

The SusTech series

October 2021

Sustainability through technology

Technologies that mitigate sustainability challenges are likely to see long-lasting waves of growth, creating long-term investment opportunities.

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GREENTECH
Keeping it clean



HEALTHTECH
Healing health care's ailments



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All values in U.S. dollars and priced as of market close, Oct. 8, 2021 unless otherwise stated
Produced: Oct. 11, 2021 3:15 pm ET; Disseminated: Oct. 18, 2021 2:25 pm ET

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GLOBAL
Insight

The SusTech series

Over the past year, Global Insight has devoted its articles to the importance of sustainability from an investment perspective.

We have highlighted a number of technologies that have the potential to mitigate the challenges of the 21st century and help curb what we see as the greatest threats to the sustainability of the global economy. We refer to these developing technology solutions to sustainability issues as “SusTech.”

Some of these innovative technologies will likely enjoy secular growth, perhaps for decades, creating potentially compelling long-term opportunities for companies and shareholders alike.

Sustainability in business isn’t just about “doing good”—it’s about good business sense and the pursuit of wealth-creating strategies.

We have assembled all the sustainability-related articles published this year for your convenience.

We hope you enjoy this broad look at the SusTech opportunity.

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27 The FinTech future

In this fourth article in the SusTech series, we focus on FinTech, the convergence of finance and technology, which can help make economic growth sustainable by empowering unbanked populations. With the face of finance changing rapidly, we believe there will be investment opportunities in companies that effectively embrace the evolution.

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Today's realities and tomorrow's challenges are calling for new, technology-driven food production and distribution solutions spanning a range of activities from farm to table. In the fifth article in the SusTech series, we look at technologies that offer the promise of feeding a growing global population while limiting the burden on the environment.

43 Smart Cities, sustainable cities

With cities around the world facing increasing environmental pressures and infrastructure needs, the final article of the SusTech series focuses on metropolises that use high-tech solutions to manage the challenges of urbanization in the 21st century. As these Smart Cities enable urban sustainability, the companies and industries at the forefront of this transformation should see long-lasting channels of growth.



**Wealth
Management**



SusTech: Sustainability through technology

Sustainability in business isn't just about "doing good"—it's about good business sense. Technologies that mitigate the challenges of the 21st century are likely to see long-lasting waves of growth, creating long-term opportunities for companies and shareholders alike.



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A number of technologies have emerged to help make the world we live in more sustainable. More are on the horizon. Many are the result of innovations and will likely enjoy secular growth, perhaps for decades.

This report looks at the importance of sustainability from an investment perspective. It highlights some of the technologies and innovations that could help curb the greatest threats to the sustainability of the global economy. In our view, companies at the forefront of developing technology solutions to sustainability issues may offer compelling long-term investment opportunities.

Why sustainability as an investment theme?

Sustainability has become a key concern for companies and investors alike in recent years. It is understood that both can benefit if growth and profits are sustainable—not earned at the cost of the depletion of natural resources and the deterioration of human living conditions, nor at the expense of future generations. For companies, sustainability has ramifications beyond their main business activities—it may also encompass the way offices and places of business are located or configured, or the manner in which products are distributed.

A large majority of companies are now using their annual reports to speak to their progress on this front. The KPMG Survey of Sustainability Reporting 2020 found that out of a survey sample of the largest 100 companies by revenues in 52 countries, 80 percent reported on sustainability. Interestingly, the U.S. leads with 98 percent of its 100 largest companies reporting on sustainability, compared to 92 percent in Canada, 85 percent in Western Europe, and 84 percent in Asia-Pacific.

Investors approve. According to Morningstar, assets in sustainable funds hit a record high of \$1.7 trillion at the end of 2020, up from just under \$1 trillion a year earlier. The rapid growth was driven by a combination of record inflows, existing funds repurposed to make sustainability a major decision factor, and rising markets.

Making the world sustainable

In the March edition of Global Insight, we explored how [climate change](#) is one of the biggest threats to the sustainability of the global economy. Several other pressing challenges also need to be addressed to ensure we can continue to enjoy economic growth for decades to come. Among

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the most preoccupying threats to sustainability being discussed at the government and agency level are diminishing access to fresh water, the massive proliferation of waste from human activities, and the lack of social progress.

Access to fresh water has diminished greatly over recent decades. Agriculture consumes more water than any other activity, while inefficient manufacturing processes, storage, and transportation often result in waste. Climate change and industrialisation have also played their part.

According to the World Wildlife Fund, 1.1 billion people globally lack access to fresh water and as many as 2.7 billion experience water scarcity during at least one month of the year. The disastrous UK floods of 2015 and 2019, recent severe flooding in France and Italy, the prolonged disruption to shipping resulting from record-low water levels on Germany’s Rhine River in 2018, and the crippling flood in Houston, Texas in 2019 (one in a string of three “once-in-500-year” floods in the same region) all serve to remind us that this is not solely an issue confronting emerging markets.

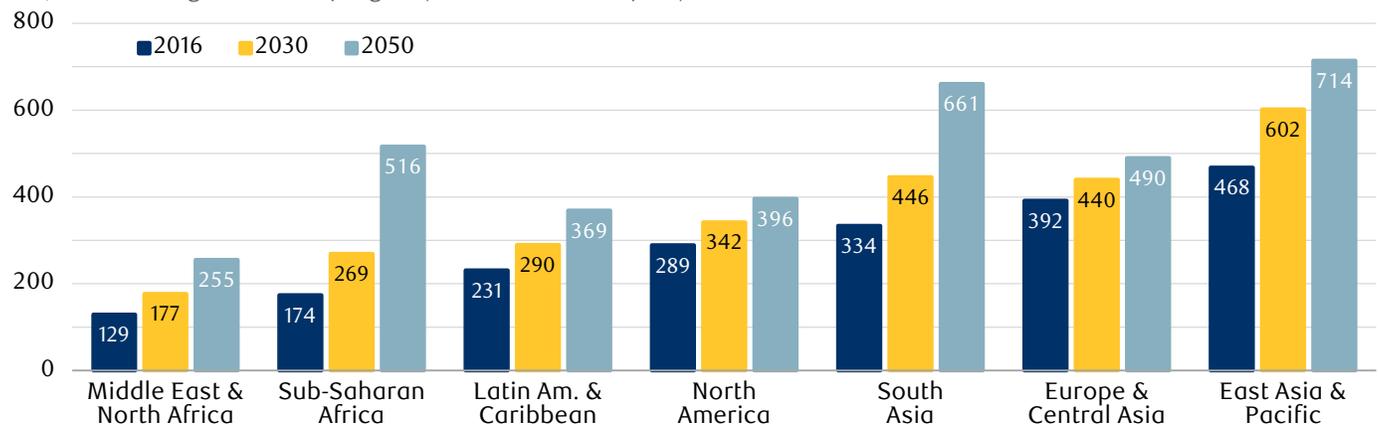
Water scarcity is also an acute problem for China’s growth. The country is home to 20 percent of the world’s population but contains just seven percent of its fresh water. Moreover, pollution limits the amount of available fresh water as 70 percent of lakes and rivers in China are polluted, according to the World Economic Forum (WEF).

The huge amount of waste the world generates each year is another growing threat to sustainability and global prosperity. According to the World Bank, two billion tonnes of solid waste, enough to fill over 800,000 Olympic-sized pools, was generated in 2016, the last year for which global figures are available. Of this, a mere 16 percent was recycled, with 46 percent disposed of in a manner which threatens the environment. Rich countries burn their waste, releasing greenhouse gases (GHGs), while others dump it in rivers and oceans. At the current rate, the WEF estimates that by 2050 plastics will outweigh fish.

Finally, there is a growing appreciation that a lack of social progress could also inhibit the global economy from realising its growth potential. Annual

Waste generation is set to increase in all regions by 2050, though at an accelerated pace in some

Projected waste generation, by region (millions of tonnes/year)



Source - World Bank

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global GDP growth slowed from an average of 3.8 percent over 1960 to 2000 to just 2.9 percent in the most recent decade. A March 2021 study by Bloomberg economists suggests that global GDP could see a \$20 trillion boost by 2050 if women were to enjoy the same levels of education and employment as men, relative to a baseline scenario of persistent gender inequality. Meanwhile, a Goldman Sachs study indicates that closing the 35 percent pay gap suffered by Black women in the U.S. could add \$300 billion to U.S. GDP per year, or 1.3 percent of the country’s \$21.4 trillion economy.

Technology can help

Our recent climate change article argued that tackling these challenges requires the dual involvement of governments (via regulation, incentives, and funding) and the private sector. Innovation and technology will play critical roles in creating solutions to make a more sustainable global economy. In our view, companies at the forefront of developing such solutions potentially offer compelling long-term investment opportunities.

We group these opportunities in five overarching themes:

- GreenTech (green technologies)
- AgriTech and FoodTech (agricultural technologies and food technologies)
- FinTech (financial technologies)
- HealthTech (health care technologies)
- Smart Cities

The table below shows how each can help tackle the threats outlined above.

SusTech technologies	Threats to sustainability			
	Climate change	Fresh water scarcity	Waste management	Lack of social progress
GreenTech	✓		✓	
AgriTech/FoodTech	✓	✓	✓	✓
FinTech				✓
HealthTech				✓
Smart Cities	✓	✓	✓	✓

Source - RBC Wealth Management

We will delve into each theme in more detail in Global Insight articles in coming months. We kick things off here with profiles of these topics.

GreenTech

Environmentally-friendly technologies which aim to reduce GHG emissions

Our climate change article looked at several emerging technologies used in buildings to dramatically cut fossil fuel consumption. We highlighted geoexchange technology, which takes advantage of constant subterranean temperatures to heat and cool structures.

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GreenTech also encompasses electric vehicles (EVs) and the ecosystem around them, including batteries, parts, and semiconductors. According to a Deloitte Insights report released in 2020, EVs accounted for 2.5 percent of new car sales globally in 2019. It expects EV sales to grow by an average of 29 percent per year over the next decade, with EVs constituting just over 30 percent of new car sales globally by 2030 thanks to a broader model offering, a reduction in battery costs, and greater access to affordable public and home charging infrastructure. Regional differences will emerge depending on governments' commitments to investing in EV infrastructure and offering cash and tax incentives. Deloitte expects EV sales in 2030 to account for 48 percent of domestic new car sales in China, 42 percent in Europe, and a more modest 14 percent in the U.S.

Other GreenTech industries include wind farms and solar power, and the development of batteries to store the power generated by these intermittent sources of energy—*the wind doesn't always blow and the sun doesn't always shine*—while comparatively the demand for electricity is more constant. Wind energy accounted for some 8.8 percent of total electricity generation in the U.S. in 2020, according to the U.S. Energy Information Administration (EIA), while solar energy contributed a lesser 2.3 percent. Together they provided some 10 percent of all electricity generated in the U.S. The EIA predicts the share of all renewables (i.e., including hydro) in the U.S. electricity generation mix will double from the current 21 percent to 42 percent by 2050, with wind and solar driving much of that growth.

Hydrogen, another key aspect of GreenTech, could potentially help meet a non-negligible 14 percent of U.S. energy demand by 2050, according to the Fuel Cell & Hydrogen Energy Association. While much of the attention garnered by hydrogen has focused on transportation applications—cars, heavy trucks, locomotives, ships, even planes—a number of technological hurdles to realise that potential still need to be cleared. However, there are currently feasible applications in oil refining (as a substitute for natural gas) and steelmaking (as a substitute for coking coal) that are already attracting considerable investment by industry majors.

Cement manufacturing and steel production are the two largest industrial sources of GHG emissions. Engineered wood, another GreenTech product, is being used to replace both of these materials in the construction of larger buildings—one built in Norway rises 18 stories.

Some GreenTech solutions, such as recycling robots, also tackle waste management. These have become increasingly popular after China banned the import of plastic waste in 2018 following three decades of importing close to half of the world's recyclable plastic waste. This ban has provided the impetus for innovations elsewhere in the world that can efficiently process this waste in place of China. For example, artificial intelligence robots are able to not only sort rubbish but also extract recyclable components from it, and assess their purity—valuable data to have in order to recycle these materials efficiently.

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AgriTech and FoodTech

Food development and delivery solutions spanning a range of activities from farm to table

Agriculture has already benefitted from the growing adoption of soil-friendly techniques such as no-till farming and cover cropping. GPS technology has enabled more precise land management and reduced input usage (fertilizers, pesticides, and fuel). But the industry remains one of the largest sources of GHG emissions.

Technology solutions in this field can potentially address all four of the threats outlined above while tackling the challenge of feeding a growing world population. Since the 1950s, consumption of protein in China has grown by five times while the country's population has doubled. AgriTech and FoodTech can be leveraged to produce protein foodstuffs in a sustainable manner.

Agricultural innovations, such as the development of vertical farming, a reengineered farming process using stacked production systems, may permit the same or greater production of some foodstuffs on drastically less land. Moreover, this type of farming can be employed in closer proximity to cities, reducing the need for transport. Technologies that enable cultivation with less water can also help to mitigate water scarcity, while hydroponics use little to no soil.

