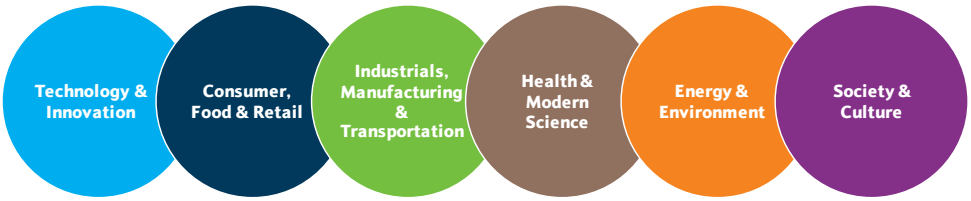
FIGURE 52
Planning & constructing the 2030 Thematic Roadmap

Source: Barclays Research

Initial brainstorm: Our initial list of trends was compiled using a variety of inputs, including sector analysts, research publications from global organisations (e.g. United Nations, World Bank, World Economic Forum), prior publications within Sustainable & Thematic Investing, charities (e.g. Ellen MacArthur Foundation, WRAP), industry experts & conferences and underlying data providers (e.g. HolonIQ, IHS, Bloomberg).

Grouping trends: To introduce structure to the 150 trends, we selected 6 thematic paradigms including Technology & Innovation; Consumer, Food & Retail; Industrials, Manufacturing & Transportation; Health & Modern Science; Environment & Energy; and Society & Culture – Figure 53. We believe they are the key areas of focus from a thematic point of view, encompassing a wide range of sectors currently under Barclays' research coverage.

FIGURE 53
Barclays Thematic Roadmap – 6 paradigms

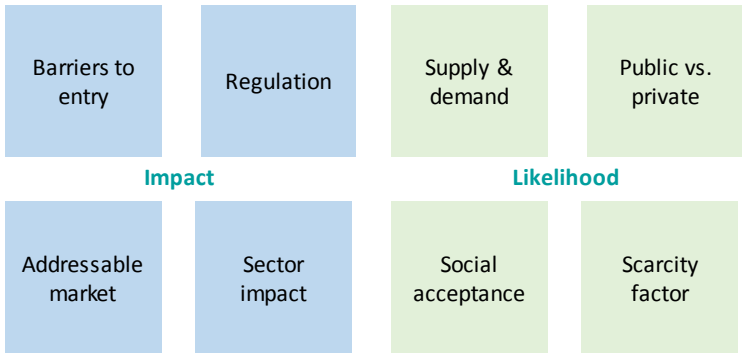


Source: Barclays Research

Discussion with sector analysts: Leveraging input from our sector analysts, we conducted various focus groups to understand each thematic paradigm in further detail. This allowed us to better understand key factors such as the underlying market opportunity, regional drivers, upcoming regulation and the extent to which such trends are on the corporate radar at the sector level. Refer to the Contributing Authors on page 2 for contact details of the participating sector analysts.

Identifying chart parameters: We selected 'Likelihood' and 'Impact' as our respective horizontal and vertical axes and thus the basis of our mapping. That is, to what extent do we believe these 150 trends will impact society, given some may be influenced by external factors such as regulation, infrastructure, consumer adoption and pricing (Figure 54).

FIGURE 54
Chart parameters



Source: Barclays Research

Impact

- **Barriers to entry:** Are there high barriers to entry influencing the number of companies present within a trend? Is there a reasonable level of competition? Common barriers to entry include high capital costs, monopolisation of resources, cost advantages, customer loyalty, regulatory barriers and inelastic demand.
- **Regulation:** Is there specific regulation influencing the market opportunity? Are certain governments taking a strong interest either in the trend or indirectly by targeting the underlying structural drivers? We considered the use of licences, permits and local permissions, as well as the regional acceptance of international agreements (e.g. 2015 Paris Agreement).
- **Addressable market:** What is the addressable market size for each trend? Are there multiple external data providers? Is the market opportunity B2C and/or B2B? To what extent is the trend global in nature? What percentage of the population will this affect?
- **Sector impact:** How many sectors will this trend affect across Barclays' coverage?

Likelihood

- **Supply & demand:** Is there a target customer and/or target market in mind? Based on the known factors today, what proportion of the addressable market is available? To what extent is the trend reliant on other overarching trends (e.g. emerging middle class, AI, ageing population etc.)?
- **Public vs. private:** Is the trend being driven by public companies? Has private funding in the trend grown? Are there private companies leading in this space? Has the sector observed significant IPO and/or M&A activity?
- **Social acceptance:** Is the trend visible to society today? If not, what is driving its expected emergence (e.g. consumer adoption, regulatory support, pricing, availability)**?**
- **Scarcity factor:** Is the trend driven by a scarcity factor (e.g. depletion of resources)?

Plotting the trends: Using the chart parameters and input from our sector analysts, we plotted the 150 trends to create our 2030 Thematic Roadmap. We acknowledge the subjectivity in conducting an exercise of this magnitude; therefore, we collaborated with our Data & Investment Sciences team to further understand the extent to which such trends are on the corporate radar globally by developing our own hierarchical clustering algorithm.

Data & Investment Sciences: Clustering algorithm

Data set & design techniques

We outline below some of the key variables we considered when compiling our underlying data pool and reference terms for our clustering algorithm.

Corporate transcripts by event type (%): Of the 440k unique events we identify, 77% are reporting events such as earnings calls and analyst meetings, not including c.2% for M&A calls and 18% for conference presentations.

Regional composition: The sample is broadly representative of global indices. Approximately 59% of securities are North American, 27% in EMEA, 17% in APAC and the remainder in LATAM. We note that US securities are more likely to hold full quarterly results and analyst calls than their RoW counterparts, we have not corrected for this.

Introducing reference names: For each of the 150 trends, between 2 or 10 words or short phrases have been subjectively identified as pertaining to the trend in question. Where possible, phrases that are less likely to trigger other subjects of conversation are chosen. Matches are recorded for every unique transcript within the dataset, alongside its metadata. For example, for the trend 'IoT', we search for IoT as an isolated term; such that words containing 'iot' (e.g. iota) should not be flagged. Other terms identified for this trend include 'Internet of Things', 'connected devices' and 'smart appliances'.

There are limitations to this approach. In searching for '(outer) space' as a term, it is not plausible to separate this trend with string matching from the generic term 'space'. The resulting erroneously large number of counts means we do not include space in the clustering analysis, as detailed below.

More nuanced Natural Language Processing approaches, such as grammar rules and topic classification, exist. We discuss the technical aspects in more detail in the note *Natural Language Processing: Grammar Rules for Event Detection in Corporate Transcripts*. However, for this use case, the matching approach works well, without the need to build and train 150 models. Whilst the human inputs of trend reference names are subjective, this approach benefits from potential lower noise than a classification model.

Tech trends readily defined by buzzwords, but conceptual trends undercounted

We also note that some trends are clearly well defined by a few buzzwords, particularly technology trends. For example, discussions of blockchain may be highly likely to contain blockchain, smart contracts or distributed ledger. However, discussion of broad societal trends such as Ageing Population, Next-gen Workforce or Societal Inequality may be discussed in detail without the key words being mentioned, resulting in undercounting.

126/150 trends were selected: Clustering was performed on 126 out of the 150 trends available. 24 trends were removed during pre-processing because they were either too frequent (i.e. 'space') or not frequent enough. We require the trend to appear in at least 10 transcripts and in no more than 50% of the transcripts. The 24 trends removed included Cyberterrorism, Clean Label and Ingredient Transparency, Environmental Protection, and Personalised Insurance.

The arc spans in Figure 9 reflect trends' occurrences (the wider the arc the more frequent the trend). Given that trends' occurrences vary greatly from sector to sector, only a small fraction of trends are visible. To overcome this issue, in Figure 55 we visualise all of the 126 trends of the clustering analysis with trend frequencies in parenthesis expressed in bps. For example, a frequency of '<1' means that the theme appeared in less than 0.01% of the transcripts.

How does the clustering algorithm work?

Similar trends, defined by tandem occurrences in transcripts, are linked… clustering bottom-up from small clusters

The 126 trends were clustered in a hierarchical fashion using a bottom-up approach. We used a **clustering algorithm** known as 'linkage', first conceived in the 1960s by the statistician Joe H. Ward, Jr. The algorithm starts by creating small clusters of trends first, subsequently merging these small clusters into larger and larger clusters until equilibrium is reached. Cluster membership is assigned using the concept of 'similarity', i.e. similar trends (such as 5G and IoT) are more likely to fall into the same cluster. And a cluster such as Tech Enablers is more likely to be merged with a Smart Society cluster in order to create a Digital 'mega-cluster' – Figure 9.

The similarity between trends was computed using a **Pearson correlation metric**. Correlation in this instance is a measure of the overlap of two trends in the same transcripts.

Within-cluster correlation

Some data limitations in extracting transcript sector, particularly prior to 2013

Every transcript record, alongside the raw text, has an event start-time and an associated Reuters Instrument Code (RIC). However, the RIC data provided is not point–in-time, nor does the RIC point to the primary equity instrument but to 'an' instrument of the organisation. The start-date of the transcript is used to select the appropriate equity instrument and sector. There remains a risk a small number of transcripts are associated with the incorrect sector. Prior to 2013, the RIC to sector mapping using this logic fails to identify between 70% and 90% of securities. Hence sector analysis uses data from 2013 onwards.

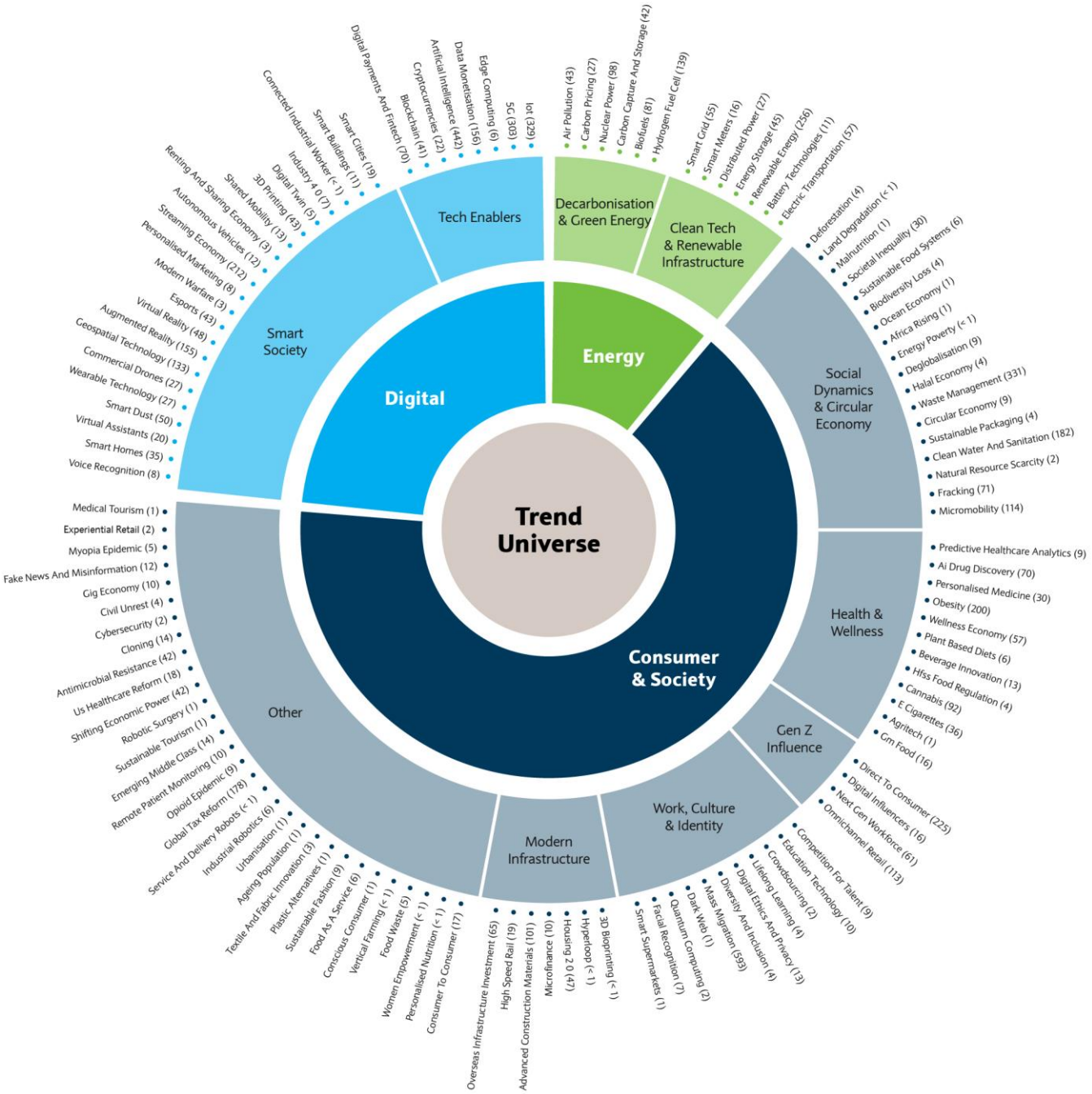
The measure chosen for sector breadth is Shannon entropy. For each of the ten Refinitiv *Thomson Reuters Business Classification System economic sectors*[3] (s), we collect the Fraction of transcripts matching that trend in sector s (F_s) and use the **entropy**:

$$entropy = -\sum_{s}[F_s * log_{10}(F_s)]$$

Hence, where equal counts occur in all 10 sectors, entropy would return a value of 1. For complete concentration in one sector, a value of zero would occur. Note that for simplicity the counts are not rebalanced for the relative count of companies occupying each economic sector.

[3] Namely Basic Materials, Energy, (Non) Cyclical Consumer Goods/ Services, Financials, Healthcare, Industrials, Technology, Telecommunications and Utilities

FIGURE 55
Trend Cluster Analysis



Source: Refinitiv, Barclays Research

APPENDIX 2 – 150 TREND DIRECTORY

Technology & Innovation

5G: 5G is the fifth generation of mobile internet connectivity, with higher speeds and significantly reduced latency, along with super high reliability for mission-critical applications. In the near term we see mobile video streaming and virtual reality as key applications; however, over time 'smarter' network infrastructure and an enhanced ability to support exponential scale for connectivity should open the doors to further applications across a variety of markets such as IoT, industrial applications, healthcare and autonomous vehicles.

Barclays Research: Refer to *#raceto5G* on Barclays Live for the latest research.

Artificial Intelligence (AI): Simply put, AI is when a machine exhibits human-like intelligence in approaching a problem. Companies have leveraged the technology to create applications that help businesses improve their ability to forecast, optimise processes, offer new services, and understand their customers better. The terminology surrounding AI is complex and can be confusing. Common terminology includes machine learning, deep learning, and cognitive systems. Semantic confusion arises from the terms being used interchangeably and inconsistently – *Artificial Intelligence: A Primer (10 April 2018)*.

Barclays Research: Refer to *#futureofai* on Barclays Live for latest research.

Augmented reality: Compared to virtual reality which implies a completely immersive experience, Augmented Reality (AR) is the blend of interactive digital elements with real-world environments. It works by generating an enhanced version of reality, by augmenting physical real-world environments with superimposed computer-generated images, text and sounds. Beyond Pokémon GO, AR has been used by many companies across transportation, retail, education, entertainment, marketing and healthcare. While AR applications in smartphones have proven popular to date, the industry is keen to develop additional hardware applications including AR glasses.

Blockchain: A blockchain is a distributed database with an architecture that records transactions in a long string or chain. Each transaction (or block) refers to an earlier record in the string and chains this together. The accuracy of the database is maintained by a consensus mechanism and blockchain uses cryptology and a distributed messaging protocol to update the blockchain among users in real time. Therefore, all users have identical information without the need for a separate reconciliation process. As all the blocks are in chronological order and cannot be changed, it creates perfect transparency and traceability. There are many streams of this distributed database and the design depends on who has access to the database (i.e. public vs. private) and who is responsible for maintaining the integrity of the database (i.e. permissioned vs. permission-less). The technology is being utilised by many sectors, including banking, healthcare, financial services, energy and real estate. It is also being used to develop blockchain-based smart contracts – self-executing code on a blockchain that automatically implements the terms of an agreement between parties.

Barclays Research: *European FinTech & Payments: Blockchain (9 March 2016)*

Cryptocurrencies: A cryptocurrency is a digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the tender. The most important feature of cryptocurrency is that it is not controlled by any central authority; the currency utilises blockchain ledgers to record and validate transactions. While there are over 1000 cryptocurrencies, bitcoin was the first and it remains the most popular with millions of users trading the c. 18m of bitcoins currently in circulation. Given prices are based on supply and demand, the rate at which a cryptocurrency can be exchanged for another currency can fluctuate widely.

Barclays Research: *European FinTech & Payments: Blockchain (9 March 2016)*

Cybersecurity: According to *Cisco*, cybersecurity is the practice of protecting systems, networks and programs from digital attacks. These cyberattacks are usually aimed at accessing, changing, or destroying sensitive information; extorting money from users; or interrupting normal business processes. Types of cybersecurity threats including phishing, ransomware, malware, fraud/digital identity theft and social engineering. Historically, the rise of cyber-attacks has far outpaced the level of investments in cybersecurity. As society adopts emerging technologies relating to big data, artificial intelligence and IoT, cyberthreats/attacks are likely to grow in volume and complexity and thus enterprises will need to invest in the appropriate safeguards to develop proper cyber resilience (e.g. cyber insurance, security management, cloud security and application gateways).

Dark web: The dark web is part of the internet that isn't visible to search engines and requires the use of an anonymising browser to be accessed. The number of dark web listings continues to grow, with the majority relating to illicit material and/or criminal activity including online marketplaces for drugs, exchanges for stolen data and anonymous message boards. In recent years its popularity has grown, driven by the growth in cryptocurrency which enables two parties to conduct a trusted transaction without known each other's identity. According to the *Futurist Speaker*, the dark net is growing in its appeal with far less offensive offerings that cater to a more *mainstream* audience. The growth in the dark web will likely influence how regulators approach internet governance and the concept of cybersecurity going forwards.

Data monetisation: This refers to using data for quantifiable economic benefit e.g. cost savings, revenue increases and risk minimisation (*Gartner)*. Data monetisation can include indirect methods such as measurable business performance improvements, beneficial terms or conditions from business partners, information bartering, productising information (i.e. new information-based offerings), 'informationalising' products (i.e. including information as a value-add component of an existing offering), or selling data outright (via a data broker or independently). In order to use data to its full potential, companies are increasingly looking to collect external data too, with Forrester finding that 73% of decision-makers want to expand their ability to source external data. If data can be securely shared with other partners in the ecosystem, new business models could be developed in sectors like insurance, retail and financial services. This includes data brokers – entities that collect information about consumers and then sell that data to other data brokers, companies and/or individuals.

Digital ethics & privacy: As technology advances, people are becoming more aware of their digital footprint and how their personal information can be used by companies. While the European GDPR regulation (2017) has helped to address the issue of data privacy, high-profile data scandals including Facebook/Cambridge Analytica have meant digital ethics & privacy is a growing concern across society. According to Gartner (*2018*), the backlash will only increase for organisations that are not proactively addressing these concerns. In addition, shifting from privacy to ethics moves the conversation beyond 'are we compliant?' toward 'are we doing the right thing?' We see ethical obligations associated with responsible data collection, handling & privacy as being key areas of focus through to 2030.

Barclays Research: *Sustainable & Thematic Investing – The rise of e-regulation (12 June 2018)*

Digital payments & FinTech: The transition from cash to digital payments is likely to continue, aiding financial inclusion, economic participation, transparency & security, cost savings and convenience & accessibility. The payments industry has already seen significant innovation in recent years, with new entrants (e.g. FinTech, challenger banks, tech giants) and ongoing regulatory developments (e.g. PSD 2.0 and Open Banking) contributing to the transformation in Point-of-Sale retail, mobile & ecommerce payments, cryptocurrencies and cashier-less stores. The industry is likely to experience ongoing consolidation, with biometric authentication, increased need for security and value-added services driving additional points of differentiation. Beyond payments, we're also seeing peer-to-peer lending and banking-as-a-service emerge as reputable business models within FinTech, placing additional pressure on traditional players to adapt.

Barclays Research: Refer to the European FinTech & Payment Primers: *Vol 13: Sleeping walking into 3DS2.0 and PSD 2 (12 November 2018)* and *Vol 12: Invisible payments pressuring incumbents (18 July 2018)*.

Digital twin: Digital twins are a virtual simulation of real-world objects, used by engineers to run simulations before actual devices are built and deployed. According to IBM, digital twins enable companies to learn faster and break down old boundaries surrounding product innovation and complex life-cycles. They can help to visualise products in use and help companies understand changing customer preferences, customisations and experiences across a wide range of industries including manufacturing, automotive, industrials and healthcare.

Edge computing: Edge computing is a distributed, open IT architecture that enables decentralised processing power and mobile computing. It is conducted near the source of where the data is generated, including difficult to reach locations such as wind turbines and oil rigs (vs. sending data to the cloud or a centralised data-processing warehouse). This reduces the distance and time the data has to travel and thus enabling real-time data processing without latency. It allows smart devices to respond to data almost instantaneously and thus is critical for the Internet of Things and self-driving cars where localised action is integral. This suggests the amount of data generated and processed by companies outside of a traditional data centre is likely to increase going forwards.

Education technology: We define Education technology (EdTech) as the application of digital technology to deliver a new form of learning architecture; one that has the power to harness the social reach of the internet to create efficiency, enable new levels of standardisation and encourage democratised access to learning. EdTech has the potential to redefine how education is resourced and consumed; ultimately changing the results that it can yield for individuals and society. We see consumer-facing education apps proving popular in after-school and adult learning, as well as seeing value in virtual learning environments and online degrees. According to HolonIQ, total global education expenditure is expected to reach $10tn by 2030 (+4% CAGR 2018-30). Within this EdTech is likely to play a large role, with spending forecast to reach $342bn by 2025 (+12% CAGR 2018-25).

Barclays Research: *Sustainable & Thematic Investing – Education Technology: Out with the old school (12 March 2019)*

eSports: Electronic sports (eSports) is a form of competitive, organised video gaming. The concept has proven popular amongst the younger demographic (Gen Z and Millennials), with various leagues with teams and players around the world. Worldwide viewership of eSports competitions has helped, with demand for stadium-based tournaments and live streaming having increased. We see the diversity of game genres, geographical expansion of leagues,

regulation of competitions and ownership of media rights being key factors supporting the underlying 2030 market opportunity.

Barclays Research: *Global Internet: State of Global Internet (6 Jan 2020)*

Facial recognition: Facial recognition technology uses a database of photos to identify people in security photos and videos (*Forbes)*. It uses biometrics to map facial features and verify a person's identity. In 2019, The House of Commons Science and Technology Committee warned that innocent people could have their faces included in these watch lists created to catch criminal suspects. In addition, facial bias could mean the wrong people could be identified, including people of colour and people wearing makeup. Driven by discussions in China surrounding public surveillance systems, the key area of debate at the moment is live facial recognition and the collection of sensitive data. We see lip-reading technology and emotion-detection cameras being relevant sub-trends within the overarching facial recognition opportunity.

Geospatial technology: Geospatial technology relates to the collection or processing of location-associated data. Common examples of these technologies include: Geographic Information systems (GIS), Remote sensing (RS) and Global Positioning System (GPS). In its simplest form, it enables us to collect data that is referenced to the earth for analysis, modelling, simulations and visualisations. Geospatial data and technology play a pivotal role in satellite positioning systems, real-time traffic maps, ride-hailing services and ecommerce logistics. A report from the National Geospatial Advisory Committee (*NGAC -2016*) identified five overarching trends that will drive new geospatial developments: i) real-time data, ii) miniaturisation of technologies, iii) new mobile sensor platforms e.g. small satellites and drones iv) expanding wireless and web networks and v) high-performance computing networks e.g. CyberGIS and cloud GIS.

Internet of Things: The Internet of Things (IoT) is considered a network infrastructure, driven by the dramatic increase in internet-linked connected devices. These connected devices are typically physical objects that have sensors embedded in them, which provide specific information (e.g. the location, the condition of the environment, the condition of the subject or some other pre-determined variable). IoT touches every industry – healthcare, finance, retail and manufacturing – with uses cases including predictive maintenance, smart metering and asset tracking.

Barclays Research: *Global Technology Outlook – "Internet of Things": Beyond the hype (15 May 2014)*

Quantum computing: Quantum computers can use the fundamentals of quantum mechanics to speed up the process of solving complex computations (*CB Insights)*. In other words, quantum computers can process massive and complex datasets more efficiently than classical computers. Using a conventional computer will still be the most economical solution for the majority and thus quantum computers are not intended to replace conventional computers. One of the most promising applications for quantum computers is in simulating the behaviour of matter down to the molecular level within material science and pharmaceutical research. Quantum computers have been under development for decades, with the technology experiencing a *Hello World* moment in October 2019 when Google announced it has achieved 'quantum supremacy' (*Source: Nature)*. This is the point at which a quantum computer can complete a mathematical calculation that no ordinary computer can match at that moment in time.

Service & delivery robots: The International Organisation for Standardisation defines a service robot as a robot that performs useful tasks for humans, though professional service robots are different from industrial robots. According to *Infineon*, service robots can be broken down by precise area of application, including domestic robots (such as lawn mowers, vacuum cleaners), hospitality industry robots (such as serving robots for food and beverages), agriculture robots (such as seed-planting robots, drones for monitoring and spraying), healthcare and medical robots that assist patients and surgeons, toy robots (such as robotic dogs, entertainment robots), educational robots, security robots and some that resemble humans, known as humanoid robots. We also see delivery robots being a key focus area for food delivery companies.

Barclays Research: *Global Catering: Catering in a delivery world (6 September 2019)*

Smart dust: Smart dust refers to a system of microelectromechanical sensors (MEMS) that can detect conditions (e.g. light, temperature, vibration and noise) and autonomously communicate this information back to a receiver. The sensors are the size of dust particles (1-2mm). However, in order for them to operate they must have microscopic batteries that can last for years. Whilst smart dust is not yet an operational technology, in theory smart dust is considered as the natural next step for today's Internet of Things in specific applications across industrial monitoring and medicine.

Smart homes: A smart home is a home that incorporates inter-connected devices to enable remote monitoring and the management of appliances and systems, such as lighting and heating. Smart home technology can easily be used to automate everyday tasks and can be quickly adjusted via your mobile depending on your personal preferences. Smart homes are often posited as the solution to the ageing population/social care crisis, as well as the future of the Internet of Things and smart city applications. The introduction of voice assistants has proven to be the first major inflection towards spurring accelerating growth across the connected home industry. Over time smart homes will become intelligent homes, where the devices learn how you live and then adapt their functionality automatically based on your personal preferences.

Barclays Research: *Home is where the $$$ is: The Connected Home (8 September 2017)*

Virtual assistants: This is a personal software-based agent that assists in performing daily activities based on verbal commands. Compared to basic voice search, a virtual assistant aims to understand the intent behind a question rather than using a pre-programmed response, by leveraging natural language processing. Examples include Apple's Siri, Amazon's Alexa and Google's Assistant. Virtual assistants are becoming increasingly sophisticated as machine-learning technology improves. Current notable features include checking the weather, traffic and current affairs, performing simple actions around the house (controlling devices), receiving and making phone calls, setting alarms and timers and media control.

Functionality going forwards will become more sophisticated, with the ability to book travel, recommend products and organise diaries.

Virtual reality: Virtual reality (VR) immerses users in an artificial digital environment, by generating realistic images and sensations that place the user within an imaginary world. VR is often used in the entertainment and gaming industry, but its uses also extend to healthcare, for example in helping patients suffering from anxiety, and to education, for example in helping students experience what they are being educated on. VR is different from augmented reality (AR) where the user is viewing a real-world environment and virtual objects are overlaid, and mixed reality, where the virtual and real worlds are combined. Virtual reality is a fully immersive experience, usually conducted using headsets or gaming consoles connected to a computer, but sometimes using standalone headsets that can connect to a smartphone.

Voice recognition: This refers to the technology that enables an electronic device to identify, distinguish and authenticate different spoken words. The process is usually divided into two parts: phonetic voice recognition and construction/interpretation of spoken language. The latter is known as natural language processing. It saw mainstream adoption with the launch of Apple's Siri in 2011 and since then we have seen the development of progressively sophisticated virtual assistants. One of the primary uses is voice search – allowing users to perform a verbal internet search through a smart device such as a virtual assistant (Amazon's Alexa – see below) – but the technology is being increasingly implemented into a wide range of other devices such as Sonos speakers.

Wearable technology: This is a category of devices (often including health and fitness related tracking data) that can be worn by a consumer. For example, the Apple Watch can monitor your heart rate and track metrics like steps, distance, calories burned and sleep quality. Wearable technology is considered a popular lifestyle trend within the consumer domain, however to date its use case has been limited to activity tracking. Going forwards, its capabilities are likely to expand as healthcare turns towards preventative care, which may create new opportunities for the technology within the insurance and fitness sector.

Consumer, Food & Retail

AgriTech: This refers to the use of technology to improve the efficiency and output of agriculture. It allows farmers to make data-driven decisions that increase agricultural productivity by improving farming practices. AgriTech could also be applied to horticulture and aquaculture. Driven by evolving weather patterns and climate change, the sector is under pressure to lower its carbon emissions whilst also raising productivity at the same time to grow more food for a growing global population. According to the UN's Food and Agricultural Organisation, food production will have to increase by 70% by 2050 to keep up with population growth. Examples of AgriTech innovation include soil sensors to measure moisture content and moisture flow, robots that can identify individual weeds before plucking them out and using algorithms to determine the optimal growing conditions by considering weather, pesticides and nutritional profile. A large proportion of the innovation has been led by private startups and thus we have seen large agribusinesses create venture arms to align themselves with new innovation as it is formed.

Barclays Research: *Sustainable & Thematic Investing – Food Waste: Ripe for Change (4 March 2019)*

Beverage innovation: This refers to the rise in non-alcoholic alternatives, low-sugar/low-calorie beverages, premiumisation, convenience, personalisation, globally inspired flavours and innovative packaging. Desire for a healthy life has become a powerful trend and it is impacting people's eating and drinking habits. The harmful effects of alcohol are already well documented but it acts as bridge for social interactions. In this light, availability of alternative drinks with low or no alcohol or better-for-you beverages is aimed at meeting that social need without the harmful effects of alcohol. The market opportunity will be influenced by the extent to which beverage manufacturers are able to respond to consumer needs and the challenges posed by governments and stakeholders around health and consumer education.