FoodTech has fostered the development of plant-based products, which directly reduce GHGs (cattle produce a significant amount of methane), as well as the creation of protein sources via processes that use much less water. The United States Geological Survey estimates that the production of a hamburger weighing a quarter-pound (113 grams) requires 460 gallons of water (some 1,750 litres). Alternative sources of protein can require only half as much.

Other aspects of FoodTech such as food traceability for just-in-time delivery can lower inventories, thus reducing waste and GHG emissions. The World Wildlife Fund estimates that one-third of food ends up as waste, and as it rots, it produces methane.

AgriTech can also foster social progress to the extent that more efficient farming practices can help raise farmers' standards of living, particularly in developing countries, and in the process enable family planning and reduce the pressure to migrate.

FinTech and HealthTech

Foster social progress, which itself underpins economic growth

FinTech

Development of applications that can empower economically "unbanked" populations

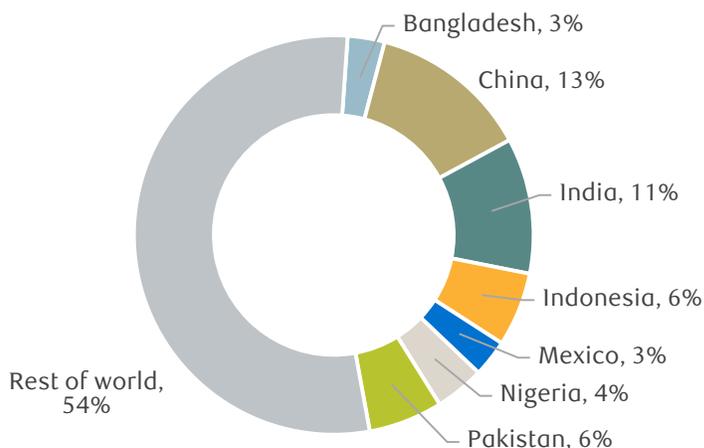
According to the World Bank, in 2017 just over 1.7 billion people in the world were unbanked, i.e., no access to financial services. While that number most likely has come down, the issue is particularly acute in low-income countries. But richer nations are not spared entirely. According to the

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Nearly half of all unbanked adults live in seven countries, though this is not exclusively an emerging market phenomenon

Global distribution of adults without a bank account, 2017



Source - Global Findex database

Federal Deposit Insurance Corporation, as of 2019, 7.1 million households remained unbanked in the U.S., representing a non-negligible 5.4 percent of the country's households.

FinTech solutions, including blockchain and emerging digital payment systems, are among the new technologies that can improve access to banking and credit. One example is the M-Pesa text message-based payment system initially launched in Kenya in 2007. The service allows the user to send and withdraw funds via basic mobile phones. By its 10-year anniversary, the service was used by 30 million customers across 10 countries, with over 95 percent of households in Kenya having at least one M-Pesa account. According to the World Bank, M-Pesa has advanced the financial empowerment of women, helping them gain control over their income, and fostered start-up businesses.

HealthTech

Development of devices, medicines, and systems to improve the quality of life

Ageing societies, rising health care costs, and unequal access to health care are widespread problems. Where access to proper care is inadequate, it is often due to the lack of reliable diagnosis, and substandard equipment, medication, and/or doctors. By reducing costs and improving efficiencies, telemedicine and digital diagnostics can make some of these services more widely available.

The ability to remotely collect, read, and interpret data, and provide an expert diagnosis to a patient in an underserved community or rural area can go a long way to improving the living conditions for many, in both emerging and developed regions. In the latter, telemedicine practitioners are able to not only diagnose but also prescribe medication to patients due to the increased popularity of smartphones and wearables.

Remote surgery can improve access further to those living in remote areas. This involves using an internet-connected robotic system to perform increasingly complex surgical procedures. This technology can circumvent

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lengthy and costly transport by ambulance or helicopter, and in doing so may also speed up treatment.

Smart Cities

Tackle climate change, fresh water shortages, waste management, and even foster social progress

Smart Cities can help reduce the detrimental impact of urbanisation on the environment and improve the quality of urban life. These are cities in which infrastructure, utilities, services, homes, and more are connected via the Internet of Things and 5G and use artificial intelligence technologies to optimise the flow of goods and people. This connectivity enables cities to optimise waste management and water consumption. It can also facilitate more efficient traffic flow to enhance public safety.

For example, many cities today already employ sensors on trash receptacles to alert authorities when capacity is reached, allowing the refuse collection fleet to be deployed more efficiently. And while artificial intelligence is already being used to manage traffic, with greater connectivity more progress is possible on this front.

Sensors in sewage systems can monitor water levels and alert managers to a potential leak, enabling them to redirect wastewater if necessary to prevent floods. Such technologies can prevent economic losses and help protect livelihoods.

Parking management solutions is another area that can bring added productivity. Some cities offer the option for people to reserve a parking spot at the same time as when they make an appointment/reservation, so they don't have to waste time—and gas—looking for a parking space. If they see that no spot is available, they can adjust their plans accordingly to make more efficient use of their time.

Asia is leading the global race to create Smart Cities, with a number of high-tech hubs in China including Shenzhen, Shanghai, and Guangzhou, but the technologies are being increasingly adopted in the West. Singapore also ranks very highly on this front, thanks to integrating the Internet of Things into mobility and transport, health care, and public safety, combined with a highly digitised public administration.

Closing words

Over the next several months, we will cover each of these SusTech themes in more detail. As technologies emerge that make the world more sustainable, companies at the forefront of developing technology solutions to sustainability issues may offer compelling long-term investment opportunities, in our opinion.

The companies and industries that revolve around innovations and new technologies can make for volatile investments. Implementing these themes can carry higher-than-average risk and should thus be viewed within the context of a well-diversified portfolio.

We believe that for investors who can withstand such a higher level of risk, the secular opportunities that emerge out of these themes should contribute to portfolio performance in the long term.



GreenTech: Keeping it clean

Once, the green technologies theme was a niche that was “nice to have.” Now, we’re seeing a transformative shift to a clean energy world, and with it the next normal. We explore four key drivers underpinning the GreenTech growth prospects. Companies developing environmentally-friendly technologies present interesting long-term investment opportunities, in our view.



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A profound energy transition

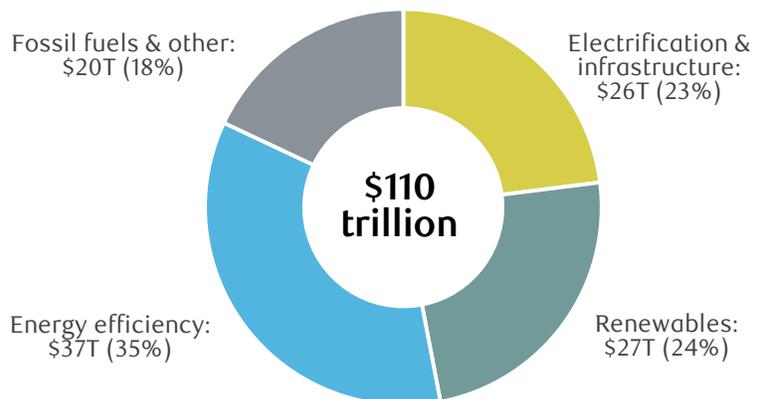
The world is in the midst of a transformative shift toward renewable energy. This transition will be more rapid and potentially more profound than the adoption of oil in the 1850s. In that instance, it took a century from the time commercial oil wells were first drilled for oil to account for a quarter of the energy used worldwide. Today’s goal is to achieve the bulk of this energy transition by 2050, or over just three decades, in line with the Paris Agreement’s aim to keep global warming to well below 2 degrees Celsius compared to pre-industrial levels.

A considerable share of the energy currently produced from fossil fuels will need to be replaced by energy from renewable sources, remembering that demand for electricity will go on rising from current levels as the world population grows and many activities, such as transport, become increasingly electrified.

In short, the energy transition requires that within a few decades, the way energy is *produced, stored, transmitted, and consumed* will need to change.

According to IRENA, the International Renewable Energy Agency, an intergovernmental organisation that supports countries in their transition to greater reliance on sustainable energy, \$110 trillion will need to be invested over the next 30 years to realise the global energy transformation.

Cumulative investments needed for energy transition



This article was originally published May 5, 2021 and priced as of market close, April 30, 2021, unless otherwise noted.

Note: Fossil fuels = mostly oil, natural gas, coal
Source - IRENA

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A wide range of industries are needed to make the energy transition a reality.

Importantly, this transformative investment is being driven by a government policy roadmap that is synchronised for the first time, with 2020 marking a turning point:

- The European Green Deal refocused the EU’s COVID-19 stimulus package onto renewables—charging infrastructure, power generation, and green hydrogen projects, allocating up to \$600 billion to green projects.
- China’s 14th Five-Year Plan called for electric vehicles (EVs) to constitute 20 percent of overall new car sales in China by 2025 from just five percent now and to reduce its dependence on coal (spending up to 10 trillion yuan, or \$1.5 trillion).
- Joe Biden won the U.S. presidential election, with a sweeping infrastructure programme (up to \$2 trillion) one of his key initiatives.

Some industries set to benefit from the energy transition

Transformation	Industry
Renewables	<ul style="list-style-type: none"> • Independent wind farm operators • Wind turbine manufacturers • Utility companies with expertise in renewable power • Solar panel equipment manufacturers • Enablers (semiconductor manufacturers) • Software/enablers • Monitoring systems
Energy storage	<ul style="list-style-type: none"> • Battery systems operators • Battery manufacturers
Transmission & distribution	<ul style="list-style-type: none"> • Transmission systems managers • Electric cable manufacturers • Power equipment manufacturers (e.g., substations, transformers) • Electricity distribution companies
Electric vehicles	<ul style="list-style-type: none"> • Manufacturers and operators of charging infrastructure • Parts manufacturers

Source - RBC Wealth Management

Transformation #1: The way energy is produced

As we noted in our [climate change report](#) in March, energy used in industry, transport, and buildings is responsible for some three-quarters of all greenhouse gas emissions. At the moment, fossil fuels (mostly oil, natural gas, and coal) are burned to produce electricity, creating carbon emissions in the process. One way to reduce emissions is to shift to electricity generated by wind turbines, solar panels, and other renewables. Hydropower is already being used as much as it likely can: not all countries have the water resources necessary, and those that do have already developed them as much as possible over the past 100 years.

The International Energy Agency (IEA) projects that renewables will account for 95 percent of the net increase in global power capacity through 2025. It points out that solar and onshore wind, for which costs have fallen dramatically over the past two decades, are already the cheapest ways of

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adding new electricity-generating capacity in most countries. The IEA expects solar alone to account for 60 percent of all renewable capacity additions through 2025, with wind providing another 30 percent. Within the latter, offshore wind is expected to see the most growth, driven by further cost declines and a move beyond Europe/UK, where it is already a major factor, to new markets such as China and the U.S. where ample potential remains.

Various countries' renewable energy situation

They are all making an effort

	Electricity production 2020			Comment
	Wind	Solar	Hydro	
China	5%	3%	17%	China boasts the world's largest renewables sector and produces close to three-quarters of the world's solar modules, two-thirds of its lithium-ion batteries, and close to half of its wind turbines. It also controls the global supply of cobalt and lithium, key elements used in battery storage. China is currently the world's largest greenhouse gas emitter, but plans to increase its renewables capacity by 40% between 2020 and 2025.
European Union	15%	5%	13%	In 2000, Germany was the first EU country to announce it would start to move away from fossil fuels, creating the conditions for European industry to develop a global edge in renewables technology. Many of Europe's largest utility companies have now transformed themselves into energy transition pioneers, building wind and solar farms and investing in grids around the world. The EU has continued to lead the way in the energy transition by linking its COVID-19 crisis fiscal response to the goal of achieving a greener economy. Plans to redesign the EU's electricity markets should enable further progress.
U.S.	8%	2%	7%	The U.S. has lagged others so far, as it focused on shale oil and gas to become the world's largest oil producer. President Biden is now focusing on decarbonising the U.S. economy. His \$2 trillion infrastructure package would be the most ambitious in decades. It includes some \$175 billion for electric vehicle tax credits and charging stations, \$100 billion to upgrade the country's electric grid, and a similar amount to retrofit residential and institutional buildings.
Canada	5%	0%	60%	Historically, Canada has focused on hydroelectricity given its abundant water resources. Alberta also has a well-developed oil sands industry, but given the high cost of extraction combined with relatively weak oil prices over the past six years, the region is exploring new technologies. Benefiting from the province's wealth of geological resources, the Alberta government is actively encouraging the development of geothermal energy, as well as the production of hydrogen. It is also looking to foster the extraction of minerals used in the production of batteries.
UK	25%	2%	2%	Over the past decades, the UK has completely eradicated its reliance on coal, replacing it with natural gas and renewables, thereby cutting carbon emissions faster than other developed countries. The UK boasts the largest offshore wind farm in the world with more than 170 turbines across 400 km ² (however, China has a project on track to surpass this in the next decade). To achieve a green economy, the UK's next step is to reduce its reliance on natural gas. Decarbonisation efforts seem to have slipped in recent years and the political consensus on this issue has weakened. The government's "Green Industrial Revolution" announcement last December aims to redress the situation. The UK is hosting the UN's climate change summit, known as COP26, in November 2021, which will give it the opportunity to reassert its position as a global climate leader.