Barclays Research: *European Beverages: Identifying global premium growth (1 April 2019)*

Cannabis: Cannabis is a drug that comes from Indian hemp plants, where the active chemical (THC) has psychoactive effects (mind- and mood-altering). Cannabis is commonly referred to as weed, pot and marijuana. The federal legalisation of recreational-use cannabis in Canada, medicinal-use legalisation in the UK and Germany, and partial legalisation on a state-by-state basis (with cannabis remaining federally illegal) in the US could well mark the beginning of the end of the 'prohibition era' for cannabis. As legal cannabis goes mainstream, there are three broad uses emerging: medicinal, recreational and industrial. New product developments in cannabis could, however, create disruptive risks for many other industries, particularly beverages, tobacco, food and pharmaceuticals. The market opportunity going forwards will be highly dependent on the regulatory environment and customer acceptance.

Barclays Research: *Global Cannabis: Slow Burn Toward Legalization (3 April 2019)* and *European Consumer Staples: Cannabis Inc. – A growing industry (3 September 2018)*

Clean label & ingredient transparency: This involves the shift towards minimal ingredients on food product labels. It's where food manufacturers attempt to clean up their product labels to ensure that they contain ingredients that consumers find easy to recognise. The process of 'cleaning' labels involves reducing the amount of chemical names included on labels and making sure that the ingredients are more relatable to consumers. It aims to establish trust between food manufacturers and consumers – which is becoming increasingly important as demand for healthy alternatives and transparency grows. The clean label trend is expected to continue, placing greater pressure on the food manufacturers to ensure they're able to incorporate natural ingredients in a sustainable and profitable way.

Conscious consumer: Conscious consumers are those that consider the social and environmental impact that their purchases may have. They typically weigh the positives and negatives of using any product and reduce the consumption of products that may have a harmful effect on health and the environment or that are produced under unfair labour conditions. This is being driven largely by the younger demographic (Gen Z and the Millennials), who are actively punishing companies on social media on poor transparency, ethics and corporate social responsibility. The availability of information online has given consumers a wealth of knowledge and sense of empowerment. Conscious consumers will thus align themselves with brands they trust and those which support their personal values – including ethics, environmental sustainability and societal wellbeing.

Barclays Research: *Sustainable & Thematic Investing – Generation Z: Step aside Millennials (28 June 2018)* and *European Energy: Engaging Gen Z key for re-rating (17 April 2019)*

Cultured meat: Cultured meat is grown in a lab using animal cells and avoids slaughtering the animal. It is produced using many of the same tissue-engineering techniques traditionally used in regenerative medicine. The concept has strong environmental appeal as cattle farming alone is responsible for 9% of all greenhouse emissions. With global meat demand expected to increase 73% by 2050 (Source: UN FAO), livestock farming alone cannot bridge this gap, and cultured meat could provide a sustainable way to meet this demand. Mosa Meats – a cultured meat producer – notes that the cultured meat process generates 96% fewer greenhouse gas emissions and uses 99% less land and 96% less water than livestock agriculture. However, cost-effective mass production of cultured meat and social acceptability remain key issues for the industry.

Barclays Research: *Global Food: I can't believe it's not meat (22 May 2019)* and *Sustainable & Thematic Investing – Insect Protein: Bitten by the bug (24 June 2019)*

Digital detox: The smartphone is increasingly becoming our go-to medium for everyday life, changing the way we interact, work and learn in contemporary society. However, for all the advances smartphones have made in boosting productivity and convenience, smartphone addiction is on the rise. We define this as excessive dependency or obsession that interferes with daily activities and promotes distress and anxiety upon withdrawal. Children are the most vulnerable and are not helped by the rise of persuasive technology and the 'magic of maybe' thanks to social media and mobile gaming. Research warns that over-usage can impact adolescent development as well as increase the risk of loneliness, obesity and depression; yet the average age for children owning their first smartphone continues to fall. Led by the younger demographic themselves, the concept of a digital detox and stepping away from digital devices is growing in popularity across restaurants, travel and leisure providers.

Barclays Research: *Sustainable & Thematic Investing – Smartphone Addiction: The need for digital detox (19 September 2018)* and *Sustainable & Thematic Investing – Smartphone Addiction: The Gen Z Backlash (1 November 2018)*

Direct-to-consumer: Direct to consumer (D2C) refers to companies who manufacture and ship their products directly to buyers/consumers without relying on traditional stores or other middlemen (e.g. distributors). Consumers increasingly prefer a more direct experience/relationship with brands, therefore increasing the demand for D2C. These direct sales enable brands to collect more customer data to determine customer behaviour. The other benefit is cost – D2C companies can sell at a lower price than the traditional brands, yielding higher profit margins. The D2C strategy is becoming a popular route for manufacturers and consumer packaged goods brands to enter the market directly. Several large brands have either announced or acquired D2C strategies, including Unilever acquiring Dollar Shave Club (2016).

Electronic cigarettes (E-cigarettes): These are devices that enable users to inhale nicotine through a vapour (referred to as vaping), instead of the smoke from burning tobacco in traditional cigarettes. E-cigarettes are often marketed as a less harmful alternative to smoking; as their nicotine content enables them to manage cravings in the absence of tobacco, thereby reducing exposure to the carbon monoxide and tar that arise in tobacco smoke. E-cigarettes heat a liquid containing nicotine, flavourings, and other substances such as propylene glycol. There are different types of models available, according to NHS UK, including cigalikes, which can be disposable or rechargeable, vape pens and podsystems (e.g. UBS sticks). However as teen vaping reaches epidemic proportion in the US, regulators around the world are considering whether or not to ban e-cigarettes over safety fears, limit the availability of flavoured e-cigarettes and impose advertising guidelines on e-cigarette marketing in the future.

Barclays Research: *European Consumer Staples: Vaping epidemic* and *the fallacy of e-cig flavour bans (21 Oct 2019)*

Experiential retail: Consumers visiting physical stores today are not only focused on price, features or the benefits of a product but also on the buying experience. Retail companies have moved aggressively on providing a memorable buying experience to create greater loyalty, utilising immersive, interactive and technology-enhanced features. To improve the experience and engage the customer, stores have also started to provide various amenities such as cafes and lounges, live music, video displays, virtual reality and interactive games. Retailers in the UK and certain parts of Western Europe have used experiential retail to boost in-store traffic given rising rents and business rates are putting the traditional high street in many places at risk.

Barclays Research: *Sustainable & Thematic Investing – Future of Food Retail: Long Live Clicks and Mortar (12 October 2018)*

Food waste: Globally, c.1.3 billion tonnes of food produced for human consumption gets lost or wasted per year, which amounts to $680bn in industrialised countries and $310bn in developing countries. Food waste in rich countries is at 222 million tonnes a year, which is more than sub-Saharan Africa's net food production. The drivers of food waste or loss vary between regions – in developing countries it tends to occur at earlier stages of the supply chain due to factors such as harvesting technique and storage constraints, while in higher-income countries it occurs later in the supply chain and is driven more by consumer behaviour. BCG warns that the current global response to food waste is inadequate, and, if urgent action is not taken, food waste could rise by a third by 2030, to 2.1bn tonnes a year, which would mean $1.2 trillion going to waste. Food waste is a source of greenhouse gas emission, according to the UN's Food and Agriculture Organisation, accounting for 8% of total emissions, thus this issue hinders efforts to fight climate change, as well as efforts to solve world hunger. To contribute towards halving global food waste per capita by 2030, which is an objective under Goal 12 of the 2030 Agenda for Sustainable Development, the UK's largest supermarkets, including Tesco, Sainsbury's, Marks & Spencer and Lidl, as well as Nestle, have pledged to work towards halving the annual food waste bill by 2030

Barclays Research: *Sustainable & Thematic Investing – Food Waste: Ripe for change (4 March 2019)*

Food-as-a-service: This refers to a range of services that have the potential to change our relationship with food including how we shop, cook and eat. There are various underlying drivers supporting this market opportunity, including the trend towards efficiency, nutrition and transparency. To date, food-as-a-service includes online restaurant delivery (e.g. Just Eat), readymade delivery services, meal kit services (e.g. Hello Fresh) and subscription models. Success of food delivery aggregators and logistics providers is driven mainly by

change in consumer behaviour. People are now reallocating their budgets towards delivery. Further digitalisation and other technological developments should improve the user experience, bring down the cost and motivate adoption. In addition to the B2C opportunity, the addressable market going forwards will also be influenced by B2B (e.g. workplaces) and the rise in ghost kitchens/dark kitchens.

Barclays Research: *Food Tech – Delivered food: disruption is just beginning (16 Feb 2018)*; *Global Catering: Catering in a delivery world (6 Sep 2019)*, *Sustainable & Thematic Investing – Future of Food Retail: Long Live Clicks and Mortar (12 October 2018)*

GM food: This is food that has been produced from Genetically Modified Organisms (GM/GMO) – living organisms (e.g. plants, animals) whose genetic material has been artificially manipulated. The most common examples of GMO crops are corn, soybeans and cotton. The use of genetic modification is to produce food with certain desired traits. For example, the first ever GMO was the Flavr Savr tomato, introduced in 1994, which was engineered to ripen slowly. Other uses of genetic engineering in food are to create resistance to herbicides, pests and harsh weather conditions such as droughts, and to increase the nutrition foods provide. These foods are controversial given that they create room for increased chemical herbicide use, and they are patented by large companies. Additionally, there is limited knowledge about their potential long-term effects, giving rise to safety concerns. Nevertheless, they are being considered as a potential solution to famine and hunger globally given their resilience in the face of harsh weather conditions.

Halal economy: This refers to the products and services that are structurally affected by Islamic Law. The halal economy therefore captures the majority of Islamic faith-based spend, including halal foods, pharmaceuticals, cosmetics, modest-fashion, Muslim-friendly travel and Islamic finance. For example, companies producing halal-certified cosmetics do not use non-halal ingredients such as fatty acids and gelatin derived from non-halal animals. Within fashion, halal clothing should adhere to Muslim preferences on modesty as well as the consideration of the raw material used. Growth in the halal economy will predominantly be driven by the Muslim population, which is expected to account for 25% of the overall global population by 2030. Per the *State of the Global Islamic Economy* survey (*2018*), worldwide spending on Islam-inspired ethical consumption is set to increase by 45% by 2024, reaching $3tn. By region, Malaysia, the UAE, Bahrain, Saudi Arabia and Indonesia are expected to be the largest beneficiaries. By product, Islamic finance is the largest sector, followed by halal food. A challenge faced by the halal economy is the lack of standardisation in the halal certification process, given this varies country by country.

HFSS food regulation: This refers to food and drinks that are High in Fat, Salt and Sugar (HFSS) as classified by the UK's Department of Health nutrient profiling model. Foods scoring 4 or more points and drinks scoring 1 or more are classified as HFSS. Consumption of HFSS food is linked to health problems such as diabetes, heart disease, obesity, and some cancers. HFSS product advertisement has faced increasing restrictions in recent years, with the aim of reducing consumption (given its impact on health e.g. child obesity). These restrictions limit HFSS media placement, and the inclusion of celebrities or characters popular with children in HFSS adverts directed at under-12s. This has heightened the need for the food and beverages industry to consider how their products align with healthy eating and the potential implications this could have on packaging in the future.

Insect protein: We see insects as a viable source of protein and other nutrients for consumers who are conscious of making their diets more sustainable but don't want to shift to entirely plant-based. Insects require a fraction of the land, water and feed that traditional livestock require and emit up to 99% fewer greenhouse gas emissions. Globally, around 2 billion people in over 130 countries regularly eat insects as a source of protein, according to the UN's Food and Agriculture Organization. With the global population estimated to increase to 10 billion

by 2050, according to the UN 2017 population database, and food production needing to increase by as much as 70% to meet growing demand, serious challenges are posed around the sustainability of our food production systems, particularly in regards to meat. Although there are numerous hurdles to overcome, notably regulation, price and cultural acceptance, we see insects as a viable middle ground for consumers wanting to make their diets more sustainable without going entirely plant-based due to insects' high-quality nutritional profile and strong sustainability credentials. We also see insects as a credible feed alternative for animal agriculture, within the context of increasing sustainability concerns surrounding fishmeal and soy feed.

Barclays Research: *Sustainable & Thematic Investing – Insect Protein: Bitten by the bug (24 June 2019)*

Meat tax: This refers to a tax which would be levied on meat and/or other animal products to help cover the health and environmental costs that result from using animals for food. The global livestock industry is responsible for a large proportion of greenhouse gas emissions (cattle farming contributes 9% of global GHG emissions) and meat consumption is likely to increase due to the emerging middle class in developing nations. According to the Farm Animal Investment Risk and Return Initiative, meat is now following the same path as tobacco, carbon emissions and sugar towards a sin tax. Various countries such as Denmark, Sweden, and Germany are contemplating enforcing a meat tax to change consumer behaviour of using animals for food.

Omnichannel retail: A retail business model where all existing channels become integrated to offer customers a seamless, continuous and integrated shopping experience – enabling consumers to simultaneously use the various channels (e.g. physical, mobile, online, social). For example, starting their search on one channel and finishing the purchase on another. The benefits of omnichannel retail include: i) increased margins, ii) improved data collection, iii) greater efficiency, iv) integrated data analysis and v) higher conversion/retention rates. According to Salesforce (*2017*), 55% of shoppers say their retail experiences are somewhat disconnected as they switch between different channels. Retailers acknowledge the need for omnichannel retail but have experienced several technological barriers given the complexity of managing operations and the supply chain in this manner. The future of omnichannel retail will be influenced by predictive product recommendations, social shopping and interactive experiences as consumers demand deeper relationships with their brands.

Barclays Research: *Sustainable & Thematic Investing – Future of Food Retail: Long Live Clicks and Mortar (12 October 2018)*

Personalised marketing: This refers to a targeted marketing approach to deliver highly customised content regarding product/service offerings using data analysis and automation technology. It has the potential to enable brands to create more human-like experiences across different commerce channels to improve customer experience and increase brand loyalty. According to *NG Data*, there are four main steps behind a personalised marketing strategy: identify (data collection), differentiate (data analysis), interact (find the best communication channel to engage the customer), and customise (use the information on the customer to deliver the best-fitting message). Today, targeted emails, custom video messages, product recommendations and social media marketing are examples of personalised marketing. Going forwards, predictive personalisation could allow brands to understand how consumers behave on both a macro and micro level, which will enable them to remove potential barriers to purchase.

Personalised nutrition: This refers to an approach that uses information on an individual's characteristics to develop targeted nutritional advice, products or services (*Source: BMJ – Gibney et al – 2018*). Studies have found that genes influence the way the body responds to different nutrients. As such, personalised nutrition can help achieve greater health benefits and may also help to prevent diseases such as obesity, diabetes and cholesterol-related diseases. Personalised nutrition often overlaps with related terms such a precision nutrition, nutrigenomics and nutritional genomics. Nutrigenomics is a field of nutritional science investigating the effects of diet and dietary components on gene expression. To date, genetic test kits, interactive apps, portable gadgets and intelligent home dispending units have proved popular. The extent to which the major food manufacturers are able to develop personalised products to be sold by supermarkets will be influenced by a wide range of legal and social factors.

Plant-based diets: These diets are derived from plant sources, such as vegetables, fruits, nuts, seeds and grains. There is no standard definition for a 'plant-based' diet and thus there are differing views regarding to what extent animal-based products are excluded. Younger consumers, particularly Gen Z, are replacing meat with plant-based foods in their diet as a result of increased sensitivity to health, animal welfare and environmental issues. To meet the increasing demand for plant-based food options, many manufacturers are increasing their production capacity and are introducing new plant-based offerings. While lab-based meat is still likely several years away from hitting supermarket shelves, plant-based protein continues to gain ground vs. its animal-based counterpart, and we expect this trend to continue for the foreseeable future. The focus to date has mostly been on soy and wheat, which have generally lacked the desired texture, flavour and appearance to replace real meat. Plant-based food does have its shortfalls given it can also cause significant climate stress e.g. the rise in palm oil concerns and deforestation related to soy. Given the environmental burden of producing animal proteins, some governments are considering the use of a meat tax, which would make alternative proteins even more attractive.