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While wind and solar will likely play the largest role in the low-carbon economy, other technologies will also feature:

- **Nuclear:** Produces no greenhouse gas emissions, though the manufacturing of the equipment and the construction of the station most probably do
- **Carbon capture:** Removes carbon dioxide from the atmosphere or directly from industrial processes and injects it into deep underground geological formations (known as “sequestration”)
- **Hydrogen:** As a way to store solar and wind energy to be used when needed and as a direct substitute for fossil fuels including coking coal (for more see [“Five things investors should know about hydrogen’s global potential”](#))
- **Geoexchange:** Takes advantage of the fairly constant temperatures a few metres below the earth’s surface to heat homes and buildings in the winter and cool them in the summer using heat pumps
- **Waste heat recovery:** Captures the waste heat from buildings and industrial processes and converts it into electricity via thermoelectric generators

The energy transition has forced oil and gas companies to invest in renewables. European majors are leading the way. Royal Dutch Shell even links executive pay to the progress it makes in reducing emissions. U.S. Big Oil has been more reticent, though these companies are starting to take some steps. The global energy majors can be part of the solution, reinvesting part of their substantial free cash flow to help fund their transition aims. The risk, in our view, is that they overpay for renewables projects.

Transformation #2: The way energy is stored

One major challenge for renewables is the disconnect between the continuous nature of electricity demand and the intermittency of solar and wind power. The sun doesn’t always shine and the wind doesn’t always blow. Worse, storms can make a wind farm inoperable.

This can be dealt with by adding an energy source that runs only when needed—though these usually produce some harmful emissions and are costly to run if only used part-time.

Battery energy storage systems, which can store energy during periods of excess and discharge it during shortages, are another solution. These can be stationary or modular, industrial-size batteries installed at various points of the electric grid to support grid management. They are a critical component in an increasingly renewable-reliant grid.

Storage costs are coming down thanks to innovation and economies of scale. According to Shelby Tucker, RBC Capital Markets, LLC Utilities Analyst, storage system unit costs are expected to decline by 45 percent by 2030 and by 59 percent by 2050, while the next-generation battery technologies, some offering more than double the energy capacity of standard lithium-ion batteries, may drive down costs even further. Tucker believes the global market for batteries has the potential to grow 100 times by 2050.

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Battery technology can also be key to the uptake of EVs. Reducing the battery cost is important in making EVs more price competitive as batteries represent as much as 30 percent of the cost of an EV. Already down by more than 85 percent over the past decade, it needs to fall further. The average cost of a lithium-ion battery pack is currently just under \$140 per kilowatt-hour (kWh). According to BloombergNEF, EVs become cost competitive compared to traditional cars at \$100 per kWh, which appears to be achievable by 2023, with some producers reporting costs below \$100 for the first time.

Importantly, battery range, efficiency, and speed of recharging should also improve thanks to innovation and investment. Volkswagen recently committed to reducing battery costs by up to half and producing long-range and fast-charging batteries from 2024.

Hydroelectric power can act as a very large-scale battery. In Canada, Quebec recently green-lighted a large wind power project made feasible by the ability to use the province's massive hydro capacity as a back-up when wind power falters. Likewise, Alberta's extensive wind and solar potential could be much more fully developed if backed-up by neighbouring British Columbia's extensive hydroelectric resources. What's missing is a more integrated grid system along their 1,800 km border.

Transformation #3: The way energy is transported

Because solar panels and wind turbines are installed where the sun shines and the wind is blustery, and not necessarily near cities, the current transmission model based on power plants sending electricity to nearby cities is not viable.

To transport solar- and wind-generated electricity, high-voltage transmission is needed over large distances. In the U.S., as in many other places, this is an issue because the transmission system is highly fragmented and doesn't easily send electricity from one end of the country to the other.

High-voltage transmission systems are under development, but this is a complex undertaking with several stakeholders including landowners and state and local governments. One example is the TransWest Express, a high-voltage electric grid designed to move three gigawatts (GW) of wind power generated in windy Wyoming to California. Construction is finally about to start, 17 long years after planning began.

China has been building out its ultra-high-voltage transmission network since 2009 to accommodate surging electricity consumption and various power resources. By the end of 2020, it had constructed 30 networks to transmit electricity from its interior to the populated coastal regions in Eastern and Southern China.

Power distribution systems, which connect power lines to homes, will also need to be upgraded to accommodate higher electricity demand as reliance on fossil fuels in the home decreases while electricity consumption increases. For instance, according to the U.S. Federal Highway Administration, an EV uses 4,000 kWh of electricity per year to

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operate, assuming 13,500 miles driven—admittedly, a long distance by European standards. By comparison, the average U.S. household consumes 11,000 kWh per year, so having an EV would increase consumption by one-third in the U.S.

Transformation #4: The way energy is used

Despite buzz for years about EVs, such cars were a mere three percent of global demand in 2020, though with stark regional differences. Still-prohibitive prices, inadequate battery ranges, and a lack of public and home charging infrastructure have all stunted the uptake.

Global electric vehicle demand forecast

Western Europe leads, China is catching up

	EV as % of total vehicle demand			% of vehicles in operation 2050
	2020	2025E	2050E	
U.S.	2%	7%	80%	44%
China	4%	18%	95%	57%
Western Europe	6%	20%	95%	63%
Global	3%	11%	83%	46%

Source - RBC Capital Markets

But this appears about to change. RBC Capital Markets, LLC U.S. Auto Analyst Joseph Spak forecasts EVs will represent 11 percent of demand for new cars by 2025, with growth rates of some 40 percent per year, supported by regulations to phase out internal combustion engine vehicles. To date, at least 24 countries have proposed some form of zero-emission vehicle targets. For instance, the UK will ban the sale of new petrol and diesel cars from 2030.

Meanwhile, President Biden's infrastructure plan proposes allocating some \$175 billion to EVs in the form of tax credits to consumers and incentives to build 500,000 public charging stations.

Manufacturers are in the early stages of a heavy investment and capital expenditure cycle to dramatically boost the production of EVs and develop the related software. Many are planning to ramp up EV capacity, and to offer a wider range of price points and models. General Motors is accelerating its EV plans by spending \$27 billion over the next five years on electric and autonomous vehicles. It aims to deliver more than one million EVs by 2025 and to stop making gasoline-powered cars by 2035. Ford's legacy internal combustion engine vehicles should also transition to EVs, though at a slower pace than at GM. Chinese car manufacturers are also ramping up EV production. Zhejiang Geely Holding, one of China's biggest automakers and owner of Volvo Cars, launched a luxury EV brand, called Zeekr. A growing number of startups also are eyeing the country's booming EV market. Li Auto is aiming to be the No. 1 smart EV maker in China, and is targeting 20 percent market share in China by 2025.

The transition from internal combustion engines to EVs has been compared to that from horses to cars. It may not be an exaggeration. The change goes much beyond altering assembly lines. EVs are increasingly becoming more like smartphones, with wireless transmission of software updates.

GREENTECH

Keeping it clean

Getting this digitalisation right is key, as software opens up new opportunities for recurring and post-sale revenues via digital upgrades and increased customer connectivity. Volkswagen is spending €27 billion over the next five years on software, artificial intelligence, and autonomous vehicles, aiming to increase the share of its own software used in its cars from currently 10 percent to 60 percent. Like others, it is opting to keep new technologies in-house to learn how to optimise technology and costs.

Spak points out that investors have generally cheered this step-up in investment as it improves companies' future prospects. But they will likely want to see proof of better returns on these investments and of EVs as a platform with more recurring revenue opportunities, a larger addressable market, and less cyclical. For traditional automakers undergoing this metamorphosis, investor enthusiasm should be tempered by the possibility of write-downs of legacy manufacturing footprints, restructurings, labour concerns, and culture change.

Parts suppliers will also need to navigate a swift transition. Spak believes those that can show a path to stronger earnings power in an EV world should see their valuations re-rate higher—or at least sustain their recent increases in valuation. Should current levels of profitability be merely maintained or even decrease, a higher valuation would be harder to justify, in his view.

A pause that has refreshed?

GreenTech stocks have lost some ground so far this year, as the market has rotated into stocks that will likely benefit from the economic reopening. A useful gauge is the MSCI Global Alternative Energy Index, which tracks companies that derive 50 percent or more of revenues from operations that contribute to a more environmentally sustainable economy. The index lost close to 30 percent of its value between early January and early March this year. To be sure, this followed a 220 percent gain from the trough of March 2020 to the index's January peak (versus the MSCI World Index's gain of 71 percent over the same period). After the recent correction, the index's relative price-to-earnings ratio is the lowest it has been in four years. Despite the strong gains last year, the recent volatility represents a good opportunity, in our view, to build exposure to these long-term, secular themes.



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HealthTech: Healing health care's ailments

With bloated costs and gaps in access to quality services, the traditional health care model is plagued by its own chronic conditions. But at the intersection of health care and technology, we're seeing the development of a remedy for what ails health care. We look at the change that is afoot and what it means for the investment landscape.

Rising health care costs and unequal access to care are widespread, chronic challenges, even more so now as populations are becoming greayer throughout the world and have ever greater medical needs. Demand for health care solutions is growing apace and seems unlikely to slow down. This compounding burden on the world's health care systems is not sustainable.

HealthTech, the convergence of health care and technology, has the potential to meaningfully reduce costs and improve efficiencies. We believe both will be needed in large measure to ensure a more sustainable health care spending path and to improve the quality of health care services delivered.

Resisting change

While many industries, such as autos and entertainment, have embraced the digital age, swiftly transforming in the process, health care has been a glaring exception. Several barriers have conspired to slow the adoption of new technologies, blocking consequential change: Stringent regulatory requirements; the need for a secure, personal connection between physician and patients; the natural tendency of health care organizations to resist change, perhaps due to the relatively advanced average age of doctors; and a track record of failing to implement ambitious information technology (IT) projects.

Japan is a case in point. Despite its high-tech reputation, the country ranks last for management and use of data in health care within the Organization for Economic Cooperation and Development (OECD), a group of mostly rich countries. There has been opposition from the medical profession on privacy concerns, while an aging population—with more than a quarter of the population older than 65 (vs. 15 percent in the U.S.)—has also proved to be a hurdle. Yet forces are increasingly in place for digitization to finally take root in that country and elsewhere.

Change is needed

Swelling health care costs are one reason to look to improve the efficiency of health care delivery. Moreover, according to the OECD, as much as one-fifth of health care spending is wasted, and it surmises that the same services could be provided with fewer resources. With most governments

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Healing health care's ailments

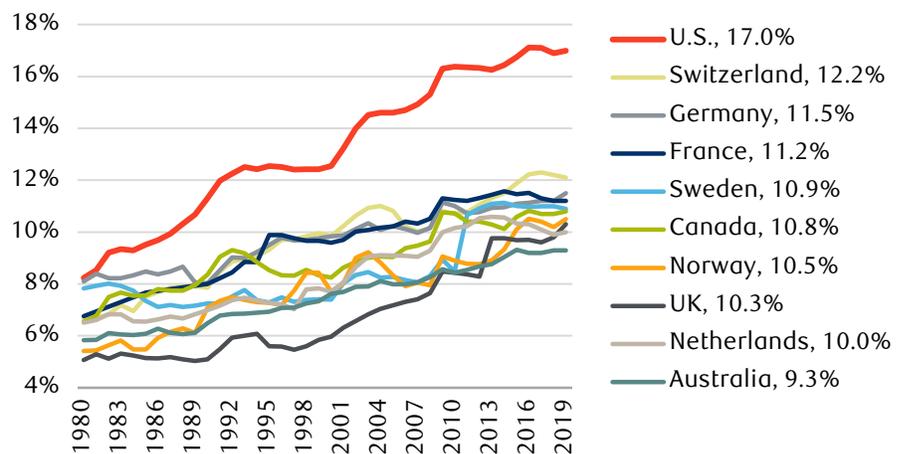
in OECD countries footing the bill for as much as three-quarters of health care costs, such waste undermines the financial sustainability of health care systems. Plainly, the incentive to improve is high.

In the U.S., the government contribution to health care costs is less, according to the Centers for Medicare & Medicaid Services (CMS), with both federal and state governments financing a lower 37 percent of the annual health care spend. But private health insurance companies, which finance 34 percent, and those who pay out of pocket (10 percent) are all equally keen to see their bills shrink, along with an improvement in health outcomes.

The U.S. also stands out with health care expenditures that are a high 17 percent of GDP, compared to an average for other advanced economies that is closer to 10 percent. This would be easier to accept if the health outcomes achieved were commensurately better. But the table on the next page reveals that on a number of measures the U.S. scores at the bottom of the OECD peer group.

U.S. health care spending is far above other nations, and rising

Health care spending as a percentage of GDP, 1980–2019



Source - OECD Health Data, OECD.Stat; 2019 data are provisional or estimated

This creates an interesting dynamic: the U.S. has the most to gain on both fronts—bringing costs down and improving outcomes. The U.S. is also home to the deepest, most diverse corporate health care sector. Properly incentivized, it should be the source of much of the HealthTech innovation in the coming decade with a potential customer base that could include all the developed economies.

Change is afoot

A new model is emerging in which patients are the central health care decision-maker, replacing the traditional model where doctors and pharmaceutical companies are in the driver's seat. This has been made possible by recent advances in big data and artificial intelligence (AI). Big Tech and surprisingly well-funded start-ups are now challenging the incumbents. RBC Capital Markets' health care analysts note that the former benefits from an aggregate \$500 billion in balance sheet cash, or

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more than twice that of the combined top-20 global health care companies; the latter is backed by private investment which is accelerating at record levels, with over \$9 billion raised in just the first nine months of 2020 amidst the pandemic.

This new model was gaining traction when the COVID-19 pandemic struck. With hospitals turning away patients requiring other treatments, and lockdowns forcing lifestyle changes, the trends became entrenched. As the world returns to normal, we believe some of the changes implemented by the medical professions during the pandemic are here to stay, particularly for routine outpatient visits and treatment of infectious diseases such as the flu. Thanks to remote care, those suffering from the flu will pose less of a risk to other patients or medical staff. Moreover, the way consumers shop for care and wellness is changing for good.

The evolving landscape has caught the eye of regulators, who are becoming increasingly supportive. Last year, spurred by the ravages of COVID-19, the CMS announced that the U.S.'s Medicare program, which serves more than 60 million elderly, would allow online patient visits. Canada's single-payer system moved to allow family physicians to be reimbursed for telephone consultations.

In September 2020, the U.S. Food and Drug Administration announced the launch of the Digital Health Center of Excellence. The initiative is geared toward digital health products, such as smartphone apps, wearable devices, and software-based treatments, and is part of an effort to modernize digital health policies, regulatory approaches, and tools.

U.S. outcomes surprisingly poor given the high cost of health care

Selected health care outcomes in OECD countries

	Health outcomes	Best	Worst	U.S.
Poor U.S. health outcomes	Life expectancy at birth (years)	Switzerland: 83.6	U.S.: 78.6	–
	Suicide rates (deaths per 100,000), 2016	UK: 7.3	U.S.: 13.9	–
	Adults with multiple chronic conditions*(%), 2016	Netherlands: 14%	U.S.: 28%	–
	Obesity rate (%)	Switzerland: 11.3%	U.S.: 40%	–
	Practicing physicians per 1,000 population, 2018	Norway: 4.8	U.S.: 2.6	–
	Survival rate for cervical cancer (%)	Norway: 73.3%	U.S.: 62.6%	–
	Avoidable mortality** (deaths per 100,000), 2017	Israel: 127	Hungary: 387	262
Good U.S. health outcomes	Adults age 65 and older immunized (%)	UK: 73%	Norway: 34%	68%
	Women age 50–69 screened for breast cancer (%)	Sweden: 90%	Switzerland: 49%	80%
	Survival rate for breast cancer (%)	U.S.: 90.2%	UK: 85.6%	–

* "Multiple chronic conditions" is defined as two or more of: joint pain or arthritis; asthma; diabetes; heart disease; hypertension/high blood pressure. ** "Avoidable mortality" refers to deaths which would be either preventable or treatable with timely access to effective and quality health care.

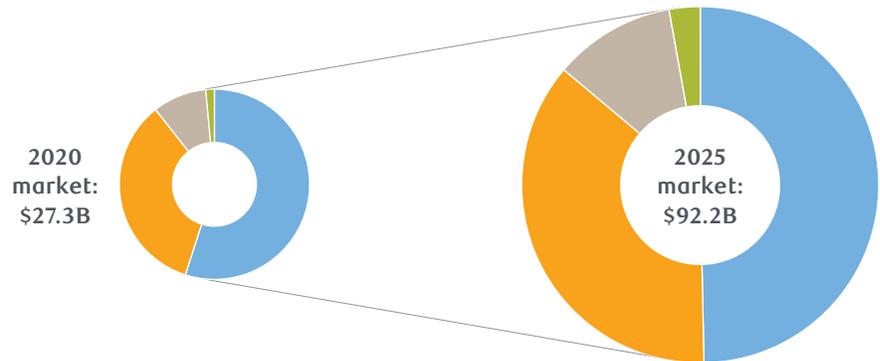
Source - OECD Health Statistics 2019

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Healing health care's ailments

Strong growth expected in all segments over the next five years

Digital health segments market opportunity, 2020 and 2025



Digital health segment	2020	2025E
Prescription digital therapeutics (PDTs)	\$2.5B	\$10.2B
AI-enabled drug discovery	\$0.4B	\$2.6B
Telehealth	\$15.0B	\$45.8B
Wearables	\$9.4B	\$33.6B

Source - RBC Capital Markets, RBC Wealth Management

The new face of health care

In its report Digital Health—Hitting Fast Forward, part of the “Imagine 2025” series, RBC Capital Markets identifies key opportunities for HealthTech. Taken together, RBC Capital Markets sees these markets at some \$27 billion as of 2020, and growing to about \$92 billion by 2025, or by more than 25 percent each year.

Telehealth

The use of telecommunications technologies, such as the telephone, video links, and the internet, to deliver telemedicine (e.g., clinical services such as doctor-patient visits as well as remote patient care) and non-clinical services (e.g., administration and training)

Telehealth is perhaps the biggest opportunity in the health care industry. It aims to improve the quality, convenience, and effectiveness of care, and to lower its cost.

An example of telemedicine is the video conferencing technology which became part of the daily routine for many of us during the pandemic. This approach is more time-efficient than traditional in-person service and requires less staff, freeing up resources.

Clearly, not all doctor visits will, can, nor should be replaced by video. Virtual contact cannot completely replicate in-person interactions during which invaluable non-verbal cues can be observed, empathy expressed, and trust built. But telemedicine does have an important role to play.

A study by McKinsey in April 2020 estimated that more than 20 percent of outpatient visits could be performed virtually. Embedded in this are assumptions that 20 percent of all emergency room visits, 24 percent of health care office visits, and 35 percent of home health visits could be

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replaced with a virtual alternative. RBC Capital Markets believes 35 percent to 40 percent of medical care and 75 percent to 80 percent of behavioral/mental health visits could eventually be done virtually.

As for non-clinical services, by using AI and integrating disparate sources of data, telehealth can help in a variety of areas such as:

- **Triaging** or assessing patients and directing them to the most appropriate level of care
- **Simplifying administrative tasks** by integrating appointments into scheduling systems and connecting into electronic health records, e-prescribing networks, and billing systems, thus automating a number of manual processes
- **Delivering care** by integrating electronic health records, thereby providing a more comprehensive picture of a patient's condition, and enabling physicians to control devices on the patient's end (e.g., digital stethoscopes, remote cameras, and other diagnostic devices); this can broaden the range of physiological data that can be collected and assessed in a shorter time frame, and without necessitating travel/transport
- **Accessing deeper pools of health care providers** by creating wide networks of medical experts, potentially elevating the quality of care by facilitating patient interactions with specialists in practically any part of the world

Telehealth's competitive landscape is evolving quickly. Over the past 18 months several notable new entrants have emerged, such as Amazon and its Amazon Care offering, a pilot program offering a combination of virtual health and in-person care. In addition, many vendors are striving to broaden and increase their scale. The \$18.5 billion merger in late 2020 between Teladoc, a U.S. virtual health care company, and Livongo, a digital disease management company focused on diabetes and hypertension, is a case in point. Meanwhile, some major insurance companies are taking steps to internalize more of these functions. For example, in February 2021 Cigna announced it entered into an agreement to buy MDLIVE, a provider of online health care delivery services and software for patients, hospitals, employers, and insurance companies.

Telehealth is more than telemedicine

Telehealth	
Clinical services	Non-clinical services
<ul style="list-style-type: none"> • Telemedicine: Remote patient care 	<ul style="list-style-type: none"> • Triaging • Integrating health records • Enabling physicians to control at-home devices • Creating large networks of specialists • Training nurses and physicians

Source - RBC Wealth Management

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Wearables

Devices that enable more detailed and frequent real-time data gathering from patients in-between physician office visits, or potentially in lieu of actual visits

Once a consultation with a doctor has taken place, the patient often has to manage their condition by themselves. According to the RAND Corporation, a U.S. think tank, this happens all too often given that as many as 60 percent of Americans now live with at least one chronic condition, i.e., an ailment that lasts at least one year and requires ongoing monitoring or treatment.

Patients are becoming empowered as consumers and are finding new, more effective ways to manage their condition. The emergence of wearables is being fueled by recent advances in device technology. Coupled with progress in data processing and AI, wearables provide patients with proactive interventions to detect early signs of illness, as well as to help prevent or minimize conditions becoming more acute.

This technology includes not only the devices used to capture the data but also the tools that enable the aggregation of all relevant data, as well as the software that analyzes it and determines an optimal course of action.

Wearables themselves range from mass market items to more specialized devices, though both have the same objective of gathering and assessing data.

For example, in certain countries, the Apple Watch is becoming one of the first mass consumer medical devices as it can perform a mobile electrocardiogram (ECG). The watch can notify wearers of an irregular heartbeat that might lead to heart failure and can even place a call to emergency services if it detects a sudden fall and the wearer doesn't dismiss the alert in a certain time frame. Another function monitors blood oxygen saturation levels, and others are under development.

As for specialized devices, several examples come to mind. The Zio patch is a monitor that sticks to a patient's chest like an adhesive bandage. Designed by medical devices company iRhythm, the patch can collect data for up to 14 days, gathering millions of heartbeats per patient. iRhythm uses machine learning algorithms to translate the data into a 10-page report, which can help cardiologists make diagnoses.

Private company TytoCare has developed connected diagnostic devices, including stethoscopes, tongue depressors, and thermometers, which enable health care providers to perform thorough virtual medical exams. The devices are designed for in-home use and can help doctors remotely examine a patient's heart, lungs, throat, skin, and body temperature.

Smartphone components, such as the screen, microphone, or the accelerometer (the sensor which tracks different motions including shaking, tilting, and swinging), can also be used to capture and analyze patient data, assisting physicians' decision-making. For instance, a smartphone's microphone can be used to perform remote self-exams and analyze bodily functions such as coughs to detect signs of pneumonia.

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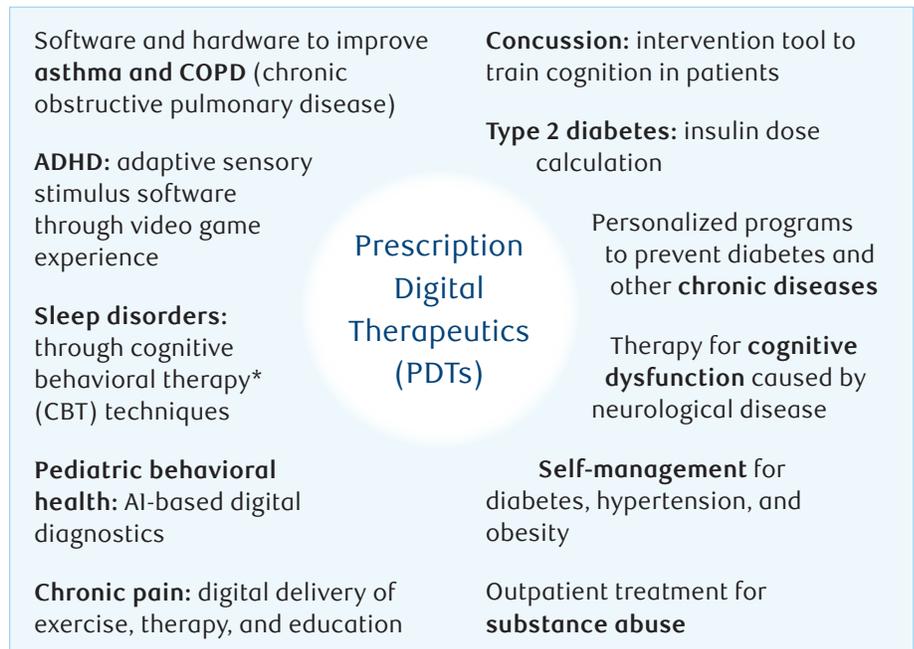
Prescription digital therapeutics (PDTs)

Software-driven, evidence-based interventions that are intended to prevent, manage, or treat a medical condition, not simply assess or monitor a condition, or transmit data to the physician

These devices are considered to be Class II medical devices in the U.S. and require regulatory approval to support the makers' claims of risk and efficacy. Their costs may be reimbursed by health insurance or Medicare/Medicaid in the U.S. and thus differ from wellness tracking or lifestyle applications, which typically require a paid subscription from consumers.

An example is Propeller Health's device, which is attached to a patient's existing asthma inhaler. The Propeller sensors track medication use and send the data to an app on the user's smartphone. According to the company, over time, the app can learn about the pattern of flare-ups and medication use, helping the patient to manage symptoms and identify triggers. Propeller also produces reports which physicians can use to adjust treatment plans.

PDTs can address a wide range of conditions and help prevent, manage, or treat a medical condition



*Cognitive behavioral therapy attempts to help people develop alternative ways of thinking and behaving in order to reduce psychological distress

Source - DTx Alliance, RBC Capital Markets, RBC Wealth Management

AI-enabled drug discovery

AI that helps develop innovative medicines faster and at a lower cost while improving success rates

Traditional drug development costs between \$500 million and \$3 billion due to the high rate of failure, and with a timeline often stretching beyond 10 years, making drug development a risky affair. As a result, only the

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most promising avenues are pursued, while abandoning research on other projects for which there may be demand, but not enough to justify the development costs.