Barclays Research: *European Food: A thirst for plant-based dairy (24 May 2019)*; *Global Food: I Can't Believe It's Not Meat (22 May 2019)*; *Sustainable & Thematic Investing – Generation Z: Step aside Millennials (28 June 2018)*

Renting & sharing economy: The sharing economy is a general term aimed at labelling the ongoing trend of collaborative, mostly peer-to-peer, consumption of goods and services. It builds off the idea that better asset utilisation, the exchange of existing goods and services (mostly for profit, sometimes not), will allow a more efficient and cost-effective way of sharing and renting products and services. We believe the trend of collaborative consumption has the potential to materially uproot and transform existing businesses and business models in a number of sectors. We have already begun to see the impact Uber has had on transportation (and potentially car ownership) and the impact Airbnb has had on travel. There is also potential for other sectors to see disruption from the growth in rental models – we highlight the fashion industry (e.g. Rent the Runway in the US).

Barclays Research: *Sustainable & Thematic Investing – Global Fashion: Green is the new black (15 Jan 2020)*

Smart supermarkets: This refers to supermarkets introducing technology into the physical store to enhance the customer experience and enable greater levels of efficiency and workplace automation. We see brick and mortar stores being transformed into experience hubs as well as localised distribution centres for click & collect and home delivery. We see technology playing a large role and expect to see productivity gains both on the shop floor and in the supply chain thanks to robotics, artificial intelligence and digital enablement. In particular, we see stock replenishment, smart shelves (e.g. electronic labels), personalised

marketing & loyalty offers, IoT sensors and check-out technology playing a large role in smart supermarkets in the future.

Barclays Research: *Sustainable & Thematic Investing – Future of Food Retail: Long Live Clicks and Mortar (12 October 2018)*

Streaming economy: This refers to the growth in streaming technology where media content is delivered online. Streaming has made it easier for consumers to access media content where and when they want it and has proved disruptive across music, television and movies to date. Platforms such as Spotify, YouTube, Netflix, HBO and Amazon Prime are leading providers of streaming services. The streaming economy doesn't only benefit consumers, it also benefits the music and TV companies who can avert their charges away from the consumer and towards advertisers, enabling them to offer services at lower cost to consumers. The next driver of growth within the streaming economy will likely be from the gaming industry, as gaming platforms such as Nintendo and Microsoft establish partnerships to provide users with gaming subscription services. We also see this impacting the future of sports and exercise, via workouts streamed live and on-demand. The future of streaming will also be influenced by increased competition, bundling/aggregator platforms and potential price increases as consumers demand additional functionality e.g. 4K resolution, uninterrupted streaming and original content creation.

Barclays Research: *Internet & Media: Why bundles are the future of streaming (2 October 2019)*

Sustainable fashion: The fashion industry is responsible for a wide range of environmental and social problems. Poor production methods have led to excessive water consumption, carbon emissions, exposure to toxic chemicals, water pollution and waste creation. While social issues include poor health & safety, worker rights, gender equality, and child labour. Apparel and footwear currently account for 8% of global GHG emissions – equivalent to the total climate impact of the EU. To this effect, we define sustainable fashion as the industry's transition towards sustainably sourced materials, improved production practices and the enabling of a circular economy. Increasing consumer pressure and rising industry profitability risk could accelerate changes throughout the supply chain to address the issues. The industry is likely to see the scale-up of experimental materials with a lower environmental impact such as pineapple leather and lab-grown cotton; emergence of second-hand, rental and subscription models; growth in advanced recycling technology; and improved supply chain transparency.

Barclays Research: *Sustainable & Thematic Investing – Global Fashion: Green is the new black (15 Jan 2020)*

Sustainable packaging: This refers to design solutions for product packaging that not only help marketing efforts but also are cost-effective and sustainable. Through material science and packaging engineering, sustainable packaging provides ways to reduce waste and bring down cost using creative designs that rely more on renewable resources and/or the circular economy. This can be achieved by product design, ingredient selection, the production process and assessing the reusability of packaging, given extending its lifecycle and usability are key sub-trends within sustainable packaging. Sustainable packaging often overlaps with plant-based packaging and biodegradable plastic packaging, and more recently a wave of niche options has emerged such as plastic packaging derived from milk proteins and even seaweed. The growth in online shopping and international shipping has led some countries to consider whether there is a need to introduce a packaging tax across relevant sectors (e.g. ecommerce platforms, online retailers and logistics & distribution).

Barclays Research: *Sustainable & Thematic Investing – Food Waste: Ripe for Change (4 March 2019)*, *Sustainable & Thematic Investing -Plastic Waste: Don't Lose your bottle (19 June 2019)*

Vertical farming: Vertical farming is an innovative and sustainable agricultural technique that involves growing plants in vertically stacked layers, substantially saving both water (up to 70%) and space. Vertical farming involves using indoor farming techniques and controlled environmental agriculture technique where many environmental factors such as light, temperature, humidity, etc. are artificially controlled. Vertical farming uses non-soil growing mediums such as: hydroponic, aeroponic, and aquaponics. Hydroponics uses a solution of nutrients instead of soil; aeroponics uses a mist environment rich in nutrients; and aquaponics combines fish farming with plant farming. Within Barclays' partnership with Unreasonable Impact, AeroFarms is a data-driven vertical farming company on a mission to enable local production at scale. AeroFarms notes that it consumes 95% less water than field farming, uses less than 1% of the land required by conventional growing and yields over 390 times more per square foot vs. traditional agriculture.

Barclays Research: *Sustainable & Thematic Investing – Food Waste: Ripe for Change (4 March 2019)*

Industrials, Manufacturing & Transportation

3D printing: This is an umbrella term which is used to describe all additive manufacturing technologies. It refers to the process of making three dimensional solid objects from a digital file using successive layers of material. The digital file, which is considered the blueprint of the physical object, is converted into 2-dimensional layers, which are then turned into a set of instructions for the printer to execute. It is a different way of producing parts compared to the traditional subtractive or formative manufacturing technologies. 3D printing enables greater levels of customisation and low-cost prototyping, but adoption has been somewhat limited to date given the costs and the technology investment required. 3D printing is considered the future of factories and is currently being developed by a wide range of sectors, including automotive, robotics, tooling, industrial, healthcare and design.

Barclays Research: *Sustainable & Thematic Investing – Global Fashion: Green is the new black (15 Jan 2020)*

Advanced construction materials: The construction industry is under pressure to raise its sustainability credentials given that, by nature, it is a big user of natural resources. According to the British Assessment Bureau, sustainable construction methods include using renewable and recyclable resources, reducing energy consumption/waste and creating a healthy, environmentally friendly environment. The fabrication of material can have a large impact on carbon emissions, as well as the mining for raw materials and the manufacture of concrete and cement. Prefabricated buildings and sustainable construction materials have proven popular across the industry, as well as efforts to improve production technology. Examples of the uses of sustainable materials in construction include using alternative mineral components, and other by-products from industrial processes such as blast furnace slag and fly ash in cement products, which can reduce the carbon intensity of the cement.

Autonomous vehicles: An autonomous vehicle is capable of sensing its environment and operating without human involvement. The concept is also referred to as a driverless or self-driving car; such vehicles use a wide range of sensors, acutators, machine learning systems and other equipment to avoid collisions. The Society of Automotive Engineers currently defines 6 levels of driving automation ranging from Level 0 (fully manual) to Level 5 (fully autonomous). These levels have been adopted by the US Department of Transportation. Autonomous vehicles are currently being trialled in various parts of the world, but they are not yet commercially available on a large scale. The current challenges include technological (e.g. Lidar technology), legislative (e.g. regulatory environment and accident liability), environmental (e.g. extreme weather) and philosophical (e.g. autonomy). The transition to autonomous vehicles is expected to reduce traffic congestion, cut transportation costs and reduce urban CO2 emissions worldwide.

Barclays Research: Refer to *#disruptivemobility* on Barclays Live for the latest research.

Battery technologies: Using different chemicals and materials affects the properties of a battery, including how much energy it can store, how much power it can provide and the number of times it can be recharged. Companies across the technology, industrials and automotive industry are experimenting to find new combinations that are cheaper, denser, lighter, safer and more powerful relative to lithium-ion batteries. Depending on the application, it is likely we will see a wide range of high-performance batteries emerge for specific applications ranging from EVs to grid storage. New battery types include: silicon-based batteries, solid-state batteries, proton batteries, magnesium batteries, room-temperature sodium-sulfur batteries and graphite dual-ion batteries.

Commercial drones: Based on our research, the convergence of technology themes, including 5G, remote computing and AI, has set the stage for widespread commercial drone deployment in the coming years. Uptake is being driven by cost-reduction potential and safety improvements, rather than large-scale incremental revenue opportunities. Initially, the market is expected to be focused on the drone itself but the longer-term angle is componentry. Across industries, drones can help companies operate more efficiently, and Barclays estimates they could reduce expenses by $100bn by 2024. By leveraging drones equipped with advanced imaging technology, workers will no longer need to conduct inspections atop bridges, telecommunication towers and energy infrastructure, reducing the risks associated with their jobs. The biggest technical barriers to autonomy include connectivity, on-board processing, image recognition and battery life. Furthermore, its use case is also being influenced by ongoing regulatory concerns regarding privacy, autonomy and security.

Barclays Research: *Global Technology: As drones rise, costs fall (30 July 2019)*

Connected industrial worker: This concept describes an industrial workforce that implements smart, IoT-enabled devices in order to improve operational performance and safety. To achieve this, the devices used target boosting efficiency, reducing mechanical failures, and increasing safety. Examples of devices that could be used as connected worker solutions include wearable technology such as smart helmets, which allow wearers to overlay maps and thermal images in order to see through solid objects such as walls, and augmented reality smart glasses. According to Accenture, 53% of US companies are already using connected industrial workforce measures. Adopting the connected industrial workforce can help position companies to remain competitive, especially as manufacturers become less able to benefit from lower-wage labour given the rise of emerging economies. Accenture estimates that adoption of the connected industrial workforce could increase a typical automotive manufacturer's profitability by up to €500 million, and could increase output by 8-9% while decreasing costs by 7-8%.

Electric transportation: The auto & transport sectors are making efforts to move from conventional internal combustion engine vehicles to e-mobility, which means the electrification of transportation is growing as the fight against climate change intensifies. Reasons for the rise in electric transportation are reduced pollution, and lower costs of ownership due to lower fuel costs and increased battery energy density. Electric transportation encompasses numerous other forms of vehicles in addition to cars, including electric land and underwater scooters, off-roaders, hydrofoils, and the more familiar subway and light rail systems. According to the IEA, electric vehicle ownership will grow exponentially, from an estimated 3.1 million in 2017 to c.125 million globally by 2030. While government policy continues to be key linchpin for electric adoption, the supply of low-cost batteries and the need for additional infrastructure (e.g. charging stations) also need to be considered.

Barclays Research: *Sustainable & Thematic Investing – Future Mobility: Making the EV equation balance (30 Nov 2018)*

High-speed rail: This refers to passenger rail systems running at operational speeds between 200 and 300 km/h, and above in some cases. In recent years, high speed rail systems have become a key infrastructure project for governments and the transport industry given they offer higher-density development than has typically been associated with highways and airports. High-speed rail can mitigate congested road and air infrastructure (particularly for short and medium-length trips) and typically consume less energy per passenger-km than when using road and air transport. China is responsible for the majority of the operational high-speed tracks today, with the China Railway high-speed project developing the world's first autonomous, driver-monitored railways. China Railways says the entire line will dotted

with A.I. based substations that will monitor the train's status and continually check for malfunction, according to Popular Mechanics (*October-2019*).

Housing 2.0: We use this term to describe a range of possible futures for housing and home ownership. Urbanisation, scarcity of land and ongoing demographic change (e.g. ageing population) are likely to impact the future housing supply, as well as affordability which suggests current housing policy in the developing world will need to adapt. According to the National Housing Federation, there are an estimated 8.4 million people in England living in unaffordable, unsecure or unsuitable homes – impacting all ages across every part of the country. The research estimated that 3.6m people are living in an overcrowded home, 2.5m people are unable to afford their rent/mortgage and 1.4m are in poor-quality homes (vs. a 56m total population). Within Housing 2.0, society is likely to observe a change in housing patterns and shifts in household composition depending on the region, including multi-generational housing, single person households, renting for life and silver/retirement villages. To address the housing challenge, cities around the world have considered tradeable land quotas, community ownership, repurposing vacant property and shared ownership.

Hydrogen fuel cell: A hydrogen fuel cell is electrochemical power generator that combines hydrogen and oxygen to produce electricity with water and heat as by-products. It offers a reliable alternative energy source given the fuel cells do not produce any harmful emissions. They also eliminate the costs associated with handling and storing toxic materials (e.g. battery acid). Compared to batteries and internal combustion generations, hydrogen fuel cells have lower operational costs given they eliminate the need for battery charging infrastructure and thus require less maintenance. Compared to battery-electric vehicles, hydrogen fuel cells are considered a nascent, emerging technology. Many vehicle manufactures are actively researching fuel cell technologies; however, cost remains the biggest hurdle today, given they're unable to compete economically with more traditional energy technologies.

Hyperloop: A vacuum train, also known as a vactrain, is a proposed supersonic mode of transport where a train levitates through a vacuum sealed tube due to magnetic forces. The vactrain proposes a solution to the limitations of supersonic air travel, given its reduced noise pollution and minimal energy requirements, as well as its higher speed, due to the lack of air resistance or resistance from wheels or tires. A development on the concept of the vactrain is the Hyperloop: a futuristic train, pitched by Elon Musk, which is a pod-like capsule levitating within a low pressure steel pneumatic tube that is expected to accelerate up to 670 miles per hour. Arguments in support of the Hyperloop claim that it is more sustainable and affordable than aviation, and faster than high-speed trains. The Hyperloop offers a sustainable mode of transport – for example Musk's model of the Hyperloop would use solar energy. The Hyperloop is expected to tackle congestion challenges and reduce cargo shipping times and costs, as well as passengers' travel times.

Industrial robotics: Industrial robots are automatically controlled, multipurpose robotic systems that can enable efficiency improvements within the manufacturing industry. This can be achieved through the completion of a range of tasks including welding, ironing, assembly, pick and place, painting, product inspection – all performed at a high degree of speed, accuracy and endurance. Robots use End Of Arm Tooling (EOAT) to perform their processes, or to hold onto objects on which processes are being performed. Cobots (collaborative robots), are the latest generation of robots, designed to assist humans, given their safer design, and enhancements from vision and sensor technology. Industrial robots and cobots are valuable additions to the workplace, as they can provide workers with more time to work on higher-value, higher-pay tasks – they are a complement to mid-skilled workers. Plus, they can be programmed to carry out the more dangerous, repetitive, or dirty tasks at a consistent level of precision. According to the Oxford Economics Global Economic

Model, the installation of robots could add $4.9 trillion to the global economy by 2030 (*Source: Oxford Economics)*.

Localised manufacturing & micro-factories: This refers to the premise that in the past businesses have focused on centralising production, but the advancements in technology and automation may make a localised approach more compelling for certain sectors given the greater flexibility and potentially lower costs. Instead of a centralised factory producing 'one size fits all' products, manufacturing companies with the help of these localised micro-factories, can provide customised products according to the needs and preferences of the local market. According to the World Economic Forum (*2019*), companies must increasingly think global (in terms of emerging customer needs) but build locally (in terms of executing those needs). A key enabler for localised manufacturing will be automated micro-factories (smaller factories) set up mostly in proximity to local markets to save on transportation costs and time.

Manufacturing/Construction Tech: The industrial software landscape is complex and consists largely of separate functional and vertical silos, including management systems, design & engineering systems, manufacturing control systems and manufacturing operations systems. The potential for smart, adaptive manufacturing is huge but the transition to 'manufacturing-as-a-service' will require more open and standardised architecture to enable systems to communicate. This might sound logical and easy on paper, but it will be a complex upgrade cycle as there has historically been a lack of standardisation in manufacturing IT systems. Complete realisation is more than 20 years away, with the sector likely to experience the following waves going forwards: accelerated robotics advancements, localisation and customisation of production, module and distributed manufacture and autonomous/synchronised manufacture. ConstructionTech is also an area gaining significant interest, given the need to address high wastage levels and a high error rate that leads to significant cost overruns and delays.

Barclays Research: *Manufacturing Tech primer vol.1: Age of hyperconnectivity and automation (22 October 2018)* and *Manufacturing Tech primer vol. 2: Deep dive into constructionTech (14 November 2019)*

Micromobility: Micromobility is an electric vehicle weighing <500kg that can be owned or shared and is connected using AI and generally used for utility purposes. We expect the micro mode to differ greatly by geography, dependent both on consumer appetite and government will. It could be that e-scooters proliferate in the sun-belt states in the US, e-bikes in Europe and e-mopeds and e-trikes in developing Asia & Africa, or a combination of all modes in all regions. Micromobility suits consumer demand for greater affordability, accessibility and availability whilst also adding velocity and vivacity (the 'fun factor'). We expect speed to be a greater enabler of micromobility than cost and the lower 'hassle' of micro to allow operators to increase pricing to deal with customer demand. MM operators are currently unprofitable, but this could change as vehicle utilisation rates improve and vehicle quality reduces vehicle churn. With a potential vehicle parc of 280m vehicles globally, based on our addressable market forecasts, we also see a revenue opportunity of €22.6bn for vehicle hardware manufacture.

Barclays Research: *Sustainable & Thematic Investing – Micromobility: Fast, Cheap and Good Solution for 'Smart Cities' (20 March 2019)*

Overseas infrastructure investment: This refers predominantly to foreign direct investments (FDI), which are cross-border transactions involving direct investments in a given time period. In recent years, overseas infrastructure investments have become strategic in nature, focusing on industrialisation, urban development and transportation. The relationship between China and Africa is of particular importance in this regard, given large known

projects like China's Belt and Road Initiative. This is an ambitious programme to connect Asia with Africa and Europe via land and maritime networks along six corridors with the aim of improving regional integration, increasing trade and stimulating economic growth.

Shared mobility: This refers to the shared use of a vehicle that allows users to access transportation services on an as-needed basis. In theory, shared mobility has the potential to increase the occupancy of vehicles in use, reduce individual ownership and enhance multi-modal travel. While ride-hailing and ride-sharing have proved popular to date, it is unlikely shared mobility will outpace vehicle sales through 2030 given expected growth in Asia. Shared mobility has proved popular in urban environments, including car sharing, peer-to-peer and micromobility, as consumer acceptance grows. According to McKinsey (*2017*), further growth in shared mobility will depend on how effectively the industry eliminates existing customer pain points (e.g. availability, use case, pricing).

Barclays Research: *Sustainable & Thematic Investing – Cutting the car ownership cord (4 June 2019)*

Smart buildings: A smart building is a structure that uses automated processes to control the building's operations, such as air conditioning, lighting, ventilation, security and heating. Smart buildings use sensors, microchips and actuators, and IoT solutions to generate and share data between the systems to optimise the building's performance. Commercial landlords are becoming increasingly agile, introducing sensory deployment into their commercial real estate to adapt to the changes in the way we work, such as increased demand for remote working. Such technologies also have the ability to reduce costs, increase tenant satisfaction and enable improved sustainability. Research conducted by management consultancy CIL indicates advanced heating, ventilation and air condition as key areas of focus amongst landlords (*2019*).

Smart cities: Driven by rapid urbanisation, smart cities combine technology and infrastructure to create efficient, clean, safe new urban areas. They are created using advanced ICT, the Internet of Things, and other advanced technology to monitor traffic and pollution, streamline public facilities, reduce energy usage, decrease traffic congestion, integrate municipal services, improve air quality and manage ecological waste. For example, a connected traffic light receives data from sensors and cars adjusting light cadence and timing to respond to real-time traffic, thereby reducing road congestion (Source: *Gemalto*). With regards to wireless technology, Low Power Wide Area Networks (LPWAN) are well suited to most smart city applications given their cost efficiency and ubiquity. 5G technology is expected to be a watershed event for smart city technology going forwards.

Barclays Research: *Sustainable & Thematic Investing – Micromobility: Fast, Cheap and Good Solution for 'Smart Cities' (20 March 2019)*

Space: The space industry has shifted from a highly regulated and government-controlled industry to becoming more open and competitive, driven by private company innovation, the involvement of new countries and falling launch costs. Within this, space tourism receives the most interest, given several billionaires have outlined their aspirations to make space travel a reality for the general public (e.g. Richard Branson – Virgin Galatic and Jeff Bezos – Blue Origin). Virgin Galatic expects to begin commercial operations in 2020 and aims to be profitable by 2021. In addition to tourism, space is also being utilised by governments to develop their military and intelligence capabilities, to generate additional satellite data to aid the monitoring of various environmental considerations and to enable broadband internet access across the world. There are various risks and challenges to commercialising opportunities within space, including regulatory, economical and technical considerations.

Supersonic travel: This refers to a rate of travel that exceeds the speed of sound. Historically the term has been associated with Concorde – a British-French supersonic passenger airline that retired in 2003 following concerns regarding its profitability, passenger safety and noise pollution. To protect the public from sonic booms, the current FAA regulations in the US ban the flight over land of any commercial aircraft at supersonic speed. However, some recent innovations suggest supersonic travel is being developed by a wide range of new players, including Boom Technology and Aerion Corp in partnership with Boeing and GE. To counter the large carbon footprint, the use of sustainable alternative jet fuel, composite fuselages and high-temperature material systems is being considered.

Textile & fabric innovation: We define this as the growth of smart fabrics and new innovative materials. The demand for more sustainably sourced materials has led to the emergence of innovative new fibers and materials that have a lower environmental impact. Aside from the increasingly popular switch to organic cotton, this theme implies the scale-up of entirely new materials such as fruit-based and lab-grown fibers. Examples to highlight: Pinatex, a vegan leather alternative made from pineapple leaves; Lyocell, a cellulosic fiber created from wood; and Orange Fiber, which can be produced into a silk-like alternative. We define smart materials as fabrics that been developed with new technologies that provide added value to the wearer – they have the ability to do what traditional fabrics cannot. We recognise two different categories: aesthetic (e.g. change colour/light up by gathering energy from the environment) and performance-enhancing (e.g. regulate body temp, control muscle vibration).

Barclays Research: *Sustainable & Thematic Investing – Global Fashion: Green is the new black (15 Jan 2020)*

Health & Modern Science

3D bioprinting: In essence, bioprinting works in a similar way to conventional 3D printing. The 3D printers deposit layers of biomaterial to build complex bodily structures like blood vessels, skin tissue and bones. To do this the required cells are taken from the patient and then cultivated until there are enough to create the bio-ink, which is then loaded into the printer. In theory, the 3D printed organ could match the exact size, specifications and requirements of each individual patients and thus reduce the risk of rejection by the body. 3D printed organs are becoming a key focus area given, on average, 20 people die each day while waiting for a transplant in the US. The shortage of organ donors is not just confined to the US and is generally considered a worldwide issue. The technology is relatively new, which means there are several different techniques being developed today by the healthcare industry.

AI drug discovery: The nature of drug R&D is inherently high-risk, and often this uncertainty translates into higher drug prices for the consumers. On average, it takes about a decade of research and expenditure of $2.6bn to move an experimental drug from lab to market, and, because of concerns over safety and effectiveness, only c.5% of experimental drugs make it to market at all (*NBC News – MASH, March 2018*). AI has the potential to improve drug discovery at the earliest stages, when the risk of failure is higher. In addition to designing new drugs or developing better biomarkers, AI is also helping to repurposes drugs – finding new uses for existing drugs or late-stage drug candidates.

AI radiology: AI can be used in medical imaging, which encompasses a range of techniques for creating visual images of the inside of the body to analyse. Using a virtual assistant to detect patterns in these images reduces the time doctors and radiologists spend on such tasks, freeing them up to perform more intricate tasks such as interpreting complicated results, and consequently forming 'care pathways' – unique solutions and treatments for different patients. AI can aid the teasing out and preparation of data for the radiologist, but it is unlikely to completely rule out the need for radiologists.

Antimicrobial resistance: Antimicrobial resistance (AMR) occurs when microorganisms such as bacteria, viruses and parasites, develop a resistance to drugs designed to kill them, including antivirals and antibiotics. Consequently, standard treatments lose effectiveness, and infections persist – which increases the risk of further transmission. This poses a serious threat to global public health, and patients with resistant infections bear higher health care costs due to the longer duration of illness, and the need for more tests and expensive drugs. AMR usually occurs through genetic changes over time; however, the misuse of antimicrobials can speed up this process – this is particularly relevant in cases where antibiotics are given without professional oversight, leading to overuse. The UK aims to contain, control and mitigate AMR globally by 2040, by promoting a lower burden of infection, optimal use of antimicrobials, and new forms of therapy, diagnostics, and interventions (Source: *HM Government – 2019*).

Biohacking: Regularly referenced in popular culture, this refers to the hacking of one's biology, in order to optimise brain and bodily function. It is a broad term that can cover a range of activities, from implementing lifestyle and dietary changes to using implant technology and genetic engineering. Some of the most extreme forms of biohacking include DNA injections and young blood transfusions, where older people pump younger people's blood in their veins in the hope of fighting ageing. Some more common forms of biohacking include intermittent fasting, taking multiple vitamin supplements to maintain a peak physical condition, and undergoing cryotherapy, to boost the metabolism or offer pain relief, and help with skin conditions such as warts.

Cloning: This is the process of generating a genetically identical copy of a biological entity. Researchers have cloned a wide range of biological materials, including genes, cells, tissues and animals. Despite the progress in animal and plant cloning, we are yet to see much movement in the field of human cloning. Cloning a human is currently illegal in most parts of the world; however cloning stem cells from humans is a very promising field of research according to *Live Science* (*2017*). This is where stem cells can be reprogrammed to become any type of cell needed to repair or replace damaged tissues or cells in the body.

Designer baby: A designer baby is a baby whose genetic makeup has been altered to select certain characteristics, or remove genes that are affiliated with certain diseases. The first genetically modified 'designer' babies were born in China in November 2018, using CRISPR (a novel gene-editing tool) to alter the embryos to rid the twins of a potential HIV-positive diagnosis. It is banned in most countries because the technology is still experimental. There are also various ethical and moral questions regarding whether or not society should be allowed to genetically modify children for purposes unrelated to health, which can be regarded as cosmetic genetic engineering and involves altering genes relating to intelligence, gender and so forth.

DNA data storage: We are currently facing a data-storage challenge, given that the amount of data society is producing is unlikely to slow down. An alternative to hard drives is progressing: DNA-based data storage. Firstly, it is ultra-compact: a single gram of DNA can store up to 215 million gigabytes of data. At that density, all the world's current storage needs for a year could be well met by a cube of DNA measuring about one meter on a side according to the *Scientific American* (2019). Secondly, DNA is easy to replicate and is stable – it can last for centuries if stored well. However, in order for DNA to compete with electronic storage, the cost and speed of writing DNA needs to fall. Large-tech companies such as Microsoft, Intel and Micron, as well as start-ups such as Catalog, have been working on their own DNA storage projects.

Longevity tech: This refers to the use of technology coupled with scientific innovation to generate breakthroughs in anti-ageing and life extension. Thanks to advancements in human biology and the growth in artificial intelligence, we will increasingly have the means to be a lot more predicative and preventative when tackling the most damaging diseases by manipulating biology to generate potentially life-altering breakthroughs in ageing. Longevity tech has garnered significant interest within healthcare and the VC community in recent years, leading to several biotech companies seeking to increase human longevity. Juvenescence, a UK biotech valued at $500m, will use an IPO in 2H20 to move 5 life-extension technologies into phase 2 trials (*October 2019*).

Medical tourism: This is where people who live in one country travel to another country to receive medical treatment because it is cheaper and/or more readily available. The word 'tourism' comes from people staying on in the foreign country following the initial medical procedure, engaging in sightseeing and other traditional tourist activities. The most popular destinations for medical tourism are developing countries, including India, Malaysia and Thailand. Currently, growth of medical tourism is predicted to go up to 25% annually for the next ten years (*Source: Med Essentially*). By treatment, orthopaedic, neurological and oncological treatments are the most popular, as well as cosmetic surgery.

Microchip implants: There are a broad range of possibilities for the use of microchips in medicine. A long-debated potential function is to store patients' electronic health records in implantable microchips. Doctors hope that use of the device will result in better treatment for patients in emergencies or when a patient is unconscious or lacks medical records. The microchip implants are RFID transponders encapsulated in silicate glass and implanted sub-dermally in the box. They are typically the size of a grain of rice and have been used for many years with livestock and pets. Though the FDA approved the first implantable microchip to

access medical records for humans more than 10 years ago, it has yet to be widely adopted given its use also raises a whole host of privacy and security concerns.

Myopia epidemic: By 2050, half the world's population – a staggering five billion people – are expected to be short-sighted compared to roughly 1.4 billion people today, according to a 2016 study published in the journal *Ophthalmology*. The prevalence of myopia – the medical term for short-sightedness – occurs when the eyes grow too long such that they are unable to produce a clear image of distant objects. Its incidence has risen rapidly in recent years driven by a lack of time spent outdoors and our fixation with screen-based devices including smartphones and computers. Experts warn that it can increase the risk of developing other eye conditions like myopic macular degeneration, glaucoma and retinal detachment. In extreme conditions, severe myopia can also lead to blindness.

Barclays Research: *Sustainable & Thematic Investing – Smartphone Addiction: The need for digital detox (19 September 2018)*

Opioid epidemic: According to the National Institute on Drug Abuse, the misuse of and addiction to opioids – including prescription pain relievers, heroin and fentanyl – is a national crisis that affects public health as well as social and economic welfare (*2019*). Opioids replicate opium's pain-reducing properties by disrupting pain signals in the brain, increasing the brain's dopamine levels and thereby boosting a feeling of euphoria. These characteristics can make opioids addictive, leading to the common abuse of both prescription and illegal opioids. The opioid epidemic has cost the US more than $800bn in the last four years alone, driving a wave of litigation against drug-makers and distributors.

Barclays Research: *U.S. Speciality Pharmaceuticals – Market implied cash outflow & Equity Value Scenarios ahead of Opioid MDL (9 October 2019)*

PAYG social care: Due to current underfunding of services and an ageing population, the future of adult social care is a growing concern for both society and governments. The key question it raises is about the way care should be paid for in the future. A range of care apps have entered the market, using technology to streamline administrative tasks and improve care quality by connecting various healthcare professionals onto one platform. Given many people want to stay at home for as long as possible, the idea of *PAYG* social care is on the rise in the developed and developing world. This is where people can book home carers via apps for personal tasks such as bathing, companionship and cooking.