AI is particularly well suited for the task, given the iterative nature of drug development. When AI and other digital tools are applied to clinical trials, the potential benefits can include more efficient trial designs, quicker enrollment, and increased patient engagement and retention, contributing to lower costs and improved success rates.

While there have been a number of early success stories, the use of AI in drug development is still largely in its infancy. The meeting of Big Pharma and Big Tech in this area has helped provide conceptual validation, but many of the emerging AI-enabled platforms still have much to prove. RBC Capital Markets expects capital to continue flowing to the category as the current R&D spend and return on investment are unsustainable.

Long-term fairway of growth

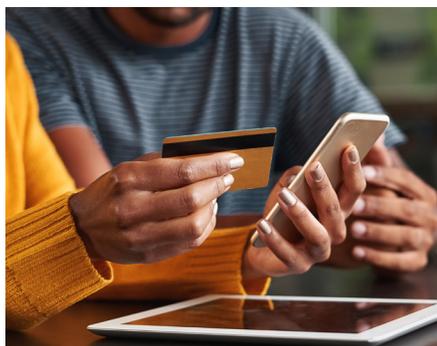
While society now seems to appreciate the crucial role technology can play in the delivery of health care services, HealthTech still faces hurdles to truly becoming a global force to lower costs and improve outcomes. Many health care systems are not digitized, and concerns about security, privacy, and hacking should not be brushed away. Additionally, digitization needs well-functioning broadband networks—still elusive in many regions, even in the developed world. Many developed countries are putting digitization at the center of their investment plans, including Japan and Italy, but many emerging economies today simply do not have the financial means to do so. Moreover, these tech-fueled devices typically carry a hefty price tag, keeping them out of reach for many, and they may be ill-suited for the less tech savvy.

Nevertheless, the traditional system appears to be coming apart at the seams, and this will likely only worsen as the world's population grows greyer. While the adoption of these technologies may not be immediately universal, they will continue to gain traction, in our view, led by the U.S. where the payoff is likely to be the greatest. According to RBC Capital Markets, health care companies that increasingly offer digital services are likely to see their valuations expand over time, reducing the gap with tech companies' valuations.

We would build strategic positions in HealthTech in portfolios, as the secular growth trends in this area should be well underpinned by both demand and technological innovations for the foreseeable future.

Appendix: Big Tech's big push into health care

Company	Notable health initiatives	Category
Alphabet	Verily Life Sciences: Stand-alone life sciences company spun out of Google X in 2015. It offers a variety of data-driven solutions across research, care, and innovation. Projects range from broad data collection efforts to disease-specific research and development.	R&D
	Calico: A research and development company focused on the diseases associated with the aging process. Calico has a portfolio of more than 20 early- and late-stage preclinical compounds in cancer, neurological diseases, and tissue homeostasis and repair.	R&D
	Google Health: Somewhat loosely defined group within Alphabet that is focused on research and clinical tools to improve patient care, often with the help of AI.	—
	Other: Alphabet has a number of other products and services that either indirectly or directly relate to health care including Google's online search ("Dr. Google"), Google Cloud, and Fitbit.	Diagnostics & wearables, chronic disease management
Amazon	PillPack: Acquired in 2008 for c. \$750M, PillPack, a full-service online pharmacy, gives Amazon a foothold in the industry while avoiding the operational and regulatory hurdles associated with building a mail pharmacy from scratch.	Online pharmacy
	Amazon Care: Launched in 2019 as a pilot health care service available to Amazon employees in the Greater Seattle area. It is described as a "first stop" for health care with both virtual and in-person services. While peers offer similar programs, Amazon Care is more external-facing, which suggests it could ultimately be expanded.	Telehealth, delivery of care
	Haven Healthcare: It is a non-profit joint venture between Amazon, Berkshire Hathaway, and JPMorgan Chase tasked with improving employee satisfaction and reducing health care costs for their U.S. employees.	Providers and payers models
Apple	Apple Watch enables Apple to collect a vast amount of data, a considerable competitive advantage. The smartwatch device can check for heart rates by detecting the amount of blood flowing through the user's wrist and its digital crown can measure the electrical signals across the user's heart, which can be used with the ECG app. Apple, along with partners such as Stanford Medicine and Johnson & Johnson, is researching areas including women's health and hearing.	R&D
	The ResearchKit framework allows researchers and developers to create apps for medical research covering areas such as identifying autism in children and providing screening tools for parents to use at home, or melanoma where participants can take photos of their mole over time and track changes—after tens of thousands of images are collected, an algorithm can screen for melanomas in early stages.	Apps
Facebook	The Preventive Health tool connects people to health resources and offers checkup recommendations from leading health organizations such as the American Cancer Society. The tool itself is based on a user's age and gender and provides a personalized list of recommended health checkups. For each recommendation, the user can view additional information; mark it as "done"; set a reminder; and find locations.	Telehealth
	The Oculus division produces virtual reality (VR) headsets. Primarily used in digital gaming, they have potential applications in health care such as medical training (e.g., surgical simulations). For example, Oculus is partnered with Children's Hospital Los Angeles to build VR simulations that place medical students and staff in high-risk pediatric trauma situations.	Telehealth
Microsoft	Microsoft Cloud for Healthcare is an industry-specific cloud offering which helps support the end-to-end security, compliance, accessibility, and interoperability of health data. It aims principally to (1) enhance patient engagement by creating individualized care plans; (2) improve health team collaboration by leveraging the Microsoft Teams platform, including its Bookings app to help health care providers schedule, manage, and conduct virtual visits in Teams; (3) improve clinical and operation data insights by using automated workflows to analyze data (for instance, Swedish Health Services used Microsoft Power Apps to build a solution to track critical hospital supplies); and (4) provide a highly secure, cloud-based tool to share patient information.	Telehealth



The FinTech future

In this fourth article in the SusTech series, we focus on FinTech, the convergence of finance and technology, which can help make economic growth sustainable by empowering unbanked populations. With the face of finance changing rapidly, we believe there will be investment opportunities in companies that effectively embrace the evolution.



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FinTech: A disruptive force

FinTech is a term coined to describe a rapidly growing industry segment that is aiming to deliver financial services more broadly, efficiently, and innovatively using powerful online technologies, enabled by “Big Data” and cloud computing. Initially arriving on the scene in the form of online-based payment services (PayPal, Alipay, Apple Pay), FinTech enterprises have begun offering access to credit, insurance, and investments. FinTech potentially represents a major disruptive force that will necessitate a response from banks and other financial services providers, as well as from regulators.

What is driving the growth of FinTech?

- Dramatic growth of e-commerce has brought with it the need for easy-to-use, online, secure payment services.
- Huge, underserved populations exist around the world with little-to-no access to banking services or credit. This acts as a powerful constraint to global economic growth and social improvement. FinTech may be uniquely suited to fill these gaps.
- Massive amounts of data available from e-commerce transactions, social media, and internet searches allow FinTech companies to determine what financial services to offer to which person, as well as how to price that product. Data has become more important than collateral for these providers.
- Regulators do not appear to have been able to keep pace with FinTech evolution. This is allowing FinTech businesses to innovate aggressively, and perhaps take risks that their customers are not fully aware of, while restraining incumbent financial services companies, which are regulated, from competing head-on with these new entrants.

What can FinTech offer?

For underserved populations, FinTech’s most dramatic impact is opening up access to credit and offering digital cash transfer platforms. Beyond these, FinTech offers services that have altered and continue to transform the financial services industry.

FINTECH

The FinTech future

Low-fee digital cash transfer platforms

Digital cash transfer platforms are now widely used worldwide. These can be particularly beneficial to migrant workers, whose families—often unbanked—rely on receiving money from abroad.

According to the World Bank, funds sent back to the home country are an important source of income for several developing countries, representing a non-negligible four percent of GDP in Mexico, for example, and up to an eye-watering 27 percent of GDP in Nepal. Global remittances in 2019 exceeded \$700 billion, with over \$500 billion flowing to developing nations. The International Monetary Fund estimates that remittances sent through traditional channels are subject to fees that average 10 percent but can be as high as 20 percent for small remittances of under \$200, which are typical for poorer migrants.

M-Pesa, the text message-based payment system initially launched in Kenya in 2007, exploited the opportunity, allowing users to send and withdraw funds via basic mobile phones. The service is now used by 48 million customers across eight countries. According to the World Bank, M-Pesa has advanced the financial empowerment of women, helping them gain control over their income, fostered startup businesses, and advanced financial inclusion, which means that individuals and businesses have access to affordable banking services.

Another example is the UK FinTech company Wise (formerly TransferWise), which provides a low-fee digital payment solution to transfer money, making financial services more affordable across society. It initially differentiated itself from the competition by being transparent about fees and focusing on small transactions. When the company entered the Malaysian market in 2019, its fourth Asian market, the authorities welcomed it, commenting that it would improve financial inclusion and support the country's balanced economic growth.

Access to credit

FinTech can help improve access to credit for small and medium-sized enterprises (SMEs) and provide services in remote areas through alternatives to traditional lending methods.

A prime example of this is Ant Group, a Chinese FinTech company, which had a profound impact on consumers' and entrepreneurs' access to loans. At its peak, Ant counted more than 1.2 billion users and handled 110 trillion yuan in payments (\$16 trillion), or over 25 times more than the U.S.'s PayPal.

Starting out as a payment service on Alibaba's e-commerce platform, the company became the leading app for mobile and online payments, providing credit facilities to smaller enterprises on Alibaba.com and enabling consumers and merchants to borrow money sourced from banks on their smartphones.

Ant is able to gather a large amount of consumer finance data from its parent's e-commerce platform. This enables it to assess borrowers' creditworthiness even if they lack the repayment track record required by

FINTECH

The FinTech future

traditional banks, and to tailor the financial terms of a loan to suit each borrower based on the particular risk profile. As such, Ant can help SMEs access trade finance, supporting their development and expansion.

Other services

Beyond these, FinTech offers a wide range of services, and we highlight four key segments.

Large global payment networks

Provide payment processing services to merchants who accept credit and debit cards

When paying with a credit card, consumers use a bank-issued card that is linked to a global payment network, such as Visa or Mastercard. The merchant, in turn, works with a merchant processor who manages the credit card transaction process and is an intermediary between the merchant and the financial institution involved, authorizing transactions and helping merchants get paid on time by facilitating the transfer of funds.

Global payment networks enable consumers and merchants to smoothly conduct commerce on a global scale and to utilize digital mobile devices, opening up new opportunities for merchants. They can also enhance overall efficiency and working capital management for businesses of all sizes by digitizing business-to-business payments.

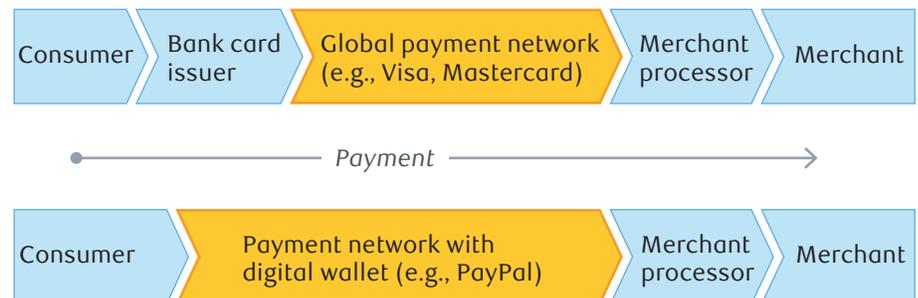
Payment networks using digital wallets

Provide direct connection between consumers and merchant processors, operating via software-based systems that store users' payment information

Digital wallets allow a party to make electronic transactions and bypass traditional banks. According to market data provider Statista, digital wallets accounted for 44.5% of all global e-commerce transactions in 2020. Solutions within a consumer digital wallet can include merchant payments, peer-to-peer payments, international money transfers, bank accounts, lending, and cryptocurrency trading.

How large global payment networks and payment networks using digital wallets work

Several steps between you and the merchant



Source - RBC Wealth Management

FINTECH

The FinTech future

Merchant processors

Manage the credit card transaction process and act as an intermediary between the merchant and the financial institution involved

Merchant processors can have a large impact for small merchants by enabling them to accept electronic payments so they do not have to handle cumbersome cash and checks.

Technology providers

Foster the digitization of a financial institution's ecosystem

Unlike other FinTech segments, this one is not dominated by a handful of key players. A myriad of companies of all sizes offer their technological expertise. Technology providers enable small-to-midsized financial institutions to digitize their ecosystems so they can provide banking services to consumers and businesses more efficiently and cost-effectively.