Personalised insurance: Personalised insurance enables insurers to identify customer signals and assess risks by using machine learning algorithms to analyse customer behavioural data. It involves basing the premium, cover and claim around the individual, rather than around a pool of similar people. Wearables, telematics and IoT sensors are reputable sources of individual data and support the underlying direction of travel that we foresee through 2030. A more contentious source of data is using social media to determine individual attitude to risk. One of the key benefits of insurance is financial certainty; however, the inevitable consequence of personalisation is price instability. The future of personalised insurance is likely to be driven by the insurer's ability to leverage real-time data to assess both risk and pricing.

Personalised medicine: This refers to an increasingly popular market within health based on the concept that a one-size-fits-all approach to the diagnosis and treatment of disease is outdated, as humans have different biological make-ups and environments. A better understanding of genetics and genomics (e.g. whole genome sequencing) and wearable technology is enabling doctors to provide better disease prevention, more accurate diagnoses and safer drug prescriptions on an individual basis. According to the NHS, traditionally medicines were built around clinical teams specialising in a particular organ system working back from a patient's symptoms to arrive at a diagnosis. Personalised medicine turns this

approach on its head. It recognises that complex diseases should no longer be considered as a single entity. One disease may have many different forms, or 'subtypes', resulting from the complex interaction of our biological make-up and the diverse pathological and physiological processes in our bodies (*Source: NHS 2016*).

Predictive healthcare analytics: As data storage and analysis capabilities continue to develop, technology is becoming increasingly integral to healthcare, which has created the opportunity to gain predictive insights into future outcomes for patients, using historical data and machine learning to build predictive models within healthcare. According to KPMG, by 2025, 90% of US hospitals will apply artificial intelligence when conducting diagnoses. Predictive analysis could enable physicians to find quicker, more effective healthcare solutions for patients by stratifying them from the onset, and using real-world data to find the correct treatments. For example, artificial intelligence and genomics can contribute to a preventive model for the NHS to apply to patients – which could use NHS data, or data gathered from remote patient-monitoring devices. The use of lab testing, biometric data, patient health data, and claims data, as well as other social indicators that could factor into a patient's health, could be used to create risk scores, which could then enable easier identification and management of higher-risk patients, reducing costs and improving the quality of healthcare provided, according to the Association of American Medical Colleges.

Remote patient monitoring: Remote Patient Monitoring (RPM) uses digital technology to provide healthcare and gather patient data outside of traditional healthcare settings. RPM can also facilitate early interventions, by predicting imminent health risks through sensors on the monitoring device and alerting relevant healthcare professionals. Smartphone apps are increasingly relevant in this field, as they can provide the data storage to process and analyse health data, and provide treatment recommendations and notifications. Examples of RPM systems are voice apps that remind patients to take insulin and digital blood pressure cuffs through which patients can remotely send blood pressure and pulse readings to their physicians.

Robotic surgery: This is the process whereby surgeons attach small tools to a robotic arm, and control the arm, using a computer or console, to perform more complex procedures with better flexibility, precision and control than more traditional methods. It is usually associated with minimally invasive surgery, though it can be used in traditional open surgical procedures. Robotic surgery with the da Vinci Surgical System was approved by the FDA in 2000 and has now been adopted widely in the US and Europe. The benefits of robotic surgery include reduced pain and discomfort, faster recovery time, smaller incisions and reduced blood loss. Electronic data collection is expected to improve over time, with the robotic surgery industry likely to benefit from increased surgical volumes and healthcare systems globally becoming more focused on value for money.

Sleep tech: This refers to technology that helps improve sleep, including snooze-inducing headphones, smart pillowcases and sleep monitoring apps. Public awareness around sleep has increased, and academic research suggests that a lack of sleep among the US working population is costing the economy up to $411bn a year. This equates to 2.28% of the country's GDP according to RAND Europe (*2016*). Sleep technology is moving from simply telling people how long they have slept to performing more sophisticated, personalised functions such as monitoring the heart rate and blood pressure, in order to better inform users about the reasons they don't sleep enough. Examples of sleep technology include the Nokia Sleep sensor, which acts as a light switch, sleep tracker and blind opener, and Philips-owned NightBalance, which improves body positioning in bed.

US healthcare reform: Unlike other western economies, the US does not have a universal healthcare program and thus most people in the US have health insurance. The US is known for over-spending on healthcare, spending 18% of its GDP on healthcare in 2016 (vs. 11% in Germany). The funding is also inefficient, with a study published in *The Journal of the American Medical Association* concluding that 20-25% of US healthcare spending, equivalent to about 4% of the country's entire GDP, is simply wasted. Healthcare continues to be a key issue in the US presidential elections. Whilst Obamacare (2010 Affordable Care Act) reduced the number of people that were uninsured, rising costs continue to be a key area of concern, with the Republicans wanting to repeal Obamacare.

Wellness economy: This global industry, worth over $4 trillion in 2018 as estimated by the Global Wellness Institute, enables consumers to incorporate wellness lifestyles and activities into everyday life. The wellness ecosystem is made up of the following essential components: personal care, beauty & anti-aging, healthy eating, nutrition & weight loss, wellness tourism, fitness & mind-body, preventive & personalised medicine, traditional & complementary medicine, wellness real estate, spa economy and workplace wellness. As chronic disease, unhappiness and stress are on the rise, priorities are shifting and people are refocusing their attention on wellness. Since external factors play an important role in our health and longevity, these factors are being addressed through wellness goods and services.

Energy & Environment

Air pollution: Air pollution is a mix of particles and gases that can reach harmful concentration, both outside and indoors, according to the National Geographic. Air pollution is a major environmental risk to health, having been linked to higher rates of cancer, heart disease, stroke and respiratory diseases such as asthma. In addition to outdoor pollution, indoor smoke from household air pollution is also a serious health risk. According to the WHO, nine out of ten people are breathing in air that contains a significant amount of pollutants. The 2005 WHO Air quality guidelines offer global guidance on thresholds and limits for key air pollutants that pose health risks. The guidelines indicate that by reducing particulate matter (PM10) pollution from 70 to 20 micrograms per cubic metre (μg/m), air pollution-related deaths could fall by c. 15%.

Biodiversity loss: Biodiversity loss refers to the decrease in biodiversity within a species, an ecosystem and geographic area. Deforestation, poaching, industrial farming, climate change and pollution are some of the key primary drivers, which are ultimately influenced by human population growth, increasing consumption and reduced resource efficiency. According to the UN, this loss in biodiversity has deep rooted negative effects, threatening the achievement of eight SDGs related to poverty, hunger, water, cities, climate, land, oceans and health. Goal 15 particularly aims to combat biodiversity loss, as up to one million plant and animal species face the threat of extinction due to this biodiversity crisis. Mining and the energy sector have significant negative impacts on biodiversity, as poorly managed operations can pollute the environment.

Biofuels: Oil price spikes and global efforts to combat climate change have increased the urgency to find clean alternative fuels. Biofuels are a renewable energy source, made from organic matter or wastes (e.g. corn, sugar, vegetable oils or waste feedstock). To date, biofuels have not been able to compete with conventional fuels in terms of price and scale, however to meet the International Energy Agency's sustainable growth targets, global biofuel output must increase threefold by 2030. According to the IEA, sustained annual biofuel output growth of 10% is needed to meet its Sustainable Development Scenario consumption, and current production is falling short. Recently the EU revised its Renewable Energy Directive (RED) in an effort to ensure the biofuels being promoted are based on wastes and residues, and not food crops such as rapeseed, soy, or palm oil – palm oil's greenhouse gas emissions are the highest of all biodiesels.

Barclays Research: *Impact Series: Oil in 3D: the demand outlook to 2050 (7 May 2019)* and *Utilities: Net Growth from Net Zero (3 February 2020)*

Carbon capture & storage: Carbon capture & storage (CCS) technology can capture c.90% of CO2 emissions from fossil fuels, taking it out of the atmosphere. The CCS process includes capturing CO2, transporting it, and storing it safely underground, either in deep rock reservoir under the sea or in depleted oil and gas fields. CCS separates the CO2 from other gases using either oxyfuel combustion, or pre- or post-combustion capture. According to the Intergovernmental Panel on Climate Change, CCS helps to halve the cost of avoiding severe climate change. The EU aims to store 12bn tonnes of CO2 by 2050. Two risks of the CCS system are the threat of leakage post-storage and the costs. According to the Energy Technologies Institute, a delay in implementing CCS in its entirety by 2050 could double the annual cost of carbon abatement.

Barclays Research: *Utilities: Net Growth from Net Zero (3 February 2020)*

Carbon pricing: This refers to the cost placed on carbon pollution in order to encourage polluters to reduce their greenhouse gas emissions. The aim of carbon pricing is to make polluters internalise the costs of their carbon emissions, which would otherwise not be captured. Carbon pricing also raises funds that can be used to finance climate change

mitigation and adaptation measures. Countries' governments either levy a carbon tax on the use, distribution or sale of fossil fuel, or they may require companies to operate under a quota system. Companies are given a fixed, capped total of allowable emissions, and can trade permits, creating a market for pollution. Concerns have been raised about whether the existence of carbon pricing in certain regions shifts carbon-intensive activities to regions and countries without carbon pricing mechanisms. To address this concern, the EU is looking to implement a carbon border tax which would impose a levy on carbon-intensive products made in regions without carbon pricing policies.

Barclays Research: *Sustainable & Thematic Investing – (E)mission (Im)possible: A guide to embedding carbon pricing in investment decision (2 April 2019)* and *Utilities: Net Growth from Net Zero (3 February 2020)*

Circular economy: According to WRAP, a circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. This new economic model seeks to decouple global economic developments from finite resource consumption, with the Ellen MacArthur Foundation estimating the circular economy could generate $4.5 trillion in new economic output by 2030. A circular economy distinguishes between technical and biological cycles. The technical cycle involves the management of stocks of finite materials, while the biological cycle encompasses the flows of renewable materials. Goal 12 of the 2030 Agenda for Sustainable Development also promotes the building of a circular economy by 2030.

Barclays Research: *Sustainable & Thematic Investing – Plastic Bottles: Reinventing for the circular economy (2 October 2019)*

Clean water & sanitation: This refers to poor water quality and inadequate sanitation which negatively impacts food security, health and educational opportunities for poor families around the world. Today, 2.2bn people lack access to safely managed drinking water services and 4.2bn people lack safely managed sanitation services according to UNICEF and the World Health Organisation. Goal 6 of the 2030 Agenda for Sustainable Development aims to ensure that water and sanitation are sustainably managed and available for all by 2030. In 2017, the World Bank said countries need to quadruple spending to $150 billion a year to deliver universal safe water and sanitation, helping to reduce childhood disease and deaths while boosting economic growth.

Barclays Research: *Impact Series: The water challenge: preserving a global resource (22 March 2017)*

Climate migration: This refers to the movement of people between geographical locations due to the consequences of climate change. This includes temporary moves due to displacement by climate-related disasters, forced permanent migration due to recurring disasters, forced migration to avoid gradual environmental deterioration, and voluntary migration. An example of the link between climate change and migration is Bangladesh, where vast numbers of people in coastal farms are leaving for urban areas, in order to avoid storm surges and sea-level rises. By 2050, 200 million people, one in every 45, could be climate migrants according to The International Organisation for migration (2008).

Deforestation: Deforestation is the permanent destruction of forests in order to make the land available for non-forest purposes such as for roads and agriculture. Forests currently cover about 30% of the world's landmass, with tropical rainforests particularly targeted. According to the UN's FAO, 18 million acres of forest (roughly the size of Panama) are lost each year. Common methods of deforestation include burning trees and clear cutting. It is widely considered as one of the contributing factors to climate change given uprooted trees release carbon dioxide into the air. Given that 1.6 billion people globally depend on forests for

their daily subsistence and livelihood, and forests absorb 2.4 billion of CO2 emissions annually, which is a third of the CO2 emissions from burning fossil fuels, deforestation poses significant risks for the health and wellbeing of the global population (Source: *International Union for Conservation of Nature*). Solutions to deforestation include erosion control, natural forest regeneration, reforestation and additional regulation on land-use planning.

Distributed power: Distributed power systems are a decentralised electrical and mechanical power system, through which distributed generators can satiate local power demand across the network. This is particularly useful: in the case of remote regions, for customers with high reliability requirements, and to help bear the burden of supplying power during peak demand periods. The challenge of electrification in many sub-Saharan African markets has boosted the demand for distributed power options, and, as fuel options become more diverse, distributed power technologies have become key drivers of decentralised power systems. This is an important step towards meeting Goal 7 of the 2030 Agenda for Sustainable Development, which is universal access to affordable electricity.

Energy poverty: According to the European Commission (*2016*), energy poverty can be defined as a situation where a household or an individual is unable to afford basic energy services (heating, cooling, lighting, mobility and power) to guarantee a decent standard of living due to a combination of low income, high energy expenditure and low energy efficiency of their homes. Being affected by energy poverty can have severe implications for social inclusion and quality of life. Around the world, 3.8 billion people still cook with solid fuels, such as wood, charcoal or other forms of biomass, on traditional open stoves. Of these people, 1.9 billion live in Asia, making up around half the region's population. Goal 7 of the 2030 Agenda for Sustainable Development is to ensure universal access to modern, reliable, safe energy by 2030.

Energy storage: This refers to utility-scale batteries or thermal stores which allow the capture of heat or electricity when it is readily available, typically from a renewables system, and save it until a time when it is required. Energy storage systems provide a wide range of technological approaches to managing our power supply in order to create a more resilient energy infrastructure and bring cost savings to utilities and consumers. According to the Energy Storage Association, there are five main categories: batteries; thermal; mechanical storage; hydrogen; and pumper hydropower. Declining battery costs and an increase in renewable energy targets are accelerating the adoption of utility-scale energy storage.

Barclays Research: *Utilities: Net Growth from Net Zero (3 February 2020)*

Fracking: Fracking, also known as hydraulic fracturing, is the process of recovering gas and oil from shale rock by drilling down into the earth, after which high-pressure water, sand and chemicals are directed at the rock to release the gas. Given the oil and gas is found in the rock formations called shale, these fuels are usually called shale oil or shale gas. The benefit of fracking is that it enables access to oil and gas that would otherwise be difficult to reach. However, the considerable environmental costs fracking incurs, including the cost of transporting the large amounts of water needed for the process, and earth tremor concerns, make this a controversial method. While the US leads the way, the future of fracking in other countries is heavily intertwined with political uncertainty.

Land degradation: Land degradation occurs when multiple forces, such as extreme weather conditions and human activities, pollute the quality of the soil, degrading land utility and thereby negatively affecting food production and reducing biodiversity. Land degradation is happening at an alarming pace; globally c.25% of the total land area has been degraded. When land is degraded, soil carbon and nitrous oxide is released into the atmosphere, making land degradation one of the most important contributors to climate change, according to the

Global Environment Facility. Globally, 3.2bn people are affected by land degradation, especially rural, poor communities.

Natural resource scarcity: The pressures of population growth, economic growth and climate change highlight that there are insufficient resources to support the current model of production and consumption. Natural resources include freshwater, minerals, oil, natural gas and coal. In this context, scarcity could lead to a number of potentially destabilising social effects, including lower agricultural production, economic stagnation, resource migration and weakened governing institutions according to the US's Population Reference Bureau (*2001*). A wide range of industries (e.g. energy, mining, extraction, industrials and transport) are developing clean alternatives, with the shift to geothermal energy reducing our reliance on coal, for example.