Four key segments of FinTech and their impact on financial inclusion

FinTech can improve financial inclusion on many levels

	Function	Key companies	Range	Users	Promote financial inclusion by ...
Large global payment networks	Provide the “pipes” that connect consumers to merchants, and merchants to banks	Mastercard	Global	U.S.: 234M credit cards Rest of the world: 709M	Facilitating commerce on a global scale and through digital mobile devices; enhancing efficiency and working capital management for businesses of all sizes by digitizing business-to-business payments
		Visa	Global	U.S.: 340M credit cards Rest of the world: 800M	
		American Express	Mostly U.S.	U.S.: 55M credit cards Rest of the world: 57M	
		UnionPay	China, global	200M users	
Payment networks using digital wallets	Operate two-sided electronic payment networks for e-commerce merchants and consumers via digital wallets	Tencent's WeChat ¹	China, global	1.2B users	Providing a widening array of financial services to merchants and consumers through digital means
		Ant Group's Alipay ¹	China, global	1.2B users	
		PayPal	U.S., global	377M users	
		Paytm	India	350M users	
Merchant processors	Connect merchants to global payment networks	Square	U.S.	2M merchants	Enabling electronic payments, which are easier to handle and less cumbersome for merchants, and thus bringing small and micro merchants into the fold of the financial system
		Adyen	Netherlands	4,050 merchants ²	
		PagSeguro	Brazil	6.7M merchants ³	
Technology providers	Provide technology solutions to foster the digitization and higher efficiency of financial institutions' ecosystems	This sector is not dominated by a handful of key participants; a myriad of companies of all sizes offer services	NA	NA	Enabling small-to-midsized financial institutions to digitize their ecosystems so they can provide banking services to consumers and businesses more efficiently and cost-effectively

¹ Alipay and WeChat process more than 90% of all mobile transactions in China

² Defined as merchants processing €25 million annually

³ Micro merchants

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The FinTech future

A FinTech opportunity: Improving financial inclusion can unleash growth

Financial inclusion is a key challenge across the globe. A lack of access to basic financial services can create crippling financial problems for individuals and businesses, in turn holding back an economy's growth potential.

According to the World Bank, more than 1.6 billion adults, or just over a quarter of the world's adult population, do not have a checking or savings account, access to credit, or insurance. This leaves them unable to store, send, and receive payments, unprotected from theft and loss, and without safeguards if they lose their jobs or fall ill, making them vulnerable to predatory lenders.

Substandard infrastructure ranging from an inadequate supply of electricity to poor internet access (particularly in remote areas), the struggle to maintain minimum balance requirements, the lack of identification documentation (which affects one billion people worldwide and 45 percent of women in low-income countries), the lack of a financial track record, and prohibitive costs are typically the reasons why adults do not have a bank account.

However, per the World Bank, more than two-thirds of adults who do not have access to a bank account, do have a mobile phone. Today's technology enables the delivery of financial services through even a basic mobile phone (i.e., non-smartphone).

Low financial inclusion also affects small and microbusinesses. In 2016, the International Finance Corporation estimated that more than 160 million of these entities lacked access to finance and another 160 million were underbanked—meaning they might have a bank account but do not have access to banks' term loans or working capital loans.

Not exclusively an emerging market issue

The unbanked adults are predominantly in emerging economies. Some emerging market governments that are alert to this issue have invested in infrastructure and encouraged banks and startups to look to seize the opportunity this state of affairs presents.

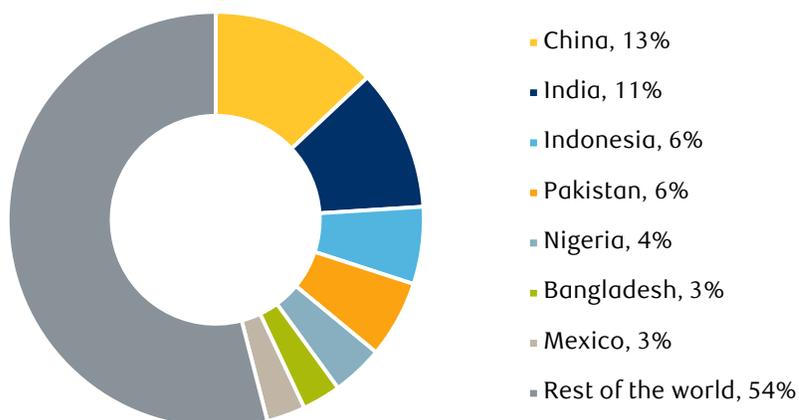
China strove to address the urban/rural differences at the root of its large unbanked population as it recognized the economic potential of closing this gap. It encouraged the development of infrastructure such as broadband networks alongside allowing a growing role for the private sector to advance financial services, hence the progress of Alibaba's Alipay and Tencent's Tenpay (including WeChat Pay). Together these online payment platforms process more than 90 percent of all mobile transactions in the country.

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Nearly half of all unbanked adults live in just seven countries

Percentage of global unbanked population by country, 2017



Source - RBC Wealth Management, World Bank's Global Findex Database

But poor access to banking services is also a problem faced by an uncomfortably large population in developed economies, particularly the underbanked who have a bank account but no access to credit or other financial services.

The Federal Deposit Insurance Corporation's 2019 survey "How America Banks" found that 7.1 million (or 5.4 percent) U.S. households had no bank account, while a report by the Federal Reserve the same year calculated that 16 percent of U.S. adults were underbanked. Mintel, a market research firm, reports that six percent of Canadians are unbanked, without a checking or savings account of any kind, and a further 28 percent are underbanked. In the UK, the Financial Conduct Authority estimates 1.3 million adults are unbanked, while the European Central Bank (ECB) calculates that some four percent of households in the EU do not have a bank account.

Central banks and regulators need to adapt ...

RBC Global Asset Management Inc.'s Julie Thomas, a senior portfolio manager specializing in global financials, points out that while the traditional financial system is regulated, offering safety and security for savings, and thus a high level of comfort to users, FinTech sits outside this regulation, affording no such security.

Moreover, for central banks, unregulated newcomers can make delivering monetary policy more difficult. How can central banks control the risk to the economy from increased leverage as FinTech represents a growing share of financial services?

Concern over the loss of control over the economy explains the recent flurry of activity by many central banks to create their own digital currencies. A central bank-backed digital currency would be a digital version of cash, equivalent to a deposit with a nation's central bank.

China launched the e-yuan in 2020; the ECB aims to launch its own digital currency in 2025, while the Bank of England and the Fed are actively exploring the issue. A January 2021 survey by the Bank for International Settlements (the bank for central banks) reported that most central banks

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are considering digital currencies. The survey found that central banks representing a combined 20 percent of the world's population are likely to launch their own digital currencies within three years.

Increased regulatory scrutiny on FinTech is also likely, particularly with the advent of “super apps,” which are popular in emerging countries. These platforms started out by being a dominant provider of a service used daily by customers, such as ride-hailing services (e.g., Grab in Singapore) or e-commerce (e.g., Mercado Libre in Latin America), and expanded from there into financial services including payments, insurance, and investment. Super apps are blurring the lines between financial services and other industries. Regulatory authorities will likely focus on who controls the data and how it is used. This will be a key issue particularly in Europe where protecting data privacy is a primary concern.

... as will traditional banks

Some traditional banks, concerned about the newcomers encroaching on their territory, are adopting some of these FinTech approaches. Technological capability is not an issue: most banks have been delivering progressively more online access to services for the past 20 years. But FinTech entrants, unencumbered by legacy systems and traditional banking practices, not to mention regulation, have successfully gained ground in market segments that banks traditionally regarded as uneconomic, lacking potential, or too risky. They have also pushed into offering some “high-touch” services, usually delivered person-to-person, with a “clickable” ecosystem featuring decision-making algorithms.

Some traditional banks have opted to create hubs external to their main businesses so that these new approaches can be properly nurtured. Once mature, these processes may be adopted into the core businesses. This should be a low-risk way to integrate new technology into a traditional bank, mitigating threats to branding or customer confidence while closing the technological marketing gap with FinTech companies.

Others may choose to buy established new entrants, much like JPMorgan's recent acquisition of Nutmeg, a successful and well-known UK robo-adviser.

Embrace the evolution

The face of finance is changing rapidly, and regulators and central banks alike are taking notice. The arrival of a wider range of participants in financial services makes their task more complex. They will have to adapt, as will traditional banks in order to fend off the approach of newcomers into their territory.

FinTech will not single-handedly lift all of the “bottom two billions”—the poorest individuals in the world—out of poverty. But to the extent that it can reach a portion of them and give them access to financial services, economies will likely benefit and the companies that make inroads into this market segment with a well-thought-out strategy should see bright prospects.

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We believe the disruption can create investment opportunities in those FinTech companies that gain staying power, as well as in the traditional banks and financial services providers that are able to effectively embrace this new paradigm.

With contributions from Jason Deleeuw, CFA, U.S. Equities Portfolio Advisor, RBC Wealth Management Portfolio Advisory Group – U.S. and Stephen Chang, CFA, U.S. Equities Portfolio Advisor, RBC Wealth Management Portfolio Advisory Group – Equities, RBC Dominion Securities Inc.



Food for thought

Today's realities and tomorrow's challenges are calling for new, technology-driven food production and distribution solutions spanning a range of activities from farm to table. In the fifth article in the SusTech series, we look at technologies that offer the promise of feeding a growing global population while limiting the burden on the environment.



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One of the biggest challenges of the coming decades is how to feed a growing world population despite limited scope to expand agricultural land and reduced labor supply due to urbanization. And all of this is coming against the backdrop of unpredictable and extreme weather patterns arising from climate change.

It is a task of herculean proportions. A University of Washington study forecasts that the world population, currently at 7.8 billion, could peak at 9.7 billion in 2064, an addition equivalent to close to six times the U.S.'s current population. To sustain current food consumption patterns, the Food and Agriculture Organization (FAO) of the United Nations predicts food production would have to rise by a whopping 50 percent.

The massive environmental impact makes this scarcely sustainable. Agriculture is the single-largest user of freshwater, accounting for over 90 percent of global annual freshwater consumption, according to our national research correspondent, while single-handedly generating 18 percent of greenhouse gases (GHGs) worldwide (for more, see our article on [climate change](#)). Too many harvests can also lead to soil degradation.

Consumers are doing their part. Concerned about the carbon footprint of their food as well as their own health, they are becoming more discerning. Healthy eating is a priority for many, and preferences are undergoing a seismic shift.

To meet the challenges, agriculture and food industries have to adapt, the former by delivering more food from fewer resources, the latter by producing healthier food via methods that are less harmful to the planet. Demand for tools and solutions to increase productivity and boost profits has increased as it is clear that technical innovations are needed.

In this report we look at some of the innovative agricultural methods offered by AgriTech that aim to optimize crop yields and efficiencies, and the FoodTech solutions that seek to satisfy consumers' new demands.

AgriTech

Technical solutions from farm to table that increase crop yields while reducing stress on the environment

We highlight a few key strategies to deliver more with less: increasing yields on agricultural lands; controlled environment farming; and supply chain efficiencies. Many of the innovative solutions driving these strategies are already in use in some parts of the world, but we believe their adoption will become increasingly widespread over the next decade.

AGRITECH & FOODTECH

Food for thought

Increase yields on agricultural lands

Precision farming

Tractors, harvesters, and other self-propelled farming vehicles have come equipped with GPS capability for the past couple of decades. More recently, drones equipped with autonomous controls, crash avoidance systems, and an array of sensors are making farming more precise and productive by assessing soil moisture and nutrient deficiencies, as well as crop density and health. This can save valuable work hours and reduce costs while improving farm knowledge through the collection and processing of millions of data points.

Drones can be used to spray powdered insecticide or fertilizer on specific areas to sow seeds, as well as be employed to monitor weeds and pests. Drone-enabled infrared mapping can allow a farmer to assess crop conditions at a cost as low as \$5 per acre, according to a 2018 paper from Deloitte. The study argued that the information provided by a drone could permit farmers to boost crop yields by up to 20 percent. As the technology evolves, it noted that farmers will be able to see all the problem areas on a field within minutes, whereas with the traditional method of walking and observing, they would detect a mere 10 percent of them.

Another precision farming solution is smart irrigation, which uses sensors to determine and apply the exact amount of water required by plants. A valuable alternative to flood irrigation, still the most common form of irrigation throughout the world, smart irrigation can enhance yields while

Some AgriTech strategies to deliver more with less

Some innovations are already adopted but will become increasingly widespread

Strategies	Solutions
Increase yields on agricultural lands	<ul style="list-style-type: none"> • Precision farming <ul style="list-style-type: none"> – Satellite imaging, drones, sensors – Smart irrigation and soil technologies – Data analytics with artificial intelligence and big data – Internet of Things and connectivity • Gene technology <ul style="list-style-type: none"> – Disease and pest resistance – Biofortified plants – Plant phenomics and smart phenotyping
Controlled environment farming	<ul style="list-style-type: none"> • Greenhouse and indoor farming technologies • Vertical farming • LED lighting systems • Aeroponics and hydroponics
Supply chain efficiencies	<ul style="list-style-type: none"> • Direct farm-to-consumers (meal kit delivery, e-groceries) • Waste reduction technologies <ul style="list-style-type: none"> – Crop waste reuse – Cooling and storage solutions – Cold chains – Smart packaging

Note: Phenomics measures the phenotypes (physical and biological traits) that can be produced by a plant as it develops and as it responds to its environment

Source - RBC Wealth Management

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Food for thought

dramatically reducing water and electricity consumption. Despite these savings, the upfront costs of installing the technology can be prohibitive, thus making it challenging to be widely accessible.