Nuclear power: Nuclear power plants use low-enriched uranium fuel to produce electricity through a process called fission – the splitting of uranium atoms in a nuclear reactor. The energy released during this process releases heat, which powers steam generators to clear electricity. It is often referred to as 'clean energy', given it doesn't produce greenhouse gases when electricity is generated. Additionally, because nuclear power plants don't burn any materials they produce no combustion by-products, which helps protect air quality and mitigate climate change. However, nuclear reactors are expensive, complicated to build and environmental concerns arise when decommissioning a plant. Currently, nuclear energy supplies 12% of the world's electricity and c 20% of the energy in the US according to *General Electric*.

Ocean economy: The ocean economy, commonly referred to as the blue or maritime economy, is broadly defined as all economic activities related to or based in/on the seas, oceans, or coasts. The six key sectors within the ocean economy are marine living resources, maritime transport, port activities, marine extraction of non-living resources, shipbuilding and repair, and coastal tourism. The main activities include offshore wind, fish processing, marine aquaculture and capture fisheries. According to the OECD, the gross value of global ocean-based industries could double, increasing from $1.5 trillion currently to $3 trillion by 2030. As terrestrial reserves become depleted, the ocean economy is of increasing importance especially given the ocean's vital role in sustaining human life; over 3 billion people are dependent on the oceans for their livelihoods. However, the ocean economy also faces a number of challenges including acidification, overfishing, climate change, pollution. In efforts to make the ocean economy sustainable, Goal 14 of the 2030 Agenda for Sustainable Development calls for sustainable use and conservation of the seas, oceans and marine resources, and given the vast scale of the ocean economy, a multifaceted, integrated approach to managing it is necessary.

Plastic alternatives: Global annual plastic production is at 348 million tons, and its biggest use is in packaging. The BBC's 'Blue Planet II' documentary in 2017 highlighted the staggering eight million tons of plastic a year that ends up in our seas, harming marine life such as sea turtles and albatross chicks. Since then, the 'Blue Planet effect' has driven increased consumer awareness. Consumers are now applying increasing pressure to large multinational companies to find replacements for plastic, in order to combat climate change. The production of plastic straws, stirrers and cotton buds has recently been banned in the EU. We expect to see an increase in single-use plastic bans globally and even plastic packaging taxes in some regions. Though single-use plastic could be banned, which could prompt a transition to using more traditional materials such as aluminium and glass, or innovative alternatives such as seaweed, there are also other many possible future uses for plastic.

Barclays Research: *Sustainable & Thematic Investing – Plastic Waste: Don't lose your bottle (19 June 2019)*

Renewable energy: This refers to the energy that can be produced from a broad range of alternative sources, including solar, hydro, wind, geothermal, tidal and biomass. As climate change intensifies, and society clamps down on industries that are more prone to fossil fuel emissions, the demand for renewable alternatives to source energy from has increased. The EU has set key targets for its 2030 climate and energy framework, which include a minimum of: 40% cuts in greenhouse gas emissions, 32% share of final energy consumption from renewable energy, and 32.5% increase in energy efficiency. According to the International Energy Agency, offshore wind could potentially meet 11 times the world's electricity demand by 2040, and by 2030, the global average cost of power offshore wind generates could drop by 40%.

Barclays Research: *Global Energy: Rewarding low carbon (7 Nov 2019)*

Smart grid: The 'electric grid' is the network of transmission lines, transformers, and substations that deliver electricity from a power plant to homes and businesses. The current electric grid is being stretched to capacity, prompting the development of a new system that can handle the demands of 21st century electricity consumption. Smart grid technology meets these needs by allowing for two-way communication between the consumer and the utility provider, which enables swift responses to quickly changing demand for electricity, or emergencies. The technology will boost the efficiency and reliability of the energy industry. This is particularly important given the large impact electricity disruptions can have on central aspects of daily life such as banking, traffic and security.

Smart meters: Smart meters are self-reading gas and electric meters that inform users how much they are spending on energy. Smart meters are designed to connect to the national network remotely. According to the Energy and Clean Growth Minister in the UK, Claire Perry, the smart meter has the potential to save £1.2 billion per year off energy bills, which on average implies an annual household saving of £47. The UK government would like at least 85% of homes to have smart meters installed by 2024.

Sustainable food systems: Food systems include all the interlinked value-adding actors and activities involved in the aggregation, processing, production, distribution, disposal and consumption of food products, and they originate from agriculture, fisheries or forestry. A sustainable food system ensures the provision of nutrition for all is profitable, broadly benefits society, and has a positive or neutral effect on the environment. This concept is fundamental to achieving the SDGs' call for achieving food security and ending hunger by 2030, as seen in Goal 2. Current challenges to food systems include the wide consumption of low-nutritional, high-calorie food, increased food loss and waste, animal and human health challenges, reduced access to viable markets for small-scale producers, and a higher ecological footprint tied to the industrialisation of food supply chains. All stakeholders in food systems, including local, regional, and global public and private actors, are responsible for trying to achieve sustainability. Promoting food system sustainability can positively impact on workers' salaries, profits to asset owners and entrepreneurs, government tax revenues, consumer benefits, and the socio-cultural and natural environment.

Barclays Research: *Sustainable & Thematic Investing – Food Waste: Ripe for change (4 March 2019)*, *Sustainable & Thematic Investing – Insect Protein: Bitten by the bug (24 June 2019)*.

Synthetic trees: Plants aid in the fight against climate change by absorbing carbon dioxide, and using it to grow branches and leaves. However, especially with increasing deforestation and carbon emission, trees are having to work overtime to soak in this carbon dioxide. Synthetic trees offer a solution through the use of artificial photosynthesis technology, which imitates the natural photosynthesis process, but turns the carbon dioxide and water into carbon-rich products such as alcohol (scientists are calling for 'artificial trees' to fight climate change). The artificial nature of these trees makes the process more efficient than natural

photosynthesis, allowing for higher conversion efficiencies. These can be especially useful in areas where the soil is too shallow to hold traditional trees.

Waste management: According to the World Bank, global waste is expected to grow by 70% to 3.4 billion tonnes by 2050, unless waste is promptly adequately managed. This growth is driven by increasing urbanisation and the growing world population. Waste management offers a solution to this challenge, offering sustainable ways to manage, reduce and prevent waste, which is integral to building a circular economy. According to the London Assembly Environment Committee's waste hierarchy, the most important solutions within waste management are the prevention or reduction of waste, followed by reusing the item, recycling, or other methods of recovery such as incineration, and lastly, disposal of products. When managing waste, it is also important to design products to be reused and/or recycled. Over the past 20 years, the World Bank has committed more than $4.7bn to over 340 waste management programmes worldwide. Sustainable waste management has a positive effect on the environment, as it works towards decreasing the vast amounts of global emissions that come from waste mismanagement: in 2016, waste mismanagement contributed to 5% of global emissions.

Barclays Research: *Sustainable & Thematic Investing – Plastic Waste: Don't lose your bottle (19 June 2019)*

Society & Culture

Ageing population: This refers to the significant, inevitable growth in the number and proportion of older members in the global population, due to life expectancy improvements and decreases in fertility. The pace of population ageing is much faster than in the past. By 2020, the number of people aged 60 years and older will outnumber children younger than 5 years, according to the World Health Organisation. In addition, the number of people at extreme old age – ageing within ageing – is also increasing. By 2030, there will be 34 'Super-Aged' countries; where more than 1 in 5 people are age 65+. This includes the US, UK, France, Germany, Japan, Spain and Canada. This social transformation will likely impact the labour and financial markets, and the demand for goods and services such as housing, healthcare, social care and transport.

Barclays Research: *European Healthcare Real Estate: Debunking the 'Silver Tsunami' (3 Dec 2019)*

Africa rising: This phrase refers to Africa's strong economic performance and increasing political stability. Changing demographics and improving business environments are contributing to infrastructure investment, urbanisation, economic prosperity and rising household consumption. By 2030 one in five people will be African; seven countries – Nigeria, Ethiopia, the Democratic Republic of Congo, Egypt, Tanzania, Kenya and South Africa – will soon account for half of the continent's population. Africa's leapfrogging opportunity has meant sentiment in recent years has shifted from aid to investment; however, it does come with various societal challenges given mobile phones are now more common than access to electricity and piped water.

Civil unrest: We define civil unrest as the intentional public disturbance or disruption in response to an event or decision, which can include violent protests, arson and looting. Key examples of civil unrest include: Extinction Rebellion protests on climate change, the Ferguson unrest in the US following the killing of an unarmed black teenager, the Yellow Vest movement in France, the Chilean protests over transport costs and the pro-democracy protests in Hong Kong. According to Reuters (*October 2019*), the spread of street protests and civil protests looms large on the radar of financial markets given the resulting pressures on stretched government finances. This may impact sectors heavily reliant on public funding including healthcare, education, security and defence.

Barclays Research: *European Energy: Thoughts live from Extinction Rebellion protests (9 October 2019)*

Competition for talent: The competition for talent is expected to intensify as factors such as demographic change and technology continue to reshape the workforce. According to *Mercer's 2019 Global Talent Trends Study*, 97% of executives expect to see increased competition for talent over the next 12 months. More than half of the executives were from high-growth companies, highlighting the growing need for companies to position themselves as an employer of choice. Within human capital risk, the key issues include attracting and retaining talent, managing performance, developing leadership roles and creating appropriate reskilling and upskilling initiatives. Migration of talent now plays an important role in shaping skilled labour forces throughout the OECD area.

Consumer-to-Consumer (C2C): The Consumer-to-Consumer (C2C) business model facilitates commerce between private individuals, enabling transactions without needing a middleman. The use of third-party internet and social media sites, often referred to as marketplaces, promotes the ease of C2C transactions. Examples of C2C platforms include: Amazon, eBay, Depop, Facebook Marketplace, Gumtree and Etsy. The C2C market is expected to grow in the future because of its cost-effectiveness; the cost of using third parties is declining and the number of products is also increasing.

Crowdsourcing: This is the use of a distributed labour force, usually of freelance workers, through digital channels, to complete a piece of work. As competition for talent intensifies, crowdsourcing offers a flexible solution, providing easy access to new talent. Crowdsourcing also boosts efficiency, as big projects can be broken out and distributed to multiple teams to complete in a shorter timeframe. It is also cost-efficient – it can increase productivity by up to 9%, while simultaneously reducing costs by up to 7% (Source: *McKinsey*). To use crowdsourcing efficiently, companies must understand which tasks and platforms are best-suited for crowdsourcing.

Cyberterrorism: According to the US Federal Bureau of Investigation, cyberterrorism is any "premeditated politically motivated attack against information, computer systems, computer programs and data which results in violence against non-combatant targets by sub-national groups or clandestine agents." The likelihood of cyberterrorism is likely to increase as the number of connected devices grows, opening up the possibility for targeted attacks carried out remotely and potentially across borders. Cyberattacks can overlap with cyberterrorism but there are several key differences. Firstly, cyberterrorism is not necessarily a response to an action, but rather planned and orchestrated due to a political motivation. Similar to terrorism, the goal of cyberterrorism is to gain attention and cause mass panic and fear amongst society; however, this is conducted via the internet rather than physical means.

Deglobalisation: Recent political developments are threatening to reverse globalisation, with various anti-globalisation movements in the West including the US-China trade wars and Brexit in Europe. Globalisation has entered a critical phase, with ongoing economic disruption, more protectionism and nationalism making many countries and individuals around the world re-examine the benefits of globalisation. This has been further exacerbated by the shift economically from the developed to the emerging world, given the previous trade agreements were predominantly West-driven. In addition, illegal mass migration has also fuelled rising inequality in society, which has consequently led to a populist cultural backlash in certain parts of the world. This decoupling between regions could cause business cycles to become less correlated, which could negatively impact economic growth.

Barclays Research: *The politics of rage (2 March 2017)*

Digital influencers: This refers to an individual who uses their knowledge, following, and relationship with their audience to affect purchasing decisions; these influencers can range from industry experts, to bloggers, to celebrities. As brands attempt to engage with an increasingly diverse consumer base, 'digital' celebrities, influencers on social media platforms such as Instagram, YouTube and Vine, act as a middle party through which brands can connect with their target communities. They build relationships with brands, and are often paid to promote goods and services through the digital platforms on which they operate. With the increasing importance of social media in the past ten years, we have seen an increase in the role social media influencers play in brand advertising for large multinational companies – according to Traackr, an influencer management platform, 72% of major brands are dedicating a significant proportion of their marketing budget to influencers.

Diversity & inclusion: This refers to the recognition, empowerment, and granting of access to all human beings from all ethnicities, genders, gender identities, sexual orientations, ages, social classes, religions, physical abilities or attributes, national origins, political beliefs and ethical values systems. Companies' consideration of diversity & inclusion is not only important on the basis of values, it also has a material impact on their long-term performance, as a diverse workforce can drive innovation, and enable companies to stay ahead in the competition for talent. This is evidenced by a BCG study which found that the innovation generated by having a diverse management team increased revenues by 19 percentage points. As multicultural buying power increases, companies are needing to recognise and provide products and services for the increasingly diverse consumer base; for example, the

demand for gender-neutral goods/services, rising obesity levels and an increase in body positivity movements have led to an increase in plus size consumers. In order to engage and connect with the diverse consumer population, brands must consider multicultural marketing, and some brands are using digital influencers to achieve this.

Emerging middle class: According to the *World Data Lab*, which defines a middle class person as someone who earns $11 to $110 a day using a 2011 purchasing power parity basis, the number of middle class members of the global population is projected to increase to 5.3bn by 2030, from 3.59bn in 2018. With this rise in the middle-class population comes increasing demand for quality, as opposed to simply requiring basic needs. Discretionary expenditure is likely to increase, benefiting leisure, financial services, personal products and transport. Increased consumption by the new middle class also has wider implications for competition for resources such as food, energy and oil. This is likely to drive a rise in lifestyle-dependent diseases such as obesity and diabetes, putting more pressure on public health-care systems.

Environmental protection: This encompasses the protection of the environment, sustainable natural resources, biodiversity, ecosystem and water. Preservation of natural resources is essential for sustaining the community, and Goal 12 of the UN's 2030 Agenda for Sustainable Development aims to ensure that global material consumption does not cause the over-extraction or degradation of environmental resources. Initiatives to meet the Goal 12 by 2030 are likely to affect Energy, Transport, Utilities, and Retail.

Fake news & misinformation: This refers to news or stories created to deliberately misinform or deceive readers. Fake news is now seen as one of the greatest threats to free debate and democracy, with its relevance having increased in post-truth politics following President Trump's 2016 election victory. Going forwards, the ability to identify fake news & misinformation will become ever more crucial, as information created via AI bots is likely to further spread the breadth and capabilities of fake news and misinformation. According to YouGov (*2019*), the average trust in the news is down, as public concern about misinformation remains extremely high.

Gig economy: Broadly defined, the term 'gig economy' refers to non-standard work arrangements that are shorter-duration and/or not payroll-based e.g. freelance. It spans from Lyft, Task Rabbit and Instacart to babysitting and dog walking. Gig economy workers typically do not have benefits (health insurance, pensions, etc.). In addition, the contractor is paid on a per task basis; the gig economy monetises a worker's time, skills, or the value of possessions (e.g. car for ride hailing); and the contractor can choose how much and when to work. The technology platform that allows employees to string together more consistent employment causes it to be viewed differently than contract work in prior decades. Though very similar, the difference between the gig-economy and zero-hour contracts is that gig roles are usually paid at a set rate, per job, whereas zero-hour contracts don't usually have a set minimum, they are simply paid per hour.