Further into the future, but perhaps not that much further, Deloitte expects big data analysis will be used to direct robotic systems to spot pests on a plant and blast the appropriate amount of pesticide, or even to recognize ripe fruit and pick it. Thanks to machine learning, robots could be used to harvest a crop, perhaps even predicting harvest periods while anticipating packing and logistics requirements.

In a report issued in 2020, consulting firm McKinsey found that in the U.S., only a quarter of farms have adopted connected equipment, and most of these use the more limiting 2G or 3G networks. With better wireless connectivity, including 5G, it is possible to imagine a world where all the equipment on a farm is synchronized, sharing data to make optimal decisions and implement them from seed to end product. McKinsey posits that advanced connected infrastructure will cover four-fifths of the global agriculture landscape (excluding Africa) over the next decade.

All this change will require substantial reskilling of farmers. Dealers and vendors of farming equipment will likely play an instrumental role in educating and training farmers to the extent that their business success will no longer depend solely on product sales, but equally on how successfully farmers utilize equipment.

Precision farming through digital technologies can improve efficiency, reduce costs, and increase farmers' returns on investments. According to our national research correspondent, precision farming via artificial intelligence, drones, autonomous machinery, and smart irrigation systems could yield productivity increases of up to 70 percent by 2050.

Gene technology

In the past, fertilizers and seed technologies have been the key drivers of increasing yields. Farmers have been cross-breeding to obtain more robust, productive plants for thousands of years. Genetically modified (GM) crops can be higher-yielding, more tolerant of both drought and heavy rain, and display greater resilience to pests and diseases. Despite widespread consumer resistance to GM foods, such products are unlikely to go away given the challenges outlined at the outset of this article. In fact, there very well may be more pressure to use them. In 2016, more than 100 Nobel laureates signed a letter in support of GM crops and foods, pointing out that distrust is misplaced and outlining their advantages in feeding a world population that is increasing while environmental challenges are escalating.

Controlled environment farming

With several major regions that have traditionally supplied much of the world's food now struggling with disasters brought on by climate change, safe and economical food procurement has become front of mind. Canada is a case in point. In the winter months it is highly dependent on California, where crops have been imperiled by droughts and wildfires, to supply fresh fruits and vegetables. Shortages stemming from the COVID-19 pandemic

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Food for thought

have only exacerbated supply disruptions, with the realization that a global crisis can freeze supply chains and force trading partners to withhold exports. Moreover, in most developed countries, urbanization has led to a scarcity of farmland around cities. Transportation and intermediary costs can be more than 50 percent of total food costs, according to our national research correspondent, so a solution to ensure economical food supply security has become a priority.

Controlled environment farming is becoming an increasingly compelling option to combat these challenges. Often located on the outskirts of cities, vertical farms grow produce by vertically stacking large trays containing seeds and plants. Within the vertical farm, critical environmental factors are controlled, including light (with efficient LED technology using only the red and blue light spectrum needed by the plants), humidity, and temperature. Pests are largely eliminated. Vertical farms can optimize yields as, for example, they can produce 20 times more lettuce than agricultural fields.

Vertical farms can make use of a variety of cultivation methods. Aeroponics consists of growing crops in the air and spraying the roots with a nutrient-filled water solution. Our national research correspondent points out that according to vertical farming leader AeroFarms, this method uses 95 percent less water than traditional farming. Alternatively, hydroponics, where plants grow in a nutrient-water solution, can also be used. Our national research correspondent estimated that this method requires 12.5 times less water per kilogram of lettuce per year.

Beyond shielding crops from unfavorable weather conditions and using less water, controlled environment farming has many other advantages: avoiding soil erosion, reducing the distance between farm and market, lowering dependence on climate-threatened imports, and largely eliminating pesticides and herbicides as input costs. But we acknowledge there are drawbacks. For example, should a technological problem arise, it could shutter the entire production process. It is also true that so far the applications have mostly been limited to the production of leafy greens. More innovations, such as a new generation of LED lights and seeds that are optimized for indoor environments, will be needed to make these techniques economically feasible for the production of a broader selection of fruits and vegetables and to lower operating costs.

To be clear, controlled environment farming is not about to replace traditional farming altogether. Challenges such as the availability of low-cost land and prohibitive zoning laws remain significant hurdles and are the main reasons why Canada, for instance, is struggling to keep pace with the leaders in this field, including the Netherlands, Israel, the U.S., and Singapore. But to the extent that controlled environment farming can generate a much higher production yield—without being subject to the vagaries of the weather while consuming only a fraction of the freshwater—these approaches can go a long way towards improving food supply security.

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Food for thought

Supply chain efficiencies

According to the World Wildlife Fund, a whopping third of the food produced globally goes to waste, or enough to feed three billion people. As it rots, this wasted food produces methane, an especially damaging GHG that is 25 times as potent as CO₂ in trapping heat in the atmosphere, according to the U.S. Environmental Protection Agency. Reducing the amount of waste could see more food reach growing populations and also lower GHG emissions. Several solutions, including “cold chains” and smart packaging, can help to optimize various stages along the supply chain.

Techniques to reduce waste

Efficiencies can be gained all along the supply chain



Source - RBC Wealth Management, national research correspondent

A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of refrigerated production, storage, and distribution activities, along with associated equipment and logistics, which maintain quality through stable, low temperatures. This process can help preserve and extend the shelf life of produce, seafood, and other perishable foods.

Improving product traceability for just-in-time delivery can reduce inventories and, to the extent that information such as shelf life, moisture, and freshness is available to a tracking device, enhance supply chain efficiency. One solution is smart packaging, which uses sensors or smart labels to monitor product quality and storage conditions. Some forms of smart packaging can trace tampering within the supply chain or alert a distributor/grocer/consumer to spoiled or contaminated food. Smart packaging is widely used in health care, and is increasingly finding its way into the food supply chain. More widespread use could meaningfully reduce spoilage and extend shelf life.

FoodTech

Technologies that aim to ensure food habits are sustainable, reducing the burden on the environment

The food industry has benefited from many technological innovations in recent years. As an example, Sufresca, an Israeli company, has developed edible coatings that extend the shelf life of fruits and vegetables and reduce the need for plastic packaging.

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Food for thought

Some FoodTech strategies to deliver more with less

Alternative proteins will continue to gain share

Strategies	Solutions
Shelf life enhancement	• Edible coatings
Alternative proteins	<ul style="list-style-type: none"> • Look-alike <ul style="list-style-type: none"> – Cell-based or lab-grown meat – Plant-based dairy, meat, fish, eggs • Non-look-alike <ul style="list-style-type: none"> – Products made from beans, soy, mushrooms, chickpeas – Algae and insects

Source - RBC Wealth Management

However, the most talked about innovations of the past few years are the development of plant-based proteins, which stand out for their much lower environmental impact. RBC Capital Markets explored the potential for plant-based proteins in a recent report titled “Uprooting tradition: What plant-based alternatives mean for the future of protein” from the RBC Imagine™ series. Concerns about the environment, personal health, and, to a lesser extent, animal welfare have escalated in recent years. A 2019 Euromonitor survey found that as much as 46 percent of consumers globally restrict their consumption of animal products. Developments regarding taste, availability, and price are increasingly enabling consumers to align their purchases with their values, and without compromising their lifestyles. For example, oat milk, once a niche product, is surging in popularity. It is now very creamy and able to froth, and is thus taking share from traditional dairy as well as from other plant-based milk, such as rice milk and soy milk.

Plant-based meat substitutes which replicate processed meat products, such as burgers, chicken strips, or sausages, are a particularly interesting innovation. These are often made by altering pea proteins or fermented mycoproteins, also known as fungal proteins, to recreate the texture and appearance of real meat.

Early evidence suggests that such plant-based products have a materially less environmental impact than livestock farming, which is responsible for a significant proportion of methane emissions and water usage (see our [SusTech article](#)). A University of Michigan study on Beyond Meat, a U.S.-based producer of plant-based meat substitutes, estimates that the production of one of the company’s identical meat substitute burgers uses 99 percent less water and emits 90 percent less GHGs than that of an equal-sized meat burger. Even allowing for the fact that so far the environmental impact data comes only from the manufacturers, it is unlikely, in RBC Capital Markets’ view, that plant products could ever have a greater environmental footprint than animal products.

The market share of plant-based meat is currently low, as consumers remain very discerning about taste in this “indulgent” category, according to RBC Capital Markets. Plant-based meat substitutes have only achieved low single-digit penetration, palling in comparison to plant-based milk, which enjoys a market share ranging from 10 percent to 15 percent in developed markets, and as high as 40 percent in Asia given the prevalence of lactose intolerance among people in the region.

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Food for thought

But its market share should increase, in our view. Accelerating investment and innovation are driving marked improvements in taste, availability, price, and convenience (e.g., easy to cook). The category grew by 12 percent annually in the two years to 2019, and given continued advances as well as consumer interest, RBC Capital Markets thinks brisk growth is sustainable, forecasting an annual growth rate of 10 percent until 2030.

Still, our national research correspondent notes that while market penetration should increase, it is unlikely to reach the market share levels that plant-based milk has achieved, at least in the short term. Milk, after all, is mostly a commodity while meat isn't.

Beyond this, cell-based or lab-grown meat has generated a lot of attention since news broke of the first lab-grown burger in 2013. This food product is grown in labs from animal cells but with a very low environmental impact and without requiring the industrial-scale slaughter of animals. Currently on sale only in Singapore, this type of meat is years away from commercialization elsewhere and isn't likely to have a large impact on the market in the short term.

Barriers to wider adoption of these meat "look-alikes" include the difficulty in replicating whole muscle cuts, with visible fat marbling and muscle fiber textures. The category has been successful mostly at replicating ground or processed products. The often substantial price premium that plant-based identical meat commands is another barrier, though costs should come down, in RBC Capital Markets' view, as supply chain capacity increases and producers scale and consolidate. Finally, while plant-based substitutes that look like meat are vegetable-based, they are highly processed, which somewhat tarnishes their "health food" credentials.

Other than these plant-based look-alikes, there are a number of products that are a substitute for meat but are not meant to taste or look like it. These derive from high-protein vegetables, such as beans, soy, mushrooms, and chickpeas, and have gained consumer acceptance in recent years, with the exception of the soy stand-in. An early leader in alternative protein, soy's market share has declined over concerns regarding potential allergenic and estrogenic effects.

Other protein-rich replacements to meat include algae- and insect-based alternatives, sold whole or in flour. But after years of promise, the new plant-based technologies discussed above make these two sources less compelling as a primary animal protein substitute. This is unfortunate as, according to a paper from McKinsey, insect protein is very efficient in converting feed into edible weight, requiring just over two kilograms of low-quality feed to produce one kilogram of live animal weight. By contrast, beef requires significantly more feed and of better quality (close to nine kilograms of feed to produce one kilogram of live animal weight).

In the long term, RBC Capital Markets thinks it's likely that the plate of the future will be a mix of traditional, plant-based, and cell-based meat. Depending on the proportion each achieves, cell-based could eventually pose a threat to the plant-based category, in its view.

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Food for thought

Animal protein will likely continue to dominate for now, however, especially as meat consumption increases in developing nations as standards of living rise. But plant-based proteins are likely to continue to gain market share as technology improves and prices fall.

So as not to be left behind, many food companies are making the required investments in alternative proteins. Those that saw the opportunity and acted on it early will likely benefit from a first-mover advantage with regards to recipe, processing technology, and relationship with distribution channels, be they retailers, food distributors, or even consumer goods companies. For global, multi-brand and multi-product food companies, plant-based alternatives have yet to make a sizeable difference to their operating performance, though in RBC Capital Markets' view, as the category expands, it should become more meaningful for sales growth and valuation. It points out that Nestlé's revenues are more than 200 times those of Beyond Meat, a pure play, plant-based alternative meat producer, but its market capitalization is only 50 times larger.

Feed off the changes

Feeding a growing population in the face of shrinking farmland worldwide and all-too common extreme weather events that wreak havoc on food production is an enormous task. Technological advancements in both the agriculture and food industries can help mitigate these problems. These two industries will see important changes over the coming years. We believe companies that innovate and bring their solutions to the mainstream and those that adopt new technologies early should be in a good position to reap the benefits of their forward-looking strategies.



Smart Cities, sustainable cities

With cities around the world facing increasing environmental pressures and infrastructure needs, the final article of the SusTech series focuses on metropolises that use high-tech solutions to manage the challenges of urbanization in the 21st century. As these Smart Cities enable urban sustainability, the companies and industries at the forefront of this transformation should see long-lasting channels of growth.



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With urbanization rates climbing, and world governments having set ambitious targets to reduce carbon dioxide emissions, pressure is mounting to make cities more efficient while limiting their impact on the environment. Cities account for more than two-thirds of global CO₂ emissions. Some have picked up the gauntlet and are using technology to help manage the challenges of urban sustainability. More efficiently run cities can improve productivity, reduce costs, and foster economic growth.

This trend toward smart, sustainable cities is being made possible by the confluence of necessity, government support, and technological innovation. The companies that provide solutions should enjoy tailwinds of secular growth.

Redefining cities

“With a municipal network of 500km of optical fibre, free WiFi routed via street lighting, and sensors to monitor air quality, parking spaces, and even waste bins, Barcelona has been at the cutting edge of testing the internet of things,” trumpets the Financial Times. Barcelona is one of Europe’s Smart Cities.