Barclays Research: *Gig economy employment – A potential problem for Retail/Consumer: Why gig when you can work (23 April 2019)*

Global tax reform: The tax debate is continuing to evolve: it is no longer a question merely of whether companies are paying enough tax, but of how companies are taxed. Ongoing work by the OECD on base erosion and profit shifting ('BEPS'), shows how globalisation is changing tax regimes. Additionally, location-based taxes are on the rise, as exemplified by the emergence of digital service taxes. There are many permutations of what the future international tax landscape could look like, with robot taxes seen as a possible way to manage the rise of industrial robotics.

Barclays Research: *Sustainable & Thematic Investing – Future of tax: The need to be lean, green and employing machines (24 October 2018)*

Industry 4.0: The fourth industrial revolution, also referred to as Industry 4.0, refers to the new phase in the industrial revolution that focuses heavily on industrial technology. It is an umbrella term that refers to changes across the entire value chain; utilising real-time data, AI-powered insights and automation. According to *Siemens*, this could increase product quality and improve speed-to-market through pre-production visual testing. AI-assistance and data-driven planning will also offer companies new ways to improve production cycles and factory efficiency. Barriers to adoption include concerns over data ownership, lack of in-house talent/knowledge, insufficient funding and management inertia.

Barclays Research: *Israel Emerging Technology: Start-Up Nation Vol 1: Industry 4.0 (7 October 2019)*

Lifelong learning: This refers to a form of self-initiated education that is focused on personal development beyond formal education such as schools and university. Society will be under greater pressure to embrace lifelong learning in the future, driven by the longevity economy (e.g. ongoing life expectancy gains) and Industry 4.0. The OECD estimates that 38-42% of the UK population will need to completely retrain in the next ten years to be able to stay employed. We see education technology playing a large role, with education-on-demand companies proving popular in mobile format. The benefits of skill development and lifelong learning will spread across society; however, it does raise questions about the appropriate form and level of learning provision by the individual, employer and the state, according to the UK Government's report on Future of Skills & Lifelong Learning (*2017*).

Barclays Research: *Sustainable & Thematic Investing – Education Technology: Out with the Old School (12 March 2019)*

Malnutrition: Malnutrition occurs when a person's diet does not include the correct amount of nutrients. This could either be under-nutrition, not consuming enough nutrients, or over-nutrition, which entails getting more nutrients than needed. Malnutrition is a major driver of death and disease worldwide, exacerbated by inequalities in access to food of sufficient quality and quantity. Goal 2 of the 2030 Agenda for Sustainable Development, 'Zero Hunger', focuses on changing the global food and agriculture system to enable better food security, thereby enabling the nourishment of the 815 million people who are hungry today, and the 2 billion expected to be undernourished by 2050. According to the World Health Organisation, c. 45% of deaths among children under 5 years of age are linked to under-nutrition, occurring in low- and middle-income countries.

Mass migration: This refers to the movement of a large number of people between geographical areas. The number of people globally living outside of their country of birth shows an upward trend, according to the Legatum Institute (*2018*), from 173 million in 2000 to 258 million 2017. While conflict is a well-recognised cause of migration, higher levels of socioeconomic vulnerability and climate insecurity are also key contributing factors. Modern transportation has made migration more accessible, with 67% of all international migrants in 2017 residing in just 20 countries (US, Saudi Arabia, Germany, the Russian Federation and the UK). Despite the significant benefits of migration, some migrants remain among the most vulnerable members of society. We have also seen dissent and the rise of the far right, especially as countries struggle to cope with the economic pressures of mass migration (e.g. US/Mexico – Trump Wall).

Microfinance: This is broadly defined as a source of banking for low-income individuals and small and medium-sized businesses, which provides financial products such as savings accounts and loans to members of the global population with limited access to traditional financial services – sometimes referred to as the 'unbanked'. In addition to the financial return microfinance aims to generate, it can also make a positive impact by encouraging the sustenance of small and medium-sized businesses, which can help to eradicate global

poverty, working towards Goal 1 of the 2030 Agenda for Sustainable Development. Microfinance also champions financial inclusion, boosting access to loans for women, thereby supporting the achievement of Goal 5 of the 2030 Agenda for Sustainable Development.

Modern warfare: Relative to previous military concepts, this refers to concepts and methods that incorporate emerging technologies and preserve battle-worthiness, including biological, chemical and digital/smart warfare. According to Science Direct, biological warfare is defined as the use of pathogens or toxins against human, animal or plant populations by a state or sub-state actor to achieve military aims (*2016*). In recent years, we have also observed the emergence of 'smart' warfare, which can include missiles outfitted with a laser, television or satellite steerage system that can be remotely controlled to a specific target. Autonomous weapons systems are often considered when discussing the risks associated with the ongoing development of AI and 5G technology.

New superstate (e.g. United States of Europe): A superstate is defined as a powerful nation or governing body that has power over its subordinated states. In recent years, the idea of an EU superstate has been discussed separately by a variety of high-profile European leaders. For example, in 2018 German chancellor Angela Merkel called for the creation of a "Real, true" European Army. The impact of Brexit on the European Union will likely result in social and economic change, with the potential for longer-term political and institutional shifts which may or may not influence the hypothetical concept of the *United States of Europe*. Separately, the African Union continues to discuss whether pan-continental integration will help the continent on its future economic pathway.

Next-gen workforce: With baby boomers retiring, Millennials and Generation Z will make up the majority of the workforce by 2030 and are already reshaping the future of the workforce. Having experienced vast political, economic, social and technological change in their relatively short lives, Generation Z are bringing a new set of behaviours, expectations and preferences into the workplace. This next-generation workforce therefore tends to be rather entrepreneurial, and interested in freelance work and 'side-hustles', including online opportunities. The next-gen workforce also has an increased desire for work-life balance, values learning and development, values diversity and inclusion as well as employers with strong sustainability policies. They expect workplaces to adapt and are prepared to move for a better workplace experience.

Barclays Research: *Sustainable & Thematic Investing – Generation Z: Step aside Millennials (28 June 2018)*, *Global Catering: Catering in a delivery world (6 September 2019)*

Obesity: Obesity describes abnormal or excessive fat accumulation, that increases health risks such as mortality, hypertension, type 2 diabetes, strokes, coronary heart disease, mental illness, and gallbladder disease. As the modern lifestyle involves more cheap, high-calorie food, and more time sitting down at desks, in cars and on sofas, obesity is an increasingly prominent issue. Between 1975 and 2016, global obesity nearly tripled, according to the World Health Organisation, and 250 million children are projected to be obese by 2030, up from the current 150 million.

Shifting economic power: According to the European Commission, a dramatic reversal of the West's historical rise since 1750 should materialise by 2030, leading to a diffusion of economic power and a movement away from having a small number of hegemonic power. This shift in economic power away from the West is driven by increasing economic growth in emerging economies, larger populations, and increasing technological investments. According to the Centre for Economics and Business Research, China's economy is forecast to surpass the US economy by 2029, and China is already the world's leading economy in purchasing power parity terms, according to the WEF. Additionally, economies such as

Indonesia and Mexico could surpass France and the UK by 2030 according to PWC. This has important business implications, in terms of both increasing the breadth of customers for existing companies, and the increased possibility of disruptors. Society is likely to see an influx of multinational corporations into emerging markets to engage with previously untapped markets, and we expect to see an increase in international competitors to challenge household names, as we have seen in the smartphone industry with the rise of Chinese brands such as Huawei.

Social credit system: This monitors a person's activity, analysing how many 'good' or 'bad' activities a citizen has engaged in, to calculate a social credit score based on which the citizen could be granted, or denied, access to rights, goods and services such as loans and travel. Launched in 2014, China currently has multiple social credit systems, including local government social record systems, and unofficial private versions operated by companies, such as the Alibaba-affiliated Ant Financial's Sesame Credit system, which analyses shopping habits. There is no fixed list of criteria, as the different systems monitor different activities, however examples of activities considered can include driving through a red light, not paying a fine, or causing a disturbance on public transport. The concept of a social score is also being implemented by private companies such as Uber, with its rating system influencing passengers' ability to travel, and life insurance companies, following the New York State Department of Financial Services' announcement that life insurance companies can use social media posts when calculating premiums.

Societal inequality: Societal inequality is the existence of unequal opportunities and rewards for different positions within society. Societal inequality can be related to differences in income, gender, ethnicity and age. Across the global economy, income inequality – the extreme concentration of wealth or income in hands of a small percentage of a population – is on the rise. According to Oxfam, 2018 was a year in which the rich grew richer and the poor poorer. The reports shows that the 26 richest billionaires own as many assets as the 3.8bn people who make up the poorest half the world population (*2018*). It said a wealth tax on the 1% would raise an estimated $418bn a year – enough to educate every child not in school and fund private healthcare that would prevent 3 million deaths. According to the House of Commons library, by 2030 the world's richest 1% will own two-thirds of the world's wealth by 2030.

Sustainable tourism: The UN's *World Tourism Organization* defines sustainable tourism as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities". We see the shift to sustainable tourism being driven by actions from three key stakeholders: consumers (slower transport methods, responsible travel options), policymakers (mandatory carbon offset schemes, frequent flyer taxes) and industry (boosting fuel efficiency, reducing waste in their operations). Collective action from these stakeholders will help push the industry towards a more sustainable future whilst remaining beneficial to economic development.

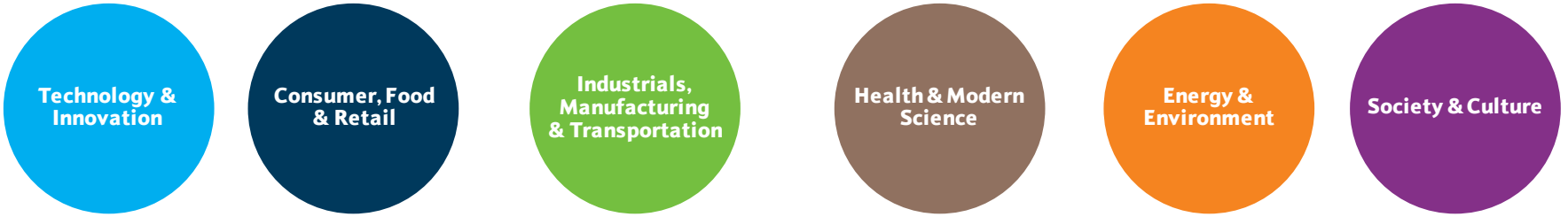
Barclays Research: *Sustainable & Thematic Investing – Sustainable Tourism: A worthwhile journey (4 December 2019)*

Urbanisation: This refers to the increase in the proportion of people living in towns and cities, due to the pull of better job and income opportunities. More than one half of the world's population lives now in urban areas, according to the United Nations, and virtually all countries of the world are becoming increasingly urbanised and thus changing the landscape of human settlement. The majority of this urban population growth will take place in Africa and Asia. By 2050, two-thirds of the world's population are projected to live in urban locations. This will put significant pressure on existing infrastructure, with governments

around the world needing to consider the impact this could have on economic development given increased competition for investments and talent.

Women's Empowerment: According to the *United Nations Population Fund*, this refers to the empowerment and autonomy of women and the improvement of their political, social, economic and health status. Empowering women and girls and thus achieving gender equality is a key focus area in the UN's SDG (*5: Gender Equality*), with a particular focus on providing equal access to education, healthcare, decent work and representation in decisions made regarding politics and economics. Various studies show companies benefit from increasing employment and leadership opportunities for women. These benefits include organisational effectiveness and growth. According to McKinsey, it is estimated that companies with three or more women in senior management functions score higher in all dimensions of organisational performance (*September 2009*).

FIGURE 56
2030 Thematic Paradigm: 150 trends



Technology & Innovation	Consumer, Food & Retail	Industrials, Manufacturing & Transportation	Health & Modern Science	Energy & Environment	Society & Culture
IoT	Sustainable packaging	Smart cities	Longevity tech	Carbon capture & storage	Ageing population
5G	Plant-based diets	Industrial robotics	AI drug discovery	Carbon pricing	Gig economy
eSports	Personalised marketing	High-speed rail	Antimicrobial resistance	Renewable energy	Industry 4.0
Artificial intelligence	Omnichannel retail	Electric transportation	US healthcare reform	Biofuels	Civil unrest
Digital ethics & privacy	Conscious consumer	Shared mobility	Robotic surgery	Climate migration	Cyberterrorism
Education technology	Experiential retail	Smart buildings	Personalised medicine	Energy poverty	Environmental protection
Cybersecurity	AgriTech	Battery technologies	Predictive healthcare analytics	Land degradation	Modern warfare
Geospatial technology	Sustainable fashion	Manufacturing/Construction Tech	AI radiology	Biodiversity loss	Deglobalisation
Digital payments & FinTech	Streaming economy	Overseas infrastructure investment	Personalised insurance	Natural resource scarcity	Urbanisation
Edge computing	HFSS food regulation	Micromobility	PAYG social care	Deforestation	Sustainable tourism
Data monetisation	Clean label & ingredient transparency	3D printing	Wellness economy	Sustainable food systems	Microfinance
Quantum computing	Cannabis	Advanced construction materials	Opioid epidemic	Energy storage	Shifting economic power
Smart homes	E-cigarettes	Textile & fabric innovation	Remote patient monitoring	Ocean economy	Emerging middle class
Blockchain	GM food	Connected industrial worker	3D bioprinting	Waste management	Women's empowerment
Voice recognition	Halal economy	Housing 2.0	Microchip implants	Fracking	Competition for talent
Augmented reality	Food-as-a-service	Space	DNA data storage	Smart grid	Crowdsourcing
Virtual assistants	Renting & sharing economy	Autonomous vehicles	Designer baby	Distributed power	Malnutrition
Service & delivery robots	Direct-to-consumer	Commercial drones	Medical tourism	Air pollution	Societal inequality
Wearable technology	Beverage innovation	Hydrogen fuel cell	Biohacking	Smart meters	Next-gen workforce
Dark web	Smart supermarkets	Supersonic travel	Myopia epidemic	Plastic alternatives	Consumer-to-Consumer
Virtual reality	Food waste	Localised manufacturing & micro-factories	Sleep tech	Nuclear power	Digital influencers
Digital twin	Personalised nutrition	Hyperloop	Cloning	Circular economy	Diversity & inclusion
Facial recognition	Cultured meat			Clean water & sanitation	Global tax reform
Cryptocurrencies	Vertical farming			Synthetic trees	Africa rising
Smart dust	Insect protein				Mass migration
	Digital detox				New superstate
	Meat tax				Lifelong learning
					Fake news & misinformation
					Obesity
					Social credit system

Source: Barclays Research

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In relation to our respective sections we, Hiral Patel, Emily Morrison, Anushka Challawala, Katherine Ogundiya, Ben McSkelly, Ryan Preclaw, Vincenzo Pota, Liujia Hu, Warren Ackerman, Arthur Reeves, Gaurav Jain, Andrew M. Gardiner, CFA, Emily Field, CFA, James Goodman, Sven Merkt, CFA, Corey Gayle, Shane McKenna, Lars Brorson, Lydia Rainforth, CFA, Sarah Wilkinson, Maurice Patrick, Mathieu Robilliard, Benjamin M. Theurer, Antonio Hernandez, CFA, Tim Long, Vicki Stern, Balaji Prasad, MD, Peter Crampton, Dominic Nash, Jose Ruiz, Mick Pickup and Andrew Ross, CFA, hereby certify (1) that the views expressed in this research report accurately reflect our personal views about any or all of the subject securities or issuers referred to in this research report and (2) no part of our compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this research report.

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