Smart Cities use technology to improve urban management, making everyday life easier and better for the people that live and work there, while optimizing the use of natural resources to minimize their environmental footprint.

More specifically, sensors collect data from across the urban landscape: traffic, transportation systems, air quality, waste management, hospitals, and law enforcement, among others. The data is stored, analyzed, and used to respond to challenges in real time.

Smart City solutions span a wide array of uses and services. They can offer more effective transport networks, better calibrated and less wasteful water supply, just-in-time waste management, efficient lighting and heating of buildings, and safer public spaces. This all may sound futuristic, but many cities we live in already have implemented some smart solutions, such as ride-hailing, municipal water leakage detection, intelligent traffic signals, telemedicine, and emergency response optimization.

SMART CITIES

Smart Cities, sustainable cities

Increasing urbanization

Rising urbanization rates, and the many challenges they create, are pushing city planners and authorities to increasingly adopt smart systems. Cities gobble up more than 60 percent of the world's energy and generate some 70 percent of global CO₂ emissions. With most governments having pledged to reduce national emissions, lowering the footprint of large cities is key. Moreover, deteriorating air quality causing health problems, lack of access to fresh water (particularly at times of flooding), overwhelmed waste management, and perennial congestion have long been critical issues and are becoming ever more pressing.

These challenges will only be amplified in the future. Global urbanization rates are expected to reach 70 percent by 2050, up from today's 56.2 percent, according to the World Economic Forum. India and China alone are expected to take in an additional 300 million and 400 million city dwellers by then, respectively. Urbanization in North America, already high at 83.6 percent, is anticipated to inch higher still.

West vs. East

Despite having many old cities with legacy infrastructure systems, Europe has long led the way in terms of Smart City projects, with its early adoption of a sustainable, environmentally friendly agenda and focus on public transport and urban infrastructure in general. A 2018 McKinsey report

Solutions in focus

Smart Cities technology implementations

Construction & engineering

Energy automation systems monitor and control energy consumption in homes and buildings, matching energy use to occupancy.

In **New York City**, according to the U.S. Energy Information Agency, half of the commercial buildings were built before 1980. New York State's Energy Research and Development Authority operates a cost-sharing program for building owners who invest in real-time energy systems capable of 15%–30% energy savings each year.

Retail

Smart retail systems automatically scan shopping carts as they leave the store, with payment via automatic deduction from the customer's bank account, or by smart card or smartphone app.

In **Toronto**, Canada's second-largest food retailer, Sobeys, has launched Smart Cart contactless shopping. Sensors enable customers to weigh and pay for items, bypassing checkout lines and saving time.

Transport

Congestion pricing applies road use surcharges during peak periods to reduce traffic congestion.

London, Singapore, Stockholm, and Milan have already implemented congestion pricing, and it will soon be introduced in New York City.

Smart parking systems monitor the availability of street parking and control parking meter rates according to location, time of day, and day of the week. Other solutions guide drivers to available parking spaces in real time.

San Francisco was one of the first U.S. cities to introduce smart parking, in 2011. **Calgary**, Canada uses a similar system. **Central London** offers Smart Park, an integrated package of technology that provides drivers with real-time information on unoccupied parking spaces.

Smart street lighting systems control connected streetlights remotely, and monitor lighting through centralized online applications.

Copenhagen has replaced half of its street lamps with 20,000 smart LED lights that brighten when cyclists, who represent half of commuter traffic in the city, approach. The lights are dimmed when streets are empty.

SMART CITIES

Smart Cities, sustainable cities

pointed out how intermodality, or combining different modes of public transport in a seamless travel experience, has been a focus of European transport strategy, and how electronic services such as ticketing systems have been driven by rapid technological development. From these, many Smart City applications have evolved.

A feature of Smart Cities in the West is that development is mainly bottom-up, with the private sector and citizens actively engaging in designing projects to improve the quality of life, drive economic growth, and safeguard the environment. For instance, in 2018 the Canadian federal government encouraged some 200 communities across the country to participate in a competition in which quality of life improvements could be leveraged through the use of technology. The Intelligent Cities program was then created with involvement from Rogers, one of Canada's predominant cellular and cable providers, and Blue City, a Montreal-based software company that focuses on intelligent road traffic management solutions. Local resident workshops were conducted to pinpoint needs and provide city officials with a roadmap to develop future traffic and public transit infrastructure.

Beyond the input and involvement of city dwellers, there also needs to be a cultural shift in the way cities are governed and operated, as well as for citywide technology platforms to be more open and not housed in “silos”

Solutions in focus, continued

Water conservation

Smart utility services encourage consumers to reduce water consumption with smart metering and digital feedback messages. McKinsey estimates smart solutions could reduce water usage by 15%–25%.

Cape Town, South Africa has reduced water use by 30% over the past 15 years, while its population has grown by a similar percentage.

Waste management

Just-in-time waste collection prevents the high volumes of rubbish generated in urban environments from accumulating.

Singapore was the first Smart City to experiment with this concept. In 2016, it installed solar-powered rubbish containers equipped with fill-level sensors and compactors that give them eight times the capacity of traditional bins. Each container also serves as an internet hotspot.

In **Seoul**, the use of similar receptacles reduced waste collection costs by more than 75%, according to the city government.

Health care

Infectious disease surveillance traces contacts with individuals who test positive for COVID-19. More than 45 countries have developed tracing apps during the pandemic.

China, together with Alipay and WeChat, introduced a system of health QR codes (machine-readable optical labels) in 200 cities that enables citizens to check whether they have been in contact with people who have tested positive for COVID-19. The app uses a “traffic light” design, with red suggesting the user should quarantine. Results of tests are shared with authorities.

Public safety

Predictive policing uses digital tools to anticipate crime before it occurs. The technology is controversial due to concern for the protection of civil liberties. McKinsey estimates predictive systems could reduce crime by 30%–40%.

London is moving towards adopting this approach, although the technology remains controversial and mask-wearing during the pandemic is making implementation challenging.

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that are unconnected and incapable of collaboration. When Los Angeles Mayor Eric Garcetti looked into implementing Smart City solutions, he found more than 40 city departments running on various disconnected technology platforms. GeoHub was created in 2016 to assemble more than 500 datasets from the city's departments, as well as from the county, state, and federal governments, to form a centralized business intelligence system. Shortly after its launch GeoHub was able to unearth insights into Los Angeles' public safety and infrastructure needs that allowed the city to manage resources and make better decisions.

In Barcelona, several silo-type models used by the city were dissolved: those where networks didn't communicate, where consumers were tied to inflexible contracts, or where the provision of services was outsourced to large operators with no government oversight of how resident data was collected or used. The responsibility for such data has since been transferred to the government to ensure privacy. Moreover, procurement of services was made transparent with a focus on small local companies.

Meanwhile, Smart City projects have proliferated in recent years in Asia, which is experiencing urbanization and digitization simultaneously. In countries with a strong central government, such as China or Singapore, Smart City development is usually top-down with the authorities formulating policies and providing funding. The focus tends to be on building up infrastructure and improving urban governance capability.

In places where the public sector owns many of the services, Smart Cities are highly developed with services, such as transport, power, telecoms, water, and waste management, all communicating with each other and collaborating. Links to smart buildings—residential, commercial, or industrial—ensure that Smart Cities are fully integrated. This interoperability, the seamless flow of data and technology, is a key requirement of a full-fledged Smart City.

Singapore is a case in point, having been consistently one of the top investors in smart systems, according to the IDC Worldwide Smart Cities Spending Guide. That the city also owns in one way or another public transportation and housing undoubtedly has helped as it reduced the complexity of the task.

China is also well-acquainted with the challenges of urbanization given it encouraged the rapid migration of rural populations to cities and saw its urban population triple to 900 million in the last three decades. This massive influx amplified already intense social pressures such as urban crowding, mass congestion, strained infrastructure, severe pollution, and a generally high cost of living. China turned to technology to mitigate some of these issues, establishing some 500 Smart Cities.

It may take several years for large legacy Western cities to reach such an advanced stage of Smart City development. It requires abolishing the silo mentality and nurturing collaboration among industries, as well as a willingness of local governments to improve infrastructure with a long-term view, as opposed to quick fixes. But the impetus for improvement is there and we are likely to see the implementation of more smart solutions, both in the East and the West.

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The enabling technology

At the core of Smart Cities is 5G, i.e., the fifth generation of wireless technology. 5G is a leap forward from its predecessor: its speed is up to 10 times faster than 4G; it has low latency, meaning there is only a minuscule delay of 1 to 1,000 milliseconds before a transfer of data begins following an instruction for its transfer; and it allows millions of Internet of Things (IoT) devices and sensors to be connected in a one kilometer square area—4G only allows a limited number of connections.

A number of technologies linked to 5G are needed to achieve advanced Smart City status, such as artificial intelligence (AI), blockchains, cloud computing, Big Data and edge computing, and, of course, the IoT.

For example, a city installs a large number of IoT sensors in order to detect traffic conditions. Once collected, the data are transferred through the 5G network. Blockchain technology can provide secure data transmission during this process. Traffic authorities then leverage edge computing analytics to analyze data in real time, and AI can efficiently sift through large quantities of Big Data to predict traffic flows and find practical solutions to congestion such as diverting traffic or altering traffic light sequences. The dataset is then stored on a secured cloud for future reference and analysis.

Technologies work together to enable Smart Cities

Glossary of technology terms

5G	Fifth-generation mobile network. Much more powerful than its 3G and 4G predecessors, it is designed to connect people and machines.
Artificial intelligence	Machines that are programmed to learn and solve problems like humans.
Blockchain	A digital ledger of transactions. It is a system of recording information that is difficult to hack because it is duplicated and distributed across its network of computers.
Cloud computing	The on-demand delivery of computer services such as data storage and computing power, without direct active management by the user.
Big Data	Large, complex datasets so voluminous and varied that traditional data processing software cannot cope with them.
Edge computing	Distributed computing system that brings computation and data storage closer to the sources of data. It can improve response times while saving bandwidth.
Internet of Things	Computer devices installed in cars, appliances, medical devices, etc. that connect wirelessly to a network and transmit and analyze huge amounts of data.

Source - RBC Wealth Management

The industries

There are a number of players and aspects involved in bringing Smart Cities into reality:

- 4G, 5G, and WiFi service providers and equipment manufacturers, which cater to the increasing demand for reliable high-speed connectivity; they transmit data collected by sensors through their systems

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- Communications infrastructure including the high-capacity telecommunications towers and data centers that facilitate edge computing
- Semiconductor manufacturers that make the sensors to collect data
- Software companies that manage devices and sensors and provide smart solutions
- Cloud storage companies that store the encrypted data
- Cybersecurity companies, which protect systems from hackers and attacks at every step throughout the process of collecting, transferring, processing, analyzing, and storing data
- Companies that provide building management systems to maintain and optimize facility operations including energy/water/waste management, reducing energy consumption
- Companies that enable the shift to smart grids and electric vehicles

All that glitters is not gold

While the allure of technology might be powerful, there are serious challenges to achieving Smart City status.

Legacy cities have significant hurdles as it is easier to start from a relatively blank slate than to upgrade antiquated infrastructure such as in New York and London. Newer cities in the Middle East and Asia are at a distinct advantage in this regard.

Very large populations are another burden and can make the adoption of some smart solutions more cumbersome. Smaller cities such as Helsinki (1.3 million people) or Zurich (400,000 people) can be more agile in the adoption of new technology. Globally, they ranked second and third, respectively, in the IMD Smart City Index in 2020.

Other challenges that are also major impediments include:

- **Lack of interoperability:** Bringing various systems together from different sectors to form a cohesive network is difficult, particularly if they are owned by different, at times competing, entities in the private sector
- **Data breaches:** High interconnectivity can make smart systems vulnerable to cyberattacks
- **Mishandling of private data:** Smart Cities collect data regarding resident location and lifestyle, so safeguarding privacy is critical; Sidewalk Labs, a subsidiary of Google's parent Alphabet, had to pull the plug on its plans to build a Smart City on Toronto's waterfront due to severe criticism from residents fearing "surveillance capitalism"
- **Lack of long-term planning:** Some cities are not taking into account the maintenance costs of smart solutions, nor are they anticipating how their needs may change over time

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One eye on the future

We believe the recent embrace of the green economy by several governments and prospective new public investments in infrastructure in the U.S. and Europe in particular make this an opportune time for cities to invest in their future and for city planners to respond to the ongoing challenges of urbanization. Large Western legacy cities such as New York and London are under pressure to upgrade their often creaking infrastructure and are moving in that direction.

Smart Cities have the potential to enable us to live and work in a safer, faster, more convenient way. They will require greater interconnection between different forms of infrastructure. Buildings will need to be connected with the grid, and an ecosystem of communicating infrastructure stands to offer more efficient, sustainable, affordable services to citizens.

Yet given the many challenges that remain, in the West, sporadic implementations of smart solutions (rather than the highly developed Smart Cities of the East) are more likely in the foreseeable future. So initially, we'll probably see Western cities becoming "smarter," as opposed to becoming outright Smart Cities.

As noted for the other SusTech themes that we've delved into this year, we believe the industries and companies that can deliver Smart City solutions will benefit from long-term, secular growth.

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Research resources

